THIRD REPORT

STANDING COMMITTEE ON ENERGY (1993-94)

(TENTH LOK SABHA)

ENERGY FOR 90'S AND BEYOND: PROSPECTS, REALITY AND CHALLENGES

(Planning Commission, Ministries of Power, Coal, Petroleum & Natural Gas and Non-Conventional Energy Sources and Department of Atomic Energy)

Presented to Lok Sabha on
Laid in Rajya Sabha on

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INTRODUCTION

I, the Chairman, Standing Committee on Energy having been authorised by the Committee to present the report on its behalf present this third report on the subject "Energy for 90's and beyond: Prospects, Reality and Challenges." The task of examining the subject "Energy for 1990s and Beyond: Prospects, Reality and Challenges" and preparing a report on it was entrusted to a Sub-Committee.

2. The Sub-Committee held 15 sittings in all of which six sittings were devoted to recording of expert and official witnesses. The Sub-Committee also held in-house deliberations at nine of the sittings.

3. The Committee wishes to express its thanks to the Ministries of Power, Coal and Petroleum and Natural Gas; the Planning Commission, the Tata Energy Research Institute and the Confederation of Indian Industry for placing before it material and information in connection with the examination of the chosen subject. The Committee also wishes to thank in particular, the representatives of the Ministries of Power, Coal and Petroleum and Natural Gas, the Planning Commission and also Dr. Amit Mitra, Economist as well as the representatives of the Tata Energy Research Institute who appeared for oral evidence and placed their considered views before the Sub-Committee.

4. The report was considered and approved by the Sub-Committee at its sitting held on February 24, 1994 and adopted by the full Committee on 1st March, 1994.

5. The Committee place on record its appreciation for the work done by the Sub-Committee.

NEW DELHI;
2 March, 1994

11 Phalguna, 1916 (Saka)

JASWANT SINGH,
Chairman,
Standing Committee on Energy

PREVIEW

Energy is security; deficiencies in this critical strategic sector compromises national security. The major issues in the energy sector are absence of an integrated long-term energy policy; inefficiencies in energy supply and utilization; and unsustainable energy mix; acute scarcity of developmental capital; a lack of rational energy pricing; insufficient environmental considerations combined with demonstrable sectoral changes which are in line with reforms in the economic, industrial and investment policies of the Government. It is the view of the Committee that these issues are all critically inter-dependent.

The Committee holds that in the energy sector the overriding need continues to be for the enunciation of a long term strategy, leading to the adoption of an overall energy policy; a policy that is marked by an optimum economic utilisation of the nation's resources; is 'user-friendly' and duly accounts for the nation's special needs; is conscious of the debilitating consequences of a shortage of capital; a policy which combines growth in the energy sector with conservation; is uniform in its application throughout the union; is environmentally conscious so as to sustain development and which addresses itself simultaneously to correcting the existing imbalances and preparing for the first decade of the 21st century.

OBJECTIVES AND SCOPE

The country is at a juncture of development where it needs to take a close look at the direction of its present energy policy and to see how it can be reoriented for the future. The concern for sustainable development is becoming increasingly evident with attention being focused on the energy sector. The Committee on Energy accordingly took up the subject "Energy for 1990s and Beyond: Prospects, Reality and Challenges", for an indepth analysis.

This report of the Committee highlights specific issues related to the energy sector in India, with emphasis on future perspectives. A broad delineation of chapters is as under:

- Chapter I provides an overview of the energy sector today and in the future (up to the year 2010) and discusses critical issues in different energy demand and supply sectors.
- Chapter II gives a chronological account of the stated objectives of Government's energy policy *vis-a-vis* the reality.
- Chapter III contains a discussion on sectoral issues—both on the demand and the supply side—along with corrective measures that are required in each of these sectors.
- Environmental considerations in the area of energy are discussed in Chapter IV.
- The conclusions and recommendations including suggestions regarding institutional changes are both given in Chapter V.
- For a Parliamentary Committee a unique innovation in the form of a select bibliography is provided at the end of the report.

The report is a collection and synthesis of data inputs, written responses and oral evidence provided by various Ministries and the Planning Commission in response to the questions raised by the Sub-Committee. The viewpoints of private and non-governmental research organizations with expertise in the area of energy and environment have also been considered. The approach adopted by the Committee is qualitative rather than statistical.

CHAPTER I

OVERVIEW OF CURRENT AND FUTURE ENERGY SCENARIOS

Energy Resource Endowments

India is a developing economy faced with rapidly increasing population coulped with the problems arising out of industrialisation and rapid, unchecked urbanisation. Assured availability of economical energy is a pre-requisite for meeting additional needs of a developing country like India. Traditional fuels, characterised by low levels of efficiency (10-15%) still account for as much as 41% of the country's energy supplies.

A look at India's share in the world energy resources reveals that India is relatively poorly endowed in terms of commercial energy resources.

Table 1.1 : Proven energy reserves

	Unit	India	World	India as per cent of the World
Coal.	(bmt)	64.9	1078.1	6%
Oil	(Bbbl)	5.87	1000.9	0.59%
Natural Gas	(tcm)	0.735	124.0	0.59%
Hydropower	(MW)	94,000	n.a.	

The above table reveals that proven reserves of hydrocarbons are small, accounting for less than 0.6% of the global reserves. India is relatively rich in terms of coal and hydropower, but their exploitation is constrained by factors such as poor quality of coal, environmental concerns, and interstate water disputes in case of hydropower and non-availability of financial resources.

Energy Supply

There has been a significant change in the pattern of energy supplies with the share of commercial fuels increasing from 26% in 1950-51 to nearly 60% at present.

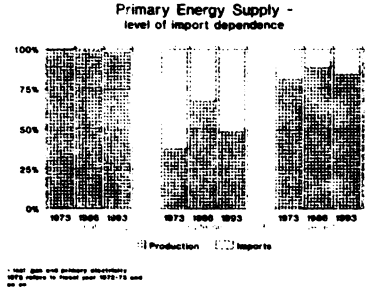
Domestic Energy Supply

The primary sources of energy available in India are coal, oil, natural gas, hydro and nuclear power. Even though coal dominates, persistent shortages of coal and power supplies during the recent past have led to substantial increases in the consumption of petroleum products (largely as

swing fuels). This can be attributed to the relative ease in importing oil and petroleum products, albeit at formidable economic costs. Natural gas is a relatively new entrant in India's energy sector and could make a significant contribution as a source of fuel and feedstock in a number of consuming sectors.

Table 1.2: Availability of primary sources of energy (mtoe)

	1972-73	1975-76	1980-81	1985-86	1990-91	1991-92	1992-93
Coal							
Production	41.6	53.7	55.9	75.6	103.7	112.43	116.72
Net imports	0.25	0.23	0.68	0.89	2.4	2.85	2.94
Crude oil							
Production	7.3	8.4	10.5	30.2	33.0	30.35	26.95
Net imports	12.1	13.6	16.2	14.6	20.7	23.99	28.75
Natural gas							
Production	1.3	2.0	2.0	6.9	15.4	15.98	15.59
Net imports	-	-	-	-	-	-	-
Hydro power							
Production	2.3	2.8	3.9	4.3	6.0	6.13	5.81
Net imports	-	-	-	-	-	-	-
Nuclear power							
Production	0.09	0.22	0.25	0.42	0.52	0.47	0.56
Net imports	-	-	-	-	-	-	-
Total							
Production	52.6	67.1	72.6	117.4	158.7	165.36	165.63
Net imports	12.4	13.8	16.9	15.5	23.1	26.8	31.69



The overall indigenous production of commercial energy in India increased from 53 mtoe in 1972-73 to 165.6 mtoe in 1992-93, at an average annual growth rate of about 6%. While coal accounted for as much as 64% of total energy availability in 1972-73, its share declined to 58-60% in the last 2/3 years. In direct contrast to this, the share of oil has increased (See Table 1.2). Interestingly, the share of natural gas has also increased from 2% to 9.8% during the same period.

Some relevant issues in each of the energy supply sectors are highlighted below:

Coal

The nationalization of the coal sector in early 1970s marked the beginning of a comprehensive programme for the development of coal mines in India. The production of coal increased steadily from 73 million metric tonnes (mmt) in 1970-71 to 238 mmt in 1992-93 with the exception of the period 1976-77 to 1978-79 when it averaged around 104-105 mmt.

A mere 19-20% of total coal produced in the country is of coking variety which is largely used in the steel industry. Non-coking coal accounts for about 80% of the total coal production, although the share of superior grade in total non coking coal is only 14%. The bulk of non-coking coal is directed for power generation and process heating in industries.

The major issues involving the coal industry are:

management of the industry by State agencies;

declining quality of coal, partly attributable to a greater deployment of opencast mining methods which result in the mixing of large quantities of extraneous matter and dirt along with coal;

growing dependence on imports of good quality steel grade coal following a decline in its indigenous availability;

economics of beneficiation of non-coking coal for use in power stations;

mismatch between demand and supply combined with inefficient distribution leading to accumulation of stocks at the coalfields;

infrastructural and administrative constraints in the movement of coal from the coal bearing regions to other parts of the country.

Hydrocarbons

The development of the indigenous oil industry has been an area of high priority since the mid-1970s, largely with the discovery of Bombay High offshore. The production of crude oil rose from 6.8 mmt in 1970-71 to 33 mmt in 1990-91, although it fell to 30.3 mmt in 1991-92 and to 26.94 mmt in 1992-93. The production of natural gas on the other hand, has increased significantly from 1,445 mcm to 18,644 mcm over the same time period. The increase has largely been due to accelerated production from the

Bombay High offshore basin, which accounted for about 62% of crude oil and 77% of gross natural gas produced in the country. However, the rapid strides in crude oil production witnessed in the first half of 1980s seem to have levelled out. After reaching a peak level of 34.09 mmt in 1989-90, crude oil production fell to 26.94 mmt in 1992-93; this was largely on account of the closure of over worked oil wells in the Bombay High region. Concomitantly, indigenous production as a percentage of total availability, which had remained steady at 63-65% in the 1980s, fell to less than 50% in 1992-93.

The major issues which need examination in this sector are:

— increasing dependence on imports of crude oil and pteroleum products;

— retardation in oil production resulting from flogging of wells in the initial rush of exploiting recoverable reserves;

— immediate attention to optimizing production of oil through
  — liquidating sick oil wells;
  — giving enhanced oil recovery schemes a time dimension;
  — development of offshore marginal fields;

— rationalisation of the production profile from refineries to meet the growing demand for middle distillates;

— provisions to encourage private capital participation in oil exploration, production, refining and marketing of petroleum products.

Primary Electricity

The potential for hydropower in India is placed at 94,000 MW. Although, hydro capacity increased from about 6,400 MW in 1970-71 to 19,340 MW in 1992-93, its share in total utility capacity fell from around 43% in the 70's to nearly 28% in the 90's. The thermal capacity, on the other hand increased much faster in this period (from 7,900 MW to 48,721 MW) thus raising its share from 54% to about 70%. The share of nuclear energy remained low and in fact, declined marginally from 2.8% to 2.5% over the same period.

Hydro generation increased from about 25,200 GWh (million kWh) to 69,776 GWh over the same time period and thermal from 28,200 GWh to 2,24,454 GWh. The corresponding increase for nuclear based generation was from 2,417 GWh to 6,759 GWh. Both hydro and nuclear power plants require large investments and have long gestation periods. These, coupled with environmental concerns associated with their construction and operation, have led to circumspection regarding their extensive exploitation. The field of nuclear energy is also stymied by the twin factors of low sectoral allocation and increased international interference.

The major concerns regarding the power supply system in the country are:

— the demand for power continues to outstrip its supply resulting in continued shortages of energy (10%) and peak electricity (19%);

— relatively low availability of thermal power plants due to unforeseen outages;

— low plant load factors of thermal power plants;

— low efficiencies of conversion of coal to electricity;

— high transmission and distribution losses (over 20% of total electricity generated);

— absence of power saving culture or incentives.

Biomass Resources

Although the share of *traditional energy* (fuelwood, crop wastes and animal dung) in total energy availability has declined significantly in the last four decades, their share was still as high as 41% in 1990-91. Thus, a discussion on the energy sector would be incomplete without making a specific reference to them.

The current production of *fuelwood* from forests, as estimated by the Forest Survey of India, is placed at 52 million m^3 (36 mmt). This includes the unrecorded production of fuelwood in the form of dead/dying and seasonally fallen wood, which is collected in the forests as head-loads. This, however, is on the lower side of the estimated sustainable yields, which vary between 36-43 mmt/year. In addition, the estimates from "unrecorded sources" which include supplies from private lands, gardens, trees around houses, shifting cultivation areas, are placed in the higher range of 30-80 mmt/year.

Thus, the total availability of fuelwood is placed in the range of 66-123 mmt/year. On account of the existing high pressure on forest resources, on substantial increase is expected in the supply of fuelwood in the decades ahead unless social forestry and afforestation acitivities are undertaken on a much larger scale. Alternatives to wood and its various uses have to be encouraged.

No reliable data are available with regard to the quantity of *crop residues* (straws, stalks, husk, leaves, fibrous material, roots and other parts of the plant material) used either as fodder or fuel. A rough estimate of non-fodder crop residues for the year 1989 is placed at around 140 mmt/ year. It is also estimated that the total *dung* available in 1989 was about 245 mmt (wet basis). No reliable data exist about how much of this valuable source of organic manure is used as domestic fuel, how much as manure, how much for other uses, or how much gets wasted.

Renewable Energy

Renewable energy sources remain a marginal contributor to the total energy supplies, especially to power generation. This continuing low contribution both due to and is reflected in the allocation of funds for the Eighth Plan (1992-97). Of the total Government outlays in the energy sector the power sector receives 69%; petroleum 21%; coal 9%, while the allocation for the renewables sector is only 0.8%.

A summary of major renewable energy devices installed till March, 1993 is given in Table 1.3 below:

Table 1.3 : Progress of various renewable energy technologies in India up to March, 1993

Programme	Cumulative achievement upto March, 1993
Family-size biogas plants	17.63 lakh plants
Improved cookstoves	145.06 lakh chulhas
Domestic solar water heating systems	12,517 systems
Industrial solar water heating systems	6,142 systems
Solar cookers	2,88,028 cookers
Photovoltaic (PV) water pumps	756 pumps
PV power units	408.86 kWp
PV community lights/TV and community facilities	719 facilities
PV domestic lighting units	14,594 nos.
PV street lights	29,198 nos.
Wind pumps	2,811 nos.
Windfarms (electric generators)	53.68 MW
Mini-micro hydro	93.44 MW

While the costs of renewable devices have been on the decline, they remain far too expensive for most applications. However, with an increasing concern about the environmental impact of conventional energy use, it is expected that renewable devices will play a much greater role in the energy sector in the years ahead.

The main issues which arise in this sector are:

— lack of definition in the specific role of renewables in the overall energy-mix of the country;

— identification of individual renewables for dissemination, demonstration and R&D as may be deemed appropriate;

— suitable mode and level of incentives which needs to be provided to renewables;

— low budgetary support resulting in low R&D effort, thus unsatisfactory economies in the use of renewable energy devices.

Energy import dependence

India is a net importer of energy, particularly oil. In 1992-93, the imports of energy accounted for about 16% of total commercial energy availability in the country. Net crude oil and petroleum product imports increased from 12 mmt in 1970-71 to 28 mmt in 1991-92. The value of imports of petroleum oil and lubricants increased sharply from a mere 9% of total export earnings to 78% over the decade 1970-71 to 1980-81, an increase which largely stemmed from sharp hikes in the international price of oil. Thereafter, this percentage declined to 19% in 1986-87 (an all time low for the decade) mainly due to softening of oil prices in the international market, only to increase gradually to a level of 27% in 1991-92. A disturbing aspect of this dependence are certain forecasts, which indicate that if all inputs remain unchanged this percentage could go as high as 75% by the year 2010. The consequences of such a development are self evident.

Energy consumption

While the overall consumption of commercial energy increased nearly 2.5 times from 54 mtoe to 130.6 mtoe over the period 1972-73 to 1991-92 (Annexure II), the per capita consumption increased by a factor of less than two, from 82 kgoe to 152 kgoe. This is very low as against the world average of over 1,500 kgoe per capita and even lower when compared to the levels prevailing in the high income countries. The situation would be different if one took into account traditional energy consumption. Among the factors which have contributed to this increase in energy consumption in India, economic growth and rapid urbanization are important in that they have not only increased the per capita demand for energy but have also brought about a shift from the traditional to modern and commercial fuels.

The share of industry in *total commercial energy* consumption declined from 62% to 60% and that of the *transport sector* from 25% to 22% in the 19 year period from 1972-73 to 1991-92. It may be noted that within the industrial sector the relatively larger decline in fuel consumption for energy purposes (from 55% to 51%) was partly offset by an increase in the demand for non-energy uses* (from 7% to 9%) over the period under consideration. As against this, the share of both *agricultural* and *residential* sectors increased from 1.4% to over 4% and from 8% to 10%, respectively, over the same period.

Table 1.4 : Trends in availability and consumption of commercial energy. 1972-73 to 1991-92

(million tonnes of oil equivalent)

Year	Gross availability	Conversion loss	Net availability / consumption (col 2-3)	Agriculture	Industry	Transport	Residential	Other energy use	Non-energy use
1972-73	68.483	14.396	54.087	0.78	29.717	13.579	4.533	1.542	3.936
			(100.0)	(1.4)	(54.9)	(25.1)	(8.4)	(2.9)	(7.3)
1980-81	92.623	23.859	68.764	1.625	36.861	17.443	5.637	1.901	5.297
			(100.0)	(2.3)	(53.6)	(25.4)	(8.2)	(2.8)	(7.7)
1982-83	109.023	28.552	80.471	1.861	44.225	18.758	6.82	2.127	6.68
			(100.0)	(2.3)	(55.0)	(23.3)	(8.5)	(2.6)	(8.3)
1984-85	121.51	34.997	86.513	2.131	46.595	20.309	8.038	2.341	7.099
			(100.0)	(2.5)	(53.8)	(23.5)	(9.3)	(2.7)	(8.5)
1986-87	141.187	40.927	100.26	2.807	53.423	22.789	9.532	2.677	9.032
			(100.0)	(2.8)	(53.3)	(22.7)	(9.5)	(2.7)	(9.0)
1988-89	163.606	52.621	110.985	3.861	56.214	26.055	11.532	3.684	9.639
			(100.0)	(3.5)	(50.6)	(23.5)	(10.4)	(3.3)	(8.7)
1989-90	179.929	64.947	114.982	4.297	54.338	27.685	12.327	3.605	12.73
			(100.0)	(3.7)	(47.3)	(24.1)	(10.1)	(3.1)	(11.1)
1990-91	187.592	63.026	124.566	4.782	61.861	27.995	12.559	3.906	13.463
			(100.0)	(3.8)	(49.7)	(22.5)	(10.1)	(3.1)	(10.8)
1991-92	193.663	63.037	130.626	5.571	66.653	29.279	13.109	3.401	12.614
			(100.0)	(4.3)	(51.2)	(22.5)	(10)	(2.6)	(9.7)

Note: Figures in brackets indicate percentage share.

*Non-energy use refers to the use of primary or derived energy products for non-energy purposes such as the use of naphtha, fuel oil or natural gas as feedstock in the manufacture of fertilizers or petrochemicals.

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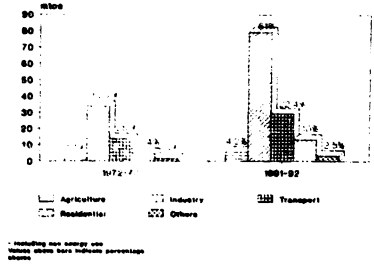
Trend in sectoral energy consumption



Between 1971-72 and 1991-92, the share of oil reduced marginally and was made up for by small increases in the share of electricity and natural gas.

Transport)

Industry

Despite a declining trend, the *industrial sector* continues to be the single largest consumer of commercial energy with its share at a little over 60%. This includes coal (both coking and non-coking), as also liquid fuels (such as naphtha, fuels oils, etc.) and natural gas for energy and non-energy uses. Within the industrial sector, coal is a predominant source accounting for a little less than three-fourths of energy use, followed by oil at 15%. Between 1971-72 and 1991-92, the share of oil reduced marginally and was made up for by small increases in the share of electricity and natural gas.

Transport

The transport sector is also a major energy consumer, particularly of oil. The share of oil in total energy consumed for transportation increased from 54% in 1972-73 to about 92% in 1991-92, while that of coal declined drastically from 44% to as low as 7% over the same period—this may be explained by an increase in diesel locomotion in the railways as also rapid increases in traffic (both passenger and freight) handled by roadways. In 1991-92, the transport sector accounted for 48% of the total consumption of petroleum products in the country.

Agriculture

Energy consumption in agriculture increased by almost six times from 0.78 mtoe in 1972-73 to 4.782 mtoe in 1990-91. This trend can be almost entirely ascribed to increased mechanization of Indian agriculture, both for land preparation and lift irrigation. Among the fuels consumed in this sector, electricity was dominant with its share as high as 88% in 1991-92, against 67% in 1970-71, followed by oil at 34% in 1972-73 and 10% in 1991-92. The balance is accounted for by the use of natural gas for tea plantation. The extensive programme of pump-set energisation coupled with heavily subsidized electricity has led to a rapid increase in the demand for electricity in this sector.

Domestic and commercial

The domestic sector accounted for about 10% of total final energy consumption at 13 mtoe in 1991-92 and commercial sector about 3.4 mtoe. Kerosene accounted for about 56% of domestic energy use in 1991-92 while its share was much higher at 67% in 1972-73. Simultaneously, the share of electricity and LPG increased from 8% to 23% and 5% to over 18%, respectively, during this period while that of soft coke has dwindled.

The above sectoral shares would be considerably different if the role of traditional fuels and draught power are considered. However, there is scarcity of exhaustive and reliable time series data on consumption of traditional energy in various economic sectors. Estimates prepared regarding traditional energy consumption are largely based on scattered micro level surveys conducted from time to time. In view of the high dependence on non-commercial fuels there is an urgent need to build databases and update them regularly. It will be worthwhile if the Central Statistical Organization undertook the task of collecting and collating such data as part of its regular Rounds of the National Sample Survey.

Projections of Energy Demand and Supply

Given the past growth rates and trends in the energy sector, this section estimates energy demand and supply for the terminal years of the Eighth and Ninth Five Year Plans, 1996-97 and 2001-02, respectively, as well for 2009-10. The projections have been made for two alternative scenarios:

(i) **Business-as-usual scenario.** This scenario is based on current Government thinking and takes it as the basis of projections.

(ii) **Conservation scenario.** This scenario takes into account the impact of specific energy conservation measures in energy production, conversion and end-use.

A summary of the assumptions made and methodology adopted is given in Annexure I. A brief discussion on the results is presented below:

Table 1.5: Scenario I: BAU (1996-97)

	Unit	Estimated demand	Estimated domestic availability	Estimated Gap[3]	
				Absolute	%
Coal	mmt	312.39[1] (311.0)	308 (308)	4.39 (3)	1.41 (0.96)
Oil	mmt	80.31 (81.37)	39.48[2] (47)[2]	43.28 (36.43)	53.89 (44.77)
Natural gas	bcm	19.79 (25)	22.33 (26.79)	-2.54 (-1.79)	-12.81 (-7.16)
Electricity	TWh	350.75 (335.84)	279.67 (335.84)	71.08	20.27

Figures in brackets indicate official projections for the Eighth Plan.
[1]Includes coal for power generation.
[2]Estimated in terms of petroleum product equivalent.
[3]Positive figures indicate deficit; while negative ones surplus.

Table 1.6: Scenario I: BAU (2001-02)

	Unit	Estimated demand	Estimated domestic availability	Estimated Gap[3]	
				Absolute	%
Coal	mmt	361.32[1]	370	-8.68	-2.40
Oil	mmt	102.38	47.25[2]	58.16	56.81
Natural gas	bcm	26.97	32.59	-5.62	-20.85
Electricity	TWh	455.00	426.52	28.48	6.26

[1]Includes coal for power generation.
[2]Estimated in terms of petroleum product equivalent.
[3]Positive figures indicate deficit; while negative ones surplus.

Table 1.7: Scenario I: BAU (2009-10)

	Unit	Estimated demand	Estimated domestic availability	Estimated Gap[3]	
				Absolute	%
Coal	mmt	505.66	573.29	-67.63	-13.37
Oil	mmt	156.77	66.5	94.78	60.46
Natural gas	bcm	48.25	60.97	-12.7151	-26.35
Electricity	TWh	705.70	703.13	2.57	0.36

[1]Includes coal for power generation.
[2]Estimated in terms of petroleum product equivalent.
[3]Positive figures indicate deficit; while negative ones surplus.

Table 1.8: Scenario II: Conservation (1996-97)

	Unit	Estimated demand	Estimated domestic availability	Estimated Gap[3]	
				Absolute	%
Coal	mmt	285.18[1]	308	-22.82	-8.00
		(311)	(308)	(3)	(0.96)
Oil	mmt	62.00	39.48[2]	23.87	38.50
		(81.4)	(47)[2]	(36.43)	(44.77)
Natural gas	bcm	18.55	22.33	-3.78	-20.35
		(25)	(26.79)	(-1.79)	(-7.16)
Electricity	TWh	316.69	299.69	17.00	5.37
		(335.84)	(335.84)		

Figures in brackets indicate official projections for the Eighth Plan.
[1]Includes coal for power generation.
[2]Estimated in terms of petroleum product equivalent.
[3]Positive figures indicate deficit; while negative ones surplus.

Table 1.9: Scenario II: Conservation (2001-02)

	Unit	Estimated demand	Estimated domestic availability	Estimated Gap[3]	
				Absolute	%
Coal	mmt	323.72[1]	370	-46.28	-14.3
Oil	mmt	81.43	47.25[2]	36.06	44.28
Natural gas	bcm	25.06	32.59	-7.53	-30.07
Electricity	TWh	414.32	470.85	-56.53	-13.64

[1]Includes coal for power generation.
[2]Estimated in terms of petroleum product equivalent.
[3]Positive figures indicate deficit; while negative ones surplus.

Table 1.10: Scenario II: Conservation (2009-10)

	Unit	Estimated demand	Estimated domestic availability	Estimated Gap[3]	
				Absolute	%
Coal	mmt	456.18[1]	573.29	-117.11	-25.67
Oil	mmt	115.55	66.5[2]	51.5	44.57
Natural gas	bcm	44.35	60.97	-16.62	-37.46
Electricity	TWh	643.76	756.33	-112.57	-17.5

[1]Includes coal for power generation.
[2]Estimated in terms of petroleum product equivalent.
[3]Positive figures indicate deficit; while negative ones surplus.

A persual of these results leads to following general conclusions:

In the BAU case the shortages in coal, oil and electricity are estimated to be of the order of 1.4%, 54% and 20% respectively at the end of the Eighth Plan period. These are higher, particularly in case of oil, than the scarcities predicted by the Plan document which are of the order of 1% for coal and 45% for oil, respectively. Moreover, the Plan predicts a balance between the availability and consumption of electricity, an assertion difficult to reconcile with actuality.

Again in the BAU case, the scenario changes marginally by the end of the Ninth Plan when the scarcity of coal could get eliminated while that of petroleum and would rise to 57%. The deficit in electricity would be reduced to about 6%. A similar trend continues up to the year 2009-10, when with the surplus of coal and deficit of oil increasing, electricity shortages could get reduced.

In the conservation scenario, the shortges of all the fuels would decline against the base case. These would result from a combined effect of demand management and supply efficient improvement measures (as detailed in Annexure III). In fact, a surplus of 8% would develop in the case of coal, while oil would still be in deficit supply by about 38.5% and electricity by about 5.4%.

The conservation scenario for 2001-02 projects significant surpluses of coal (over 14%) and electricity (over 13%) while petroleum demand continues to outstrip its supply by about 44%. Again, by 2009-10 these surpluses increase in the case both of coal and electricity while the scarcity of oil increases only marginally.

No firm conclusions can be drawn for natural gas demand in the years ahead. Future developments, would largely depend upon national policies relating to its production, trade, pricing and allocation. As of now, the unfulfilled registered demand for gas is estimated to be over 200 mcm/ day by the year 1996-97.

It is to be borne in mind that the estimates of demand and supply for 2009-10, along with the extent of gap between the two are only indicative numbers. Owing to paucity of reliable data for the terminal year 2009-10, no rigid conclusions can be drawn.

CHAPTER II

ENERGY POLICY

A comprehensive discussion of the energy policies of the Government would take us too far back in time, almost to the beginning of the planning process in India. Instead, this chapter concentrates on the developments in the last two decades and reviews the critical issues surrounding the national energy policy.

Even though there has been no firm macro policy for the energy sector, the Government of India approved the broad outline of a national energy policy in 1974 as enunciated by the *Fuel Policy Committee.* The policy emphasized maximization of efficiency of production and utilization of energy. Among commercial fuels, the policy wanted Coal to be the principal source of energy. The policy for oil was to reduce imports by increasing indigenous production as well as substitution by other energy forms wherever found economically viable. On the consumption side, the Committee identified the need to study and plan the growth of the transport sector, considering that it is the principal consumer of oil. It was suggested that attention should be paid to rural energy consumption. It was also felt that non-conventional energy sources, namely solar, geo-thermal and tidal energy should be developed, with priority assigned to solar energy and biogas. Moreover, the energy policy should be monitored and frequently reviewed in light of the developments in the energy sector.

Thereafter, the *Working Group on Energy Policy (WGEP), 1979* recommended curtailment of growth of energy demand and optimization of the fuel utilization patterns. Suitable policies for non-commercial energy sources and alternate energy sources should be explored and it was suggested that better management and marketing was required for commercialization of renewable sources of energy. With a view to achieving these goals, an increase in R&D expenditure in the energy sector was required with basic thrust on improvements and adaptation of existing technologies for conservation, development of more efficient technologies for utilizing indigenously available conventional energy and dissemination of renewables.

In the *Sixth Five Year Plan (1980-85)* the main elements of the energy strategy were accelerated exploitation of domestic energy resources, effective management of oil demand, conservation, exploitation of renewables and larger investment outlays for R&D in the emerging energy technologies.

In 1983, *the Inter-Ministerial Working Group (IMWG)* made specific suggestions with regard to energy conservation. The IMWG felt that the absence of coordination in the implementation of energy conservation programmes in the country as well as the lack of shouldering of responsibility for their implementation could be corrected by making imvestments and extending subsidies for energy conservation as a distinct programme. The Group suggested—introduction of an energy conservation cess on industrial energy consumption, constitution of a central agency to monitor energy conservation in the transport sector, a separate unit in the State Electricity Boards (SEBs) to deal with conservation in agricultural pumpsets etc. It was also suggested that all the large energy consumers should have energy conservation schemes as a part of their R&D programme.

Energy strategy to be adopted by the *Seventh Five Year Plan (1985-90)* aimed at an accelerated exploitation of coal, hydro and nuclear energy and intensification of hydrocarbon exploration and exploitation in line with the reserves position. The formulation of a national transport fuel policy was again stressed for managing the oil demand along with the need to plan for supply and utilization of the emerging natural gas potential. As in the past, the VII Plan also reiterated the necessity to use renewable sources of energy, especially to meet the energy requirements of rural communities; intensification of R&D efforts in this regard were also featured. Finally, the Plan intended to encourage public debate and ensure wider acceptance of the energy strategy for its successful implementation.

The high level *Advisory Board on Energy (ABE) (1985)*, constituted by the Government of India and reporting directly to the Prime Minister, made an assessment of the energy sector in the country. In view of the scarcity of capital, better supply and demand management was identified as a prerequisite to decrease energy intensity in the country. This could be brought about by Government action in rectification of agricultural pumpsets, in public sector industries, transportation as well as through inter-fuel substitution in various sectors of the economy. The Board also suggested a shift away from oil to natural gas and coal, especially so towards natural gas given the problems of transportation and the declining quality of coal. It advocated cross subsidies for the energy sector as a whole and cross financing amongst different fuels. It opined that there should be a movement away from oil to gas and to coal in the medium term and to renewable sources in the long term.

The following excerpts from *the Eighth Plan (1992-97)* document serve to indicate the Government's current policy in the energy sector.

"The physical infrastructure, particularly in the areas of energy, ... has traditionally been provided by the public sector. Since the scale of construction in these areas is very large and these are of direct and indirect benefits to large sections of society, *the public sector will continue to play a dominant role this area and will have the ultimate responsibility of meeting*

the demands. However, if private initiative comes forward to participate in creating such infrastructure like power plants, ... on *reasonable terms* and with full protection of people's interests, such initiative must be positively encouraged".

"Among the main components of infrastructure, energy needs particular attention during the Eighth Plan mainly because of the fast growing demand, the limits of our internal sources of energy and implications for balances of payment. The medium term energy plan has to be seen only as a component of a long term plan ... where strategies of fuel substitution and shifts from non-commercial sources of energy to commercial sources is clearly spelt out.

While planning for energy development, equal emphasis will have to be given to improving the performance of the existing plants by enforcing higher efficiency norms. Greater emphasis on developing non-conventional energy and on energy saving practices is also required".

"The goals in the energy sector, *inter alia,* envisage elimination of power shortages in different parts of the country, achievement of a minimum hydel share of 40% in the total installed capacity by the end of the Ninth Plan (1997-2002), restraining the growth in consumption of petroleum products without hampering economic development, elimination of the flaring of associated natural gas, stepping up the levels of output of coal and lignite, promotion of cost-effective technologies for the development of renewable and non-conventional energy sources and enlargement of the coverage of Integrated Rural Energy Project (IREP)".

The past two years have seen substantial changes in the policy regime. The reforms in so far as they have a bearing on the energy sector, involve:

changes in investment policies allowing, for instance, new participants to invest by providing financial incentives;

changes in taxes and duties, especially customs duties which have a bearing on both energy supply and demand sectors;

a move towards largely market determined prices for most goods (a concomitant reduction in the level of subsidies);

organisational/institutional changes including disinvestment in selected oil sector PSUs, setting up of joint-sector projects, etc.

The foregoing paragraphs constitute a discussion merely of the declaration of intent of the Government; these do not constitute an implementable energy policy for the country.

Specific Attempts Towards Energy Conservation

Energy conservation activities assumed importance in the aftermath of the first oil crisis in 1973-74, but no separate budget allocation was made initially in the Seventh Plan. The Petroleum Conservation Research Association (PCRA) was among the first Government agencies to take up

energy conservation schemes funded by the Oil Industry Development Board (OIDB), this was from 1976 onwards. A separate cell for energy conservation was created in the Department of Power (DOP) in 1986-87 and the Energy Management Centre (EMC) was established in 1989-90 for promoting energy demand management and energy conservation. In 1988-89 studies in six major energy intensive industries taken up by the Bureau of Industrial Costs and Prices (BICP) revealed considerable potential for saving energy. A special credit scheme was introduced with Industrial Development Bank of India (IDBI) providing funds for energy conservation schemes in industrial undertakings.

All the above measures have been sporadic, *ad hoc* and uncoordinated, having only a marginal impact. Realizing this a comprehensive National Energy Efficiency Programme (NEEP) has been proposed in the Eighth Plan. A target for saving 5,000 MW in the electricity sector and 6 mt in the petroleum sector have been set in the Eighth Plan. The NEEP is envisaged to cover financial arrangements including creation of a revolving fund, technical assistance, technology development, selective legislation and developing institutional capabilities. ***Considering the broad focus of the NEEP which covers all the energy consuming sectors the effect may get diffused. The Plan document does not elaborate on how the Government proposes to achieve the targets set for energy conservation or the institutional structure to carry out the NEEP. The financial allocation also seems to be incompatible with the broad scope and coverage of the programme.***

Distinct from the above statements of policy, some comments based on experiences from the energy sector need to be mentioned here.

It is the view of the Committee that:

the Government does not have a coherent, rational energy policy for the country which would also emphasize sustainability. The principal concern of the Government has been with a reduction in the gap between supply and demand with the balance of payment being a major constraint. The hefty injection of investible resources have been largely aimed at augmenting energy supply rather than attaining higher levels of efficiency and optimal resource utilization;

despite the Government's preoccupation with increasing energy supplies, extensive shortages of good quality coal, electricity and oil remain;

after years of planning and attempts at modernisation the supply systems continue to be inherently inefficient. To quote a few cases — existence of surplus manpower and low capacity utilization of equipment in the coal sector, low operating efficiencies and high T&D losses in power generation, flogging of oil wells leading to dwindling production, natural gas flaring etc.;

the energy policy has repeatedly laid emphasis on greater reliance on

coal and hydropower, the two relatively abundant energy resources. However, in the last two decades, the share of coal in total primary energy supply has gone down from about 64 to 61%, and that of hydropower in total utility capacity declined sharply from 43 to 28%;

despite the continuing importance being assigned to a greater use of non-conventional energy sources the attention to this area, in terms of both R&D and dissemination alongwith financial allocations, has been inadequate. The dissemination of renewables has been far from satisfactory since the organisational machinery entrusted with this task has been more concerned with meeting targets of numbers rather than involving the final users; this has led to poor operation and maintenance of these technologies;

the targets for energy conservation are not achieved because of the absence of a well defined plan of action, a suitable package of financial incentives and the needed institutional infrastructure to facilitate the implementation of such schemes;

energy will continue to be under the control of the public sector. Private sector participation in power generation, hydrocarbon exploration and supply though welcome will play only a subsidiary role.

The Committee is of the view that the Government does not have a well defined, coordinated and time bound plan adequately backed by financial resources for implementation in the energy sector. If the current policies of the Government are continued, there is little hope of meeting either the power needs or the overall energy needs of our growing economy. With 65% of electricity continuing to be generated from coal based thermal plants, the associated environmental impacts would be enormous. The Committee holds that if care is not taken at present, the economy would fall into a vicious circle of underdevelopment and debt trap with simultaneous extensive damage to our environmental resources.

Alternative strategies for sustainable development do exist in principle. These depend heavily on energy conservation and renewable energy utilisation. The potential for these is also singnificant. There is scope for reducing 20—30% in energy consumption in industries, agricultural pumpsets, and domestic appliances. ***Hence, it is clear that by suitable utilization of energy conservation methods and renewable energy technologies, it should be possible to achieve the goals of sustainable development, reduction in energy consumption and in controlling environmental damage.***

CHAPTER III

CRITICAL ISSUES IN THE ENERGY SECTOR

Supply Sectors

Coal

This Committee recognises that a more detailed study of the entire coal industry under the subject, "Modernisation and Growth of Coal Industry—A Critique" has also been undertaken separately. What has been attempted in, the current report under the holistic theme of Energy is a broad exercise to assess the entire energy sector. It is possible that upon a more detailed examination of various separate issues the Committee could consider recommendations with some variations.

The conventional energy supply systems are inherently inefficient, entailing large amounts of losses in production, conversion, T&D and transportation. Following is a discussion on some such issues alongwith suggestions for achieving an improvement in the performance of these sectors. Some of these suggestions have already been considered for implementation, but are reiterated.

Given the plateau in oil production in recent years and the enormous burden of foreign exchange outflows due to increased imports of oil, it is an economic imperative for India to continue with a policy that favours larger consumption of coal in the future. However, there are several vital issues and options which need to be considered and pursued in defining an enlightened coal policy for the future. Some of these issues are discussed below.

Stagnating production from underground (UG) mines

Inspite of large investments in various UG mining technologies, there has been no increase in production from them in the last two decades. The performance of longwall mining technology in UG mines has not been satisfactory due to problems related to technology absorption, indigenisation of equipment and spare parts, difficult geo-mining conditions, lack of suitable skills to utilise the technology. Being largely labour intensive, UG mining in India suffers from productivity. The mechanisation efforts in coal cutting and loading operations in these mines and coal transportation have not kept pace with the latest technological developments. Even after two decades of nationalisation, working conditions underground have not changed much. An increase in the average age of workers has adversely affected their productivity levels.

In light of the above, action needs to be taken to eliminate manual

loading of coal in UG mines. Although the Baveja Committee Report (1979) had recommended phasing out of manual loading in the subsequent five years, its implementation has been very poor. Introduction of trackless mining like joy loader+shuttle car+belt conveyer combination; continuous miner+belt conveyer or even simple chain conveyer in coal faces should be introduced. These mining methods, introduced in the 1960s, were gradually eliminated in the 1970s largely due to lack of proper maintenance and spare parts management and not necessarily due to geological conditions.

The Committee is of the view that the following measures are necessary for increasing UG production:

increase of OC mining rasises a question of environmental safety and other limitations. The only advantage of OC mining is low cost of operation.

*ntroduction of suitable scientific production method."

no replacement for natural wastage of work force;

*voluntary retirement of overaged workers;

*systematic training of workforce to upgrade skills;

*progressive mechanisation of mining and loading operations;

*opening up of medium and large capacity mines (especially in Jharia and Raniganj Coalfields) with high degree of mechanisation.

*adequate safety measures

*appropriate measures for stabilisation of mines.

*it should be mandatory for undertaking proper rehabilitation consequent on exploitation of any mine."

Problems of opencast (OC) mining

By and large, the OC mines in India are fully mechanised with average annual capacities having increased from 2 mt to 10 mt. The coal industry has acquired sufficient expertise in planning, designing, operation and management of medium to large capacity OC mines. Moreover, the equipment used in these mines is manufactured indigenously. Given the constrainst imposed by finance and technology for expanding UG mining, major increases in coal output in the future would come from OC mining. The induction of Heavy Earth Moving Machinery (HEMM) and adaptation of technology has been quite satisfactory in the OC mines. However, the capacity utilisation of equipment is low and needs to be enhanced. The prevailing workload norms of equipment in India are much lower compared to norms achieved in other countries and, in fact, even these are not adhered to in case of a majority of the OC mines. The problems of poor maintenace and spare parts management, lack of adequate workshop

*. Board and pillar mining, or room and pillar mining is an underground mining technology which involves developing rooms from large tunnels driven into the solid coal with intervening pillars of coal supporting the roof. The percentage of coal recovered from a minable seam depends on several factors, such as the number and size of protective pillars of coal thought necessary to support the roof safely, and the percentage of pillar recovery.

facilities, upgradation of skills of personnel and absence of proper work culture continue to afflict the OC mining operations.

Moreover, OC mining creates environmental problems such as those of land degradation and dust pollution which have been neglected in the past. This is an aspect that the future policy would have to come to grips with. Nearly 18,000 ha of land located in the Jharia, Raniganj and East Bokaro coalfields has already been damaged due to mining operations whereas land requirement for the Eighth Plan is estimated at 98,000 ha of which about one-fourth is forest land.

Surplus manpower in coal mining companies

The excess manpower in coal companies is estimated at more than 50,000. By enhancing and upgrading the skills of mine workers it would be possible to reduce this surplus and improve the financial performance of the coal companies.

Results of a preliminary estimate indicate that if productivity, as measured by output per manshift (OMS), in the older and less efficient coal mines is increased to the level of average OMS of new and more efficient mines, the reduction in costs per tonne of output could be in the range of 25—30%.

Problems of coal quality

Although India is endowed with large resources of inferior grade coal largely suitable for steam generation in industry and power sectors, availability of coking coal reserves required for metallurgical purposes is limited. The average quality of Indian coal has declined over the years; at present the production of inferior coal is higher than that of superior grades. This quality deterioration is a consequence of extraction from thick inter-banded coal seams by OC technology, where large quantities of shale and stone get mixed with coal due the deployment of large capacity shovels. Selective mining of coal seams has not been attempted due to high cost of operations.

Supply of coking coal for the steel sector

In recent years the demand for washed coking coal for steel plants has far outstripped its indigenous availability. Coking coal reserves which accounted fro about 25% of total coal reserves around two decades back now constitute only 15% of the total. The existing coking coal washeries, most of which are old, have been designed to beneficiate coal with an ash content of 22—24% with relatively easy to moderately difficult washability characteristics. Owning to worsening of coal quality on account of resource depletion the washeries are unable to meet the demand in terms of quality of supplies (< 17.5% ash content in coal).

A modernisation programme of coking coal washeries is presently underway in the old washeries, the benefits of which could largely accrue in the form of improved quality of coking coal supplies to the steel plants and possibility of reducing imports of coking coal from the present level of about 6.5 mt to around 2 mt by the year 2001-02.

Non-coking coal washing

Correspondingly the share of inferior quality non-coking coal in total coal production has increased substantially in the last two decades. This has led to problems of utilisation and ash handling in the consuming sectors. After many years of discussion the Government, in 1988, decided that coal to be supplied to power houses located at a distance of 1,000 kms from the coalfield would be washed to reduce its ash content to 34% from the level of over 40% (for Run of Mine coal). Five non-coking coal washeries with a total capacity of 24 mt. are under various stages of implementation for supply of washed coal to a few power houses. The principal advantages of such washing would be consistent quality of coal and savings in transportation cost. At the power house, this ought to lead to improved generation and lesser quantity of ash to be handled.

Several studies have clearly indicated the economic viability of use of beneficiated non-coking coal in power plants situated at long distances from the coalfield. Coal demand for power stations located beyond 1000 kms from the sources of supply is projected to be about 65 mt. in 1999-2000. It is estimated that if the non-coking coal washery capacity is to be expanded to 65 mt by 1999-2000 the investment required would be about Rs. 1,3000 crore. In view of the financial constraints faced by both the power sector and the coal sector, there is a clear case here to prepare alternative financing models inclusive of the participation of private capital.

The resultant benefits would accrue in the form of savings in rail carrying capacity and could be of the order of 18 mt/annum of coal by 1999-2000. In addition, the anticipated improvement in the PLF of thermal power plants, resulting from the use of a low ash and uniform quality coal, could be about 5—10%. The viability of beneficiation would improve considerably if the rejects from the beneficiation plants are utilized in Fluidised Bed Combustion (FBC) boilers to generate electricity.

The Committee are thus of the view that future investments should thus concentrate on the establishment of pilot plant facilities at select locations on:

characterisation of Indian coals from different coalfields by the degree to which they can be beneficiated;

assessing the different technologies available and their costs,

developing improved coal washing technology suitable for Indian coals.

Introduction of clean coal technologies

An important need is to upgrade the existing technology and ensuring large scale deployment of clean coal technologies in the years ahead. While a majority of R&D efforts in the past directed towards mining and

production of coal, inadequate attention was paid to coal utilisation technologies. This may have resulted from the fact that such efforts have generally been far removed from the coal industry itself, and the coal supply organisations have by and large not shown adequate interest in demand side technologies. However, in view of the substantial quantity of coal projected to be used in the future, a clearcut strategy for coal use technologies becomes paramount. It is felt that a two pronged strategy would be needed. One, which would involve upgrading of existing technologies and retrofitting of existing equipment and devices. It has been estimated that there are over 10,000 boilers which need to be replaced or retrofitted with efficient combustion systems and which would result in an annual coal savings of 5-6 mt and also involve lower emissions. The second has to be based on a more pro-active approach which would result in the evolution of efficient coal technologies that are also environmentally benign.

As for retrofitting, the problem is largely one of establishing institutional arrangements which would encourage investments in technology upgradation. ***The Committee holds that for a suitable R&D strategy, a coordinated technology development plan with a time frame of 15—20 years and involving a number of competent institutions and organisations both in India and abroad would have to be launched. The components of such a programme would comprise coal beneficiation, coal gasification, pressurised fluidised bed combustion (PFBC) and integrated gasification combined cycle (IGCC).***

Coal gasification

The share of coal produced from opencast mining (using both the shovel and dumper and dragline techniques) has increased steadily, reaching a level of about 64% in 1989-90, it being anticipated that its share will stabilize at around 73% by the year 2004-05. With declining quality of coal coupled with mixing of large amounts of extraneous matter, it is anticipated that coal supplied to power plants will contain more than 40% ash in the coming years. ***The Committee holds that the need to develop technologies for effective utilisation of indigenous coal reserves in India for the production of a fuel which can be used in the industrial and domestic sector as well as for pollution-free electricity generation cannot be overstated.*** It is extremely important to continuously upgrade coal utilisation technologies in order to minimise energy costs and environmental damage. IGCC is one such technique, the commercialisation of which would depend on the rate of transfer or development of technology in India and its diffusion. Demonstration units can be set up in one of the existing pulverised coal power plants where upstream facilities for coal, downstream facilities for hot gas and disposal system for slag, slag-gas and effluents already exist. The committee recommends a consideration of this by the Government.

Coal consumption in the domestic sector

Use of coal in the domestic sector is currently a neglected area. Technologies for manufacturing soft coke are obsolete, there is no marketing infrastructure, and efficiency of cooking stoves has received little attention. This, coupled with a pricing policy which is unremunerative for the producers. has led to dwindling production of soft coke. Supply shortages along with poor quality fuel and inconvenience in its use have led the consumers to substitute it with kerosense (which is imported at the margin) and fuelwood (with adverse environmental implications).

In 1980s a simple technology was developed by the Central Mine Planning and Design Institute (CMPDI), Ranchi to produce Special Smokeless Fuel (SSF). Its impact, however, is yet to be felt in the market, perhaps partly because regular supply of desired quality coal to these units has not been ensured.

At present, the annual coal consumption in the domestic sector is about 1 mt. and is said to meet the requirements of about 2% of the population. *The Committee suggests that medium coking coal reserves should be utilised to meet a much larger fraction of domestic energy demand. The target groups could be low income urban households, small hotels, commercial establishments, shops and households in hilly regions (for space heating).* If 7% of the population uses coal be the year 2000, and 10% by 2004-05, its demand could be about 15 mt and 19 mt respectively. To achieve the above targets, it is imperative that briquetting and devolatilisation technologies are dveloped and promoted as a National Technology Mission. The Committee recommends that SSF/ briquette units should be largely set up in the private sector, although the public sector coal companies should ensure the supply of desired quality of coal to these units.

Pithead coal stocks

Coal stocks at the pithead have mounted steadily in all the Plan periods; this is considered wasteful since it blocks scarce resources. in order to ensure that pithead stocks are reduced to a reasonable level, action is required in the following areas:

- increase in coal production only from areas having adquate rail links;
- improvement in the quality of coal despatches;
- performance monitoring of mines including in items like quantity of saleable coal produced, and sales realisation.

Coal movement by road

The transport of coal by road has been increasing and has reached a high level 40-42 mt, which is nearly 20% of total coal moved. This needs to be examined and an action plan to be drawn up to reduce this share.

Performance of alternative modes of coal transportation like ropeway and conveyor belt have not been satisfactory and should be improved. These modes of transportation largely catering to all the potential consumers near the mine-heads need to be expanded.

Budgetary support

The cumulative investment of the Government during the last two decades (1973-1992) in the coal sector is of the order of around Rs.15,000 crore. This had been towards new projects, reorganisation projects, running existing mines and infrastructural facilities like workshop, washeries, railway sidings. The return on capital invested has been poor due to various reasons including an ineffective pricing system and low productivity of machine and labour. The coal industry has always been heavily dependent on Government's budgetary support for its investments, this support being as high as 98% of the total outlay till 1984-85, though it was subsequently reduced to 80% in the Seventh Plan. As per the new policy, this budgetary support has been further reduced to a mere 19% during 1992-93, and will be totally phased out by the end of the Eighth Plan. Thus it is estimated that a resource gap of about Rs. 5,500 crore would emerge for the development of Eighth Plan project and Ninth Plan new starts, If this amount is not mobilised by the coal industry, the production plans in the Ninth Plan would be adversely affected.

- *The Committee, therefore, recommends for consideration the following changes:*

- reclamation of land should be carried out concurrently with mining. Effective institutional arrangements need to be made for ensuring this, preferably through a body with statutory powers. This body could also monitor reclamation of abandoned mines especially in Jharia and Raniganj coalfields;

- a phased approach for establishment of coal beneficiation facilities should be followed and specific time targets established and notified after which non beneficiated coal would not be moved beyond a certain distance. Establishment of coal washeries at pit-heads would require large investments and for this purpose, the private sector could be brought in to operate these washeries in a viable and efficient manner;

- the introduction of clean coal technologies in general, requires major information dissemination and educational effort. The economic benefits of improved technologies would not only have to be quantified but the methodologies for such assessment made transparent and convincing the concerned;

- Coal India Limited has to play a major role in achieving the modernisation and growth plans of the coal industry. It should accordingly shift its emphasis to implementation of long-term policies

rather than on day-do-day monitoring of subsidiary companies activities.

Hydrocarbons

Hydrocarbon exploration

Since the fourth round of bidding in September, 1991 around 160 onshore and offshore blocks have been offered to the private parties. Of these, only about 4-5 contracts have been signed or are expected to be signed. It is thus clear that the number of contracts to be signed would be grossly disproportionate to the number of blocks offered. Participation from private capital is required to supplement the efforts of public sector enterprises due to three reasons, (i) India's self-reliance in oil fell from 70% in mid 1980s to 50% in 1991-92 and needs to be increased, (ii) there is an acute crunch of budgetary resources for hydrocarbon exploration and production activities, (iii) India is an under-explored country. However, going by the present experience, private participation in oil exploration is unlikely to be significant, at least in the short term.

The Committee, therefore, recommends:

•*that the administrative machinery for organising and conducting the bidding process needs to be defined, strengthened and the process made more commercially efficient.*

•*negotiations should be conducted and contracts should be finalized without delay. For this it is important that the decision making body is suitably empowered to take timely and objective decisions on the bids submitted by parties. Interministerial interactions in this regard resulting in inordinate delays in decision making should be avoided.*

•*there is need to re-examine the need for continuation of the bidding rounds. Unless additional incentives/information are provided, future rounds of bidding inviting private sector participation for the same block are likely to evoke only declining interests. The alternative of continuous basis rather than rounds needs to be examined.*

•*Indian Private Companies that have been given exploration rights be encouraged to develop available blocks and should not be placed at any disadvantage vis-a-vis, foreign companies. The entire process of awarding blocks must be wholly transparent.*

Till such time as the benefits of private sector participation start flowing, the only option is to rely on our national oil companies (ONGC and OIL) for intensifying exploration efforts. For this appropriate policy instruments are necessary. The price of crude oil paid to the national companies has remained constant for a long period, thereby leading to declining or unstable profits on account of rising costs. A more remunerative crude oil price paid to ONGC and OIL could help in the generation of additional internal resources that could be channelized to a properly devised exploration programme. The consequent short-term effect on prices could

be taken care of by adjusting taxes and duties. In the long-term, the best insurance against oil price increases would be a greater production of hydrocarbons, which is impossible without greater exploration efforts.

As regards the statues of implementation of the recommendations of the P.K. Kaul Committee, the Committee observed that the Government have so far accepted only three recommendations. The Committee urge that the remaining recommendations of the Kaul Committee be considered for an effective implementation. It is also recommended that the Directorate General, Hydro carbons is strengthened and made more effective."

Enhanced Oil Recovery (EOR) Schemes

Having reached a peak level of 34.09 mt in 1989-90, the domestic production of crude oil in India fell to 26.94 mt in 1992-93; the production target for the current year being not very much higher at 27.17 mt. This retardation in production, caused by closure of over-exploited oil wells, has led to higher reliance on imports of crude oil. In the light of this, Enhanced Oil Recovery (EOR) techniques, aimed at tertiary recovery from depleting and sick well and improving well productivity, have gained speical significance.

Available data for ONGC indicates that funds have been earmarked for an additional recovery of a mere 0.82 mt of crude oil during the entire Eighth Plan period. Althought, for the Nineth Plan period. Although, for the Nineth Plan it is proposed to recover an additional 3 mt of crude oil by EOR schemes, detailed plans, including financial commitments, are yet to be made for that the *Committee holds here is a clear case for stepping up the planning and implementation of schemes for EOR.*

Refining capacity

The refining capacity at the beginning of 1993-94 was 52.75 million tonnes per annum (mtpa). In addition, a capacity of 16.8 mtpa is planned to be added during the Eighth Plan period. Besides, there are proposals at various stages, in the public sector, joints sector and private sector for adding another 50 mtpa capacity. The interest evinced by private parties is a new development for the refining industry. However, if all these proposals were to materialise, it would lead to a refining capacity of around 120 mtpa by the turn of the century. Since the domestic crude oil production by that time will be only around 50 mtpa, large imports of crude oil would then necessary to run the refineries at capacity. On the other hand, demands for all petroleum products is not likely to exceed 100 mmt by the end of the Ninth Plan. Consequently, there could be a surplus availability of petroleum products in the country, particularly of fuel oil and possibly of naphtha. Exporting petroleum products after refining imported crude oil is not an economic proposition. As per the present policy, the marketing or petroleum products from these refineries in the joint private sector would be in accordance with the administered pricing scheme and would be channelised through existing public sector oil

companies. A related question that would then arise is— whether the present system of assured refining margin (as part of the present administered pricing system) would continue for these new refineries even if there was no domestic demand for the products. (if, on the other hand the entire question of refining margin is left to be determined by market forces, this would involve moving away from the present system of administered prices). *The Committee thus, holds that the Government should clearly bring out the approach that is sought to be followed, in the medium term, to effect a possible transition from the present system of administered prices. If, on the other hand, the current pricing system with assured returns is to continue, its implications need to be studied carefully in the face of a possible surplus refining capacity. Irrespective of whether the proposed refining capacities materialise or not, the present policy of retention prices for refineries needs to be reexamined.*

Reduction in refinery losses

The standard fuel and product loss percentages prescribed by the Oil Prices Review Committee (1989) vary from 4% to 10% with an industry-wise average loss of 6.84%. It is estimated that for every incremental reduction in technical fuel losses in refineries by one percentage point, the additional benefits would be of the order of Rs. 122 crore/annum for the refinery sector as a whole.

On the basis of the past date on investments made for energy management measures, it is estimated that achievement of the above target (of one percentage point reduction) would cost about Rs. 330 crore, with a pay-back period of less than three years. This area needs particular attention.

Product pricing

Since private parties have been allowed to market LPG and kerosene, there will be two prices for the same product at the same location. While dual pricing has been a part of the Public Distribution System (PDS) in the country, considerable supply distortions take place wherever there is dual pricing. In any case, LPG is not supplied through the PDS. The possibility of serious supply distortions and malpractices cannot be ruled out when such dual pricing is introduced for LPG and kerosene. The recent decision of the Government to increase the price of LPG by Rs. 15 (a hefty 18%), together with a drastic cut in the customs duty on its imports from 85% to 25% was largely aimed at encouraging private marketing of LPG besides reducing the overall burden of subsidy.

The Committee are of the view that the implications of a dual pricing for LPG should be properly examined for ensuring a stable price regime that will also take into account the market forces, apart from any other pricing objectives that the Government may lay down.

Compressed Natural Gas (CNG) for transportation

Natural gas in the form of CNG can substitute both petrol and diesel. A vehicle running on petrol can be retrofitted to run on dual fuel mode. In case of diesel, the retrofit allows the vehicle to be driven on a mix of the two fuels, but not on either fuel alone. The extent of diesel substitution could vary between 30-90%. Vehicles can also be manufactured to run exclusively on CNG.

A broad break-up of the petroleum product consumption by the road transport vehicles is as shown below:

HSD-17.0 mmt

Gasoline (4-stroke vehicles)-1.4 mmt

Gasoline (2-stroke vehicles)-2.2 mmt

While it is not feasible to convert 2-wheelers powered by 2-stroke engines to run on CNG there are major problems to be overcome for successful commercialization of CNG for other categories of vehicles as well. These are:

the price of CNG at retail outlets is more than the price of HSD. So substitution of HSD by CNG is economically not feasible with the existing pricing structure;

even if CNG is made available at a competitive price, the market penetration will still be limited due to the lack of infrastructural facilities, such as

(i) absence of an extensive gas pipeline network,

(ii) absence of indigenous expertise to manufacture certain components of the conversion kit,

(iii) absence of a network of servicing centres to do vehicle retrofitting and provide servicing of the converted vehicles.

The current market price of replacing diesel by CNG is higher. However, a more rational pricing of substitute fuels, based on their real resource cost of supply, will considerably improve the replacement value of natural gas as a substitute fuel. In addition, the environmental benefits associated with its use necessitate establishment of CNG facilities and its use in environmentally stressed metropolitan cities.

Recently, the Gas Authority of India Ltd. (GAIL) has commenced field trials to develop the use of CNG in the transport sector. A tieup with the Delhi Transport Corporation (DTC) was negotiated to convert 10 buses to a diesel-CNG mix. The demonstration project aimed at building confidence in the transporters and other authorities with respect to CNG-powered vehicles involved 3 major activities, viz. (i) construction of refuelling facilities, (ii) conversion of diesel powered vehicles into diesel-CNG mix, and (iii) the field testing of these vehicles. Similar attempts were made by

the Oil and Natural Gas Commission (ONGC) in Gujarat and by MRL in Tamil Nadu to conduct trial runs for buses, while Indo Burma Petroleum (IBP) is conducting such trials on cars and trucks in the north-eastern state to Tripura.

Since natural gas retrofits require heavy front-end investment, commercialisation should be initiated only in those areas where gas supplies are easily available. Commercialisation would require infrastructural provisions in terms of local distribution network and hence its development could be in line with the city distribution network. This tie-up with the local distribution network would help in reducing pipeline investments.

To begin with, it would be advantageous to concentrate on the urban public transport where most of the vehicles use diesel for substitution by CNG largely because of the:

present low share of petrol in the transport sector as compared to diesel;

deficit of diesel relative to demand, and

organizational advantages of replacing diesel as buses and taxis tend to be concentrated in fleets This implies that each CNG fuelling station will be able to cater to a large number of vehicles, assuring it a sizeable market. This, in turn, justifies investment in fuelling stations and gas pipelines.

To increase penetration and thus the market share of these vehicles, active participation from gas companies would be needed on a continuous basis. Also, awareness of the concept and expected fuel cost savings needs to be increased. Inadequate post-conversion follow-up and support in terms of proper servicing of vehicle and refuelling stations would also hamper penetration.

Power

Power shortages

On an average there exists 7-10% deficit in energy and 12-20% in peak demand. These being average figures, the power cuts in some regions are as high as 45%. The shortages emanate from a gap of about one percentage point in the growth of supply and demand. While there are heavy shortfalls in capacity creation, there is rapid growth of agricultural and domestic loads leading to shortages.

Low thermal efficiency of conversion of coal to electricity

The efficiency of conversion of coal to electricity in the Indian thermal plants is very low (in the range of 28-30%). With a view to decrease coal burning, which would also entail lower CO_2 emissions, it is necessary that the efficiency of thermal plants is enhanced to 35%, 40%, and 47% in stages by adoption of advanced technologies. An improvement in the

Table III.1: Power requirement, supply and deficit/surplus (GWh).

Region	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93*
Northern region									
Requirement	44722	48504	55006	62891	65514	74243	79790	87219	84810
Availability	38471	43303	49807	55801	61629	69960	75520	81952	79861
Surplus(+)/Deficit(−)	(−)6251	(−)5201	(−)5199	(−)7090	(−)3885	(−)4283	(−)4270	(−)5177	(−)4949
Surplus(+)/Deficit(−)%	(−)14	(−)10.7	(−)9.5	(−)11.3	(−)5.9	(−)5.8	(−)5.4	(−)5.9	(−)5.8
Western region									
Requirement	46430	51311	57694	63135	66612	74737	81423	89393	85338
Availability	46118	50595	55263	60024	64872	72787	78502	85208	80464
Surplus(+)/Deficit(−)	(−)312	(−)716	(−)2431	(−)3111	(−)1740	(−)1950	(−)2921	(−)4165	(−)4874
Surplus(+)/Deficit(−)%	(−)0.7	(−)1.4	(−)4.2	(−)4.9	(−)2.6	(−)2.6	(−)3.6	(−)4.7	(−)5.7
Southern region									
Requirement	39729	45535	51178	55286	59931	65422	70658	75015	71905
Availability	39810	41598	45536	45927	64872	72787	62982	67248	64816
Surplus(+)/Deficit(−)	(+)81	(−)4237	(−)5642	(−)9359	(−)8250	(−)8702	(−)7676	(−)7776	(−)7089
Surplus(+)/Deficit(−)%	(+)0.2	(−)9.3	(−)11.0	(−)16.9	(−)13.8	(−)13.3	(−)10.9	(−)10.4	(−)9.9
Eastern region									
Requirement	22957	23643	26549	27560	28685	30598	32745	34075	32605
Availability	18982	20376	21860	24205	25354	26006	26678	28941	26640
Surplus(+)/Deficit(−)	(−)3975	(−)3276	(−)4689	(−)3355	(−)8250	(−)8702	(−)6067	(−)5134	(−)5965
Surplus(+)/Deficit(−)%	(−)17.3	(−)13.8	(−)17.7	(−)12.2	(−)11.6	(−)15.0	(−)18.5	(−)15.1	(−)18.3
North-eastern region									
Requirement	1594	1753	1929	2121	2452	2762	3016	3382	3387
Availability	1632	1690	1810	2019	2373	2678	2878	3083	2853
Surplus(+)/Deficit(−)	(+)38	(−)63	(−)119	(−)102	(−)79	(−)84	(−)138	(−)299	(−)534
Surplus(+)/Deficit(−)%	(+)2.4	(−)3.6	(−)6.2	(−)4.8	(−)3.2	(−)3.0	(−)4.6	(−)8.8	(−)15.8
All India									
Requirement	155432	170746	192356	210993	223194	247762	267632	288974	278045
Availability	145013	157262	174276	187976	105909	228151	246560	266432	254634
Surplus(+)/Deficit(−)	(−)10419	(−)13484	(−)18080	(−)23017	(−)15673	(−)17930	(−)21072	(−)22542	(−)23411
Surplus(+)/Deficit(−)%	(−)6.7	(−)7.9	(−)9.4	(−)10.9	(−)7.7	(−)7.9	(−)7.9	(−)7.8	(−)8.4

*April 1, 1992 through Feb. 28, 1993.

Source: Current Energy Scene in India, May 1993, CMIE.

thermal plant efficiency from 30% to 35% brought about by increasing the existing level of boiler efficiency from 80% to 86% and reducing the turbine heat rate from bout 3,000 Kcal/kWh to 2,400 Kcal/kWh, can reduce coal consumption by about 0.04 kg/kWh and of oil by 3 ml/kWh. For a 100 MW thermal capacity, the savings would be Rs. 1.5 crore per year.

Since the above mentioned improvement can be brought about by means of better housekeeping, better process control and better training of operators, the costs involved would be nominal.

Poor technical performance

While over the last 8-10 years, the technical performance of the thermal stations of SEBs has improved, there is still considerable scope for improvement. It is possible to improve considerably the plant load factor, peaking capability and the system load factor.

Renovation and modernization (R&M) programme

The impact of an R&M programme aimed at improving the PLF by 7 percentage point (from 45% to 52%) for about 201 units with a total installed capaciety of 19,980 MW, were worked out. It is estimated that this measure would generate an additional 12,264 GWh of energy, bringing in an additional revenue of Rs. 1,226 crores in the year 1996-97.

Due to improved capacity utilization, the savings in additional capacity from this measure would be of the order of 2,650 MW (Rs 8,000 crores) against an investment expenditure of Rs. 1,462 crore on the R&M schemes. Apart from undertaking R&M, life extension and uprating of plants should be done on a priority basis by allocating adequate funds for this activity, becausc the life extention schemes for power plants have to be undertaken in totality and not in partial or piecemeal manner.

Reduction in partial outages in thermal plants

Optimizing the plant operations and maintenance can result in reduced levels of partial outages and the peak lod capability of power plants can be raised from 57% to 63%. The cost of such a measure would be about Rs. 100 crore and the benefits would accrue in the form of an increase in installed cpacity by about 5,543 MW involving investment savings of about Rs. 16,500 crore. This activity will have to be undertaken by the SEBs. The Committee recommends serious consideration of this measure.

Performance of plant and equipment

Although the performance of 210 MW units which form the backbone of the system has improved considerably, the earlier 110 and 120 MW Units which are 60 in number operate at plant load factor of 40—45 per cent. This pulls down the PLF of the states in which these units predominate. The Committee recommends that BHEL should pay urgent attention for rectification of the generic defects in these units.

Table III.2 : Annual utilization (%)

	Hydel	Thermal*	Nuclear	Total
1970/71	35.62	39.56	57.55	37.95
1975/76	39.32	39.95	41.03	39.39
1980/81	34.90	39.47	34.90	36.69
1981/82	36.00	40.72	35.13	37.75
1982/83	37.24	37.05	23.51	36.84
1983/84	35.54	36.05	32.38	35.63
1984/85	36.57	37.31	37.21	36.83
1985/86	38.16	32.98	37.46	36.42
1986/87	40.62	33.25	37.76	38.12
1987/88	42.07	27.48	37.86	37.32
1988/89	39.75	32.51	37.17	37.50
1989/90	40.79	33.86	29.54	38.52
1990/91	40.74	38.14	35.99	39.88
1991/92	43.36	37.82	32.05	41.54
1992/93	46.07	36.08	38.96	43.12

Note: Utilization figures are computed using annual generation data only. This tends to underestimate the annual utilization (kWh/kW) to the extent capacity additions take place during the year.

* Includes steam thermal capacity, gas turbines and diesel generators.

Source: CEA, Power Supply Position in the Country, Vol. 17, No.5, New Delhi, May 1989.

High Auxiliary Consumption

By retrofitting large size electric motors with variable frequency couplings as well as improved housekeeping measures, it is possible to bring down the level of auxiliary power consumption from 10% to 8.5%. The benefits of an improvement of this magnitude would make available an additional 5,743 GWh of electricity every year with an additional revenue of Rs. 574 crores. Against this, the investment cost for this measure is estimated as Rs. 1,000 crores. This too needs to be considered by Government.

Optimising the operations of hydro power stations

To achieve an optimal performance of hydro plants, the Committee are of the view that the following two measures could be considered for implementation during the Eighth Plan:

— a coordinated operation of the hydro-thermal plants, whereby the hydro plants in hydro-dominated states are shut down during the off-peak hours and used for peaking purposes only.

— uprating of 49 hydro power stations involving a total installed capacity of 8,839 MW.

The cost of the above measures is estimated to be Rs. 854 crores. The

benefits would be in the form of an additional availability of 761 MW of installed capacity and 1,590 million units/annum. The incremental revenue generated from the sale of these units would be about Rs. 159 crore per year and savings in capital expenditure would be Rs. 2,280 crore. The Committee recommends that the Government examine these proposals for implementation.

Physical Resources for Power Generation

The country is endowed with vast hydel resources, large quantities of low grade coal and natural uranium. Natural gas is not available in sufficient quantities and therefore should be utilized judiciously. It is suggested that gas should not be used for power generation except at landfall points and places located far away from the coal bearing areas. Instead, gas is required as a priority for fertilizers, petrochemicals, domestic cooking, industrial heat, and for replacement of oil in the transport sector.

Accelerated hydro development

The Committee find that for a coordinated deployment of hydro-thermal resources a combination of 40% hydro and 60% thermal is considered desirable. Presently, the share of hydro capacity is low at 28%. Accelerated hydro development is, therefore, necessary by initiating urgent advance action on a number of fully investigated hydro projects in various regions of the country. The capacity requirements up to 2006-07 will be about 15,000 MW lower if an optimum hydro-thermal mix is achieved. Run-of-river plants should be preferred to storage type plants and pump storage plants should be utilised for peak load.

Nuclear power

As on March 31, 1992 the installed Nuclear capacity in the country was 1,785 MW amounting to 2.6% of total installed capacity of the utility. The gross generation of nuclear power in 1991-92 was only around 1.9% of the total generation of the utility. The nuclear power stations at present in commercial operation are at Tarapur (Maharashtra), Rawatbhata (Rajasthan), Kalpakkam (Tamil Nadu), and Narora (Uttar Pradesh). This total installed capacity of 1,785 MW has recently been derated to 1,500 MW.

Nuclear power development programme in India is based on the use of natural uranium as fuel in pressurised heavy water reactors. Heavy water is used as the moderator. The commissioning of additional plants at Rawatbhata (Rajasthan) and Kalpakkam (Tamil Nadu) was delayed due to withdrawal of Canadian assistance. The country has, therefore, had to depend wholly on indigenous efforts in design, engineering, manufacture and construction of nuclear power units.

Consequentially, there have been inordinate delays in project implementation and actual commissioning of these plants with synergetic

consequences. Delay causes cost overruns plus loss of available power, which in turn, hampers overall development. Other major factors contributing to slippages have been — problem in acquiring land, delays in fabricating critical equipment and non-availability of certain construction materials.

The country had also faced many problems in the production of heavy water. Happily, these have now been overcome. During the Eighth Plan, it is proposed to add a capacity of 1,100 MW comprising Kakkarpar in Gujarat (440 MW), Rapp Extn. in Rajasthan (220 MW), and Kaiga in Karnataka (440 MW). Further additions which have been authorised are — Kaiga (880 MW), Rapp (2,000 MW), and Tarapur (1,000 MW) adding to 3880 MW. Including the second unit of Rapp Extn.-1, the total installed capacity of Nuclear power plants at the end of 10th Plan (2006-07) is expected to be 6,700 MW. This does not include 2,000 MW plant which was proposed at Kundam-Kulam (Tamil Nadu) with assistance from the erstwhile USSR.

The Committee note with concern, however, that the plan to produce 10,000 MW of nuclear power by 2000 AD has, for all practical purposes, been abandoned.

Long Term Planning

The Committee are of the view that the 15 year perspective power generation expansion plan should take into consideration, energy conservation, inter-regional power transfers and a suitable hydro-thermal combination. By doing so it would be possible to reduce the additions to installed capacity by about 50,000 MW out of a projected demand of 1,47,000 MW.

T&D losses

The prevailing level of losses in the transmission and distribution network are in the range of 23-29% of total availability at the busbar. It is observed that out of this, 4-7% is due to non-technical reasons, such as pilferage, implying that a reduction in these losses can be achieved at little extra cost.

The Committee holds that the reduction in technical losses can be achieved by:

— installation of additional capacitors;

— installation of proper size of transformers; and

— augmentation and strengthening of sub-transmission and distribution lines.

— Similarly the non-technical losses can be minimized by:

— installation of reliable and high quality meters;

— improvement in billing and collection procedures;

— switching over from "flat rate" tariffs to metered electricity supply to agriculture; and

— strengthening of administrative and legal measures for curbing thefts.

By adopting a suitable mix of the above measures, a reduction in the T&D losses from 23 to 18 per cent can be easily achieved during the Eighth Plan period. While the incremental investment costs of these measures is estimated in the range of Rs. 7,000-10,000 crore, the benefits would be in the form of an additional 18,870 GWh of energy and 4,420 MW of installed capacity (otherwise costing about Rs. 13,260 crore). The losses need to be eventually brought down to a level of 15% by diverting resources to T&D from those presently directed towards generation.

Tariffs

Electricity tariffs charged to the agriculture sector are extremely low at about one-seventh of the average cost of generation and supply, whilst those for the domestic consumers about two-third of the average cost. The losses incurred by the SEBs on account of this subsidy, are a cumulative sum of around Rs. 5,000 crore. At the consumption end, by charging a "flat-rate" tariff the agricultural consumer is not provided any incentive to use electricity efficiently. *The Committee recommends the following for consideration:*

— ***normative tariffs for consumers' satisfaction. It is necessary that tariffs are regulated by an independent authority based on normative performance of plant and equipment and personnel. For this purpose regional tariff commissions were suggested and agreed upon by all the Chief Ministers. These should be established at the earliest.***

— ***interim tariff for agriculture. Till such time that proper agricultural tariffs are levied, a uniform tariff of Rs. 0.50 was recommended and agreed to by all the Chief Ministers. This also should be implemented uniformly.***

Privatisation of Power Sector

The Committee are of the view that while encouraging privatisation and foreign investments to increase additional resources for this sector, care has to be taken that the long term interests of the country are not jeopardized.

Private Sector Participation

The policy package of the Government of India and its efforts to attract private sector investment has been a focus of considerable attention in recent months. In particular, one major project for establishment of a large power plant based on liquified natural gas (LNG) at Dabhol in Maharashtra has received a great deal of public attention and comment in the media. Some major issues arising out of this project are discussed below:

The Government has, to the Committee's mind, correctly allowed independent power generation and only later would it consider the possibility of privatization of transmission and

distribution. Unfortunately, the manner in which this policy was formulated leaves much to be desired. An enlightened approach would have been to study the experience of other countries in such efforts and to have mobilized considerable specialist inputs before a policy package was formulated and announced. In the absence of such an approach the Government has been making some ad hoc changes to this package since it was first conceptualized. This is not a good negotiating approach simply because potential investors see the Government's stand as pliable and, therefore, they would hold back specific investment decisions in the hope that further concessions would be provided over time. The case of power is only illustrative of a much larger problem the Government would encounter and needs to deal with effectively if policy changes are to take shape and result in private investments for infrastructure development.

The Dabhol project proposal has been criticized on its high capital cost of the project being leading to the cost of power supply for the project works out in the range of Rs. 4-5/ kwh which would be much higher than present costs of generation and the guaranteed rate of return. In actual fact, the Dabhol project has ben developed outside the Government framework of a guaranteed rate on investments. It has been developed on the basis of a guaranteed price of power based on a high level of performance and assumption of considerable risk by the private investor. Undoubtedly, the capital cost of the plant turns out to be higher than conventional coal based plants, because the company would be making substantial investments in facilities for import of LNG from the Middle-East. Its capital cost of Rs. 4.48 crores per MW is therefore inclusive of port facilities, LNG regasification infrastructure as well as other ancillary facilities. As it happens, capital costs of green field coal based power stations established elsewhere in the country are tending to range between Rs. 3.5 to 4 crores/MW. While, therefore, the Dabhol project is higher than these costs, it absolves the Government of all responsibility for coal linkages, transportation infrastructure and also provides major environmental benefits, since the entire cycle of coal mining to its burning in the power plant and disposal of flyash cause major environmental impacts, which unfortunately the current system of pricing of coal does not include. In an era of increasing cost of electricity supply and distribution, new plants are bound to have marginal costs which are higher than the average cost of electricity supply from older plant and equipment, and therefore, worldwide the practice is to pool the cost of supply from all the power plants and then price it at the average cost, ensuring a reasonable and adequate return for the system as a whole. Consequently, the Dabhol power plant will also require similar pooling of costs and, therefore, a nominal increase in power tariffs for the State as a whole.

The Committee has taken up the case of ENRON only as an illustrative case study. It has neither attempted nor engaged in any independent techno-economic examination of it. Other than a broad examination of the methodology of 'provatisation' the Committee would not wish to comment on one single enterprise in the state of Maharashtra. However, a guaranteed return of 16%, with assurances about a fixed exchange rate combined with the possibility of bonus related to PLF makes the Committee wonder whether the Govt. have taken a wholly judicious step. The commitee feel that a level playing field must be provided to all entrepreneurs, whether foreign or Indian. As regards, debt-equity ratio the committee holds that with private rist capital what must be taken into account is that in India debt tends to be cheaper than equity. This aspect ought to be considered by the Govt.

Resources for power development

As mentioned above, the SEBs incur heavy losses due to to supply of subsidised electricity. Owing to their poor budgetary resources the state governments are not able to provide adequate funds to the Boards. This compels the Boards to divert capital resources to meet losses on the revenue account, thus reducing the amount available for new projects. In consequence, the physical completion of projects gets delayed causing

heavy short falls in the commissioning of new projects. Target fulfilment is thus of the order of only about 70% combined with inflation, leads to time and cost overruns. ***Some remedial measures suggested are:***

Load centre stations, particularly stations located more than 750 k.m. away from coal fields should be supplied beneficiated coal with provision for burning the rejects containing about 67% ash, in captive power plants with fluidised bed boilders. Pit head generation with low grade coal should continue to be preferred to avoid long haulage of coal.

Demand side management could be given priority by adopting time of day tariffs, energy conservation and improved efficiency of utilisation.

Institutional changes

The Committee conclude that the power sector has become very unwieldly and requires a separation of generation and EHT transmission functions from the distribution functions.

The role of regulatory bodies needs to be properly defined and these bodies suitably structured wherever necessary.

Renewable energy technologies

The renewable energy programme in India is now more than a decade old. With the exception of the installations of improved *chulhas* (cookstoves) and family size biogas plants, where an appreciable number of devices have been installed, the present installed base of renewable energy devices is low. While the potential remains, RETs have not yet made any significant contribution to meet the energy demands of the country.

Over the past decade, many new RETs have been promoted as solutions to energy problems, even before they reached the level of maturity warranting such an assertion. Aggressive promotion led to unreasonable high expectations from the RETs and the promotional effort gave the impression that these technologies were the panacea to all the energy ills of the country. Ironically, today those very efforts have resulted in the greatest barriers to the introduction of these technologies: there is a widespread feeling among those associated with energy planning process that RETs and their possible role is grossly overrated and few planners have faith in the technical viability of RETs. Hence, efforts need to be devoted to a serious re-assessment of what current technologies are actually able to achieve, and to arrive at a realistic estimate of the potential of these technologies within the context of the overall energy system.

Within RETs, there are only a few success stories, the performance broadly ranged from indifferent to poor. It is also a moot point as to what extent, the achievements (in terms of sheer numbers alone) have been the

result of the subsidies provided. These subsidies have largely been in the form of outright capital grants. While perhaps necessary to correct price distortions in markets by themselves they are too inadequate to lead to a big rise in the installations of RETs. Renewable devices have to contend with their much higher costs (not merely the higher capital costs) and their general lack of reliability. Further, many of the products themselves have been user-unfriendly, designed without looking at region specific needs, preferences of the people or social acceptance. The very mode of the subsidy — in form of a fixed capital outlay for a device — leads to a set of fixed features of the device (which is difficult to change). This mitigates against technological innovations.

There has been little effort to involve the industry in these initiatives. Nor has an effort been made to tap the non-governmental organizations involved, to popularise these devices.

The Committee having reviewed the various programmes would suggest the following:

- ***Grid connected wind electric generators (WEGs) have emerged as a cost competitive option for the power sector. The demonstration programme has built up a significant capacity and the results though mixed, show potential. This resource, of course, is very site specific. In India, Tamil Nadu, Gujarat, and Rajasthan seem to hold more promise. Facilities such as wheeling, banking and buy-back of power have helped attract participation from the private sector. This programme is also likely to receive substantial amount of funding from international funding agencies.***
- ***Another significant initiative is likely to be in the area of small hydro projects (SHPs)—of less than 3 MW capacity. The programme is most suitable and well poised to meet the energy neds of rural and remote hilly areas. Such projects can also make use of the existing irrigation infrastructure. The Energy Sector Management Assistance Programme (ESMAP) of the World Bank reviewed many such projects and identified several deficiencies: the unwarranted high costs due to the initial batch of schemes being conceived, designed and executed as scaled down versions of large conventional hydro installations, high gestation periods due to complex layout of schemes and high manpower requirements causing concerns regarding viability.***

Following substantial work on these projects costs were reduced improving their viability. Through a combination of design modification and standardisation of equipment, the unit cost of small hydro plants can be reduced by 30%. The reliability of the small hydro system can be substantially increased through inter-linked design of small hydro facilities. The hydropower structure should be arranged so that the head-work (or the intake) of one station follows closely the tail-race (open canal for

tail water) of the other. The upstream regulating reservoirs can then be designed so that the cascade process raises the dependable output of the whole basin system.

The Committee also holds that:

- Solar photovoltaics (PVs) are a viable option in remote areas for specialized applications including telecommunications, railway signalling, telemetry (oil exploration), microwave repeater stations and for refrigeration (cold chains). PV systems for lighting are also a viable option in remote, non-grid connected and low-load-demand villages where the cost of providing power through conventional means is prohibitive.
- Programmes such as windmills for pumping and gasifiers have not quite lived up to expectations and need more developmental work before they are likely to make an impact on the energy scene.
- The potential of the two biomass based programmes—improved *chulhas* and biogas-has not been realised though they are possibly the most attractive of the various renewable energy devices.
- Ocean thermal energy conservation (OTEC) using the principal of temperature difference between the warm ocean surface waters and the cold water at greater depth can be harnessed to generate electricity. An ambitious project to generate 600 MW of power through this technology is proposed to be set up off the coast of Tamil Nadu. Initially, 100 MW of capacity is likely to come up. India's potential of generating energy from this renewable, non-pulluting source is estimated at 50,000 MW.

  Tidal power is another means of tapping ocean technology — the potential in India is estimated at 9,000 MW. Techno—feasibility of tidal energy needs to be established and this Committee recommends action in this regard.

The revised targets for the Eighth Plan, if they materialise would mark a quantum-jump from the present low installed base of renewable energy devices. Though it would mark a substantial increase, the overall contribution that renewables would make would still be rather insignificant. It is the present low base that makes the proposed increases seam very impressive. Given the present installed base and the performance of RETs so far, the challenge would be to translate these plans into reality. The plan is ambitious and would have to be implemented in a short span.

The Committee are of the view that the specific constraints that are likely to emerge are:

- the mobilisation of funds could be a serious hurdle since the programme is contingent on participation from the private sector and on foreign funding.

- the technological base and capacity of the Indian industry may not be able to cope with the demand for the various devices.
- it is assumed that marketing will not pose a problem as there would be sufficient demand. This may turn out to be unfounded. In fact, with the withdrawal of subsidies the demand for some products may be considerably reduced.
- the sudden jump in installations may cause quality control problems. Similarly, adequate attention would have to be paid to service, maintenance and repair of the installations. It is not uncertain whether the infrastructure as is exists now would be wholly adequate.

The Committee therefore, recommends that:

To attract sufficient funding the level of incentives provided to RETs should be no less than those provided for conventional sources of supply. This is especially true of incentives such as guaranteed rates of return and assured buy-back of power now been offered to power projects using fossil fuels. In fact, considering the positive effects of renewable devices, there is a need to provide additional incentives over and above those meant for conventional sources.

There is a need for considerable R&D work in RETs. This is to be in the area of both basic research as well as in applied engineering work. Attention should be focused on removing technical glitches and adapting technologies to suit local conditions. The latter is especially true of biomass based technologies. Hitherto the industry has had a marginal role in such efforts. A more collaborative effort is likely to prove fruitful.

There is great scope for innovations and greater dynamism in the field of social engineering. For instance, for programmes such as biogas and improved chulhas there is a need to further decentralise the dissemination of these devices. Private entrepreneurs and non-governmental organisations need to be involved in such efforts.

Demand Sectors

The Committee also examined the issues that deserve special attention with respect to demand management in various sectors. These are discussed in the succeeding paragraphs.

Transport

Public transport system

It is the view of the Committee that of primary importance in this field is a strengthening of the public transport system. A comparative analysis of

bus *vis-a-vis* other modes in meeting a million passenger kilometre (pkm) of travel demand reveals that:

a car consumers 4.9 times more energy than a bus, whereas, a two-wheeler consumes 2.6 times and three-wheeler consumes 3.0 times.

car, two-wheeler and three-wheeler occupy 38.5, 53.6 and 14.7 times more road space respectively when compared with a bus.

the cost of operation of a two-wheeler is 9.5 times, a three-wheeler 3.1 times and car 3.4 times when compared to a bus.

as far as pollution from vehicles is concerned, a car emits 5.7 times, a two-wheeler 5.1 times and a three-wheeler 6.2 times as much pollutants as a bus.

This indicates that a desirable and cost effective solution to transport more people with less vehicles using less energy and spewing less pollution could be achieved by raising the share of buses in public transport. An increase in the share of passengers carried by buses from 57% to 80% in 83 cities would lead to a saving of 1.1 mt of oil by the end of the century. Other advantages that would ensue are a 54% reduction in total vehicles on the road, a 36% reduction in air pollution and a 33% reduction in transport costs. This would also require approximately 25,000 additional buses by the year 2000 AD (at 270 kms per day for 300 days) for the 83 cities, implying an additional investment of Rs. 1,000 crore at present costs. This would lead to additional marginal requirements of about 0.5 mt of diesel fuel which can be released by:

increasing the traffic carried by electrical suburban rail systems in metropolitan cities by 50% more than projected by the railways (i.e. 26 BPKM more) resulting in a saving of 1,60,000 tonnes of diesel.

improving fuel efficiency of buses from 3.5 km/litre to 4.5 km/litre resulting in a saving of 4,00,000 tonnes of diesel. This could be achieved partly by better maintenance practices, technological improvements in bus design and partly by traffic management measures leading to less congestion and faster flow of traffic.

the Committee regret that there are no comprehensive traffic management schemes (except in metropolitan cities) which are aimed at reducing travel demand and optimising energy use. The Committee urge that suitable efforts in this direction should be initiated.

Freight movement

In the past few decades there has been a steady shift in freight movement to road and away from railways. This has been a result of not only limits on rail capacity but also willingness of consumers to pay for a more reliable and personalized private road transport service.

However with limited and diminishing resources of petroleum products and the critical position of balance of payments it is in the interest of the

nation to encourage long distance freight movement by railways keeping in view customers'/shippers' requirements. This could be achieved through a domestic container service, matching the shippers' requirements. The main benefits of a proper domestic container service would be faster transit, lower operational costs, minimisation of time lost in switching from one mode of transport to another, protection against climatic hazards, minimisation of packing cost and damage during transit, reduction in handling and overall improvement in the quality of service.

Implementation of metro rail

Constructing a metro system along high density routes in major metropolitan cities provides a promising strategy. This involves heavy investments which become a binding constraint and necessitate funding from external sources. Yet the net benefits to the society from a suitable metro system would be substantial and exceed those from other alternatives.

What could be considered is the Build-Operate-Transfer (BOT) option, which would not only ensure a quick and efficient implementation of the project but also bring into existence management and operational expertise that is essential for maintaining the system. The Committee recommends that this concept needs to be explored and seriously considered by the Government.

Energy conservation measures in industry

If the Eighth Plan targets of energy savings are to be achieved concrete steps need to be taken urgently. Efforts in this direction have failed to make a headway mainly due to an inadequate information base and/or the sporadic and adhoc nature of activities, along with an uncoordinated approach.

There is considerable untapped conservation potential (about 25-30%) in a whole range of energy intensive industries within the sector for which energy efficiency norms and targets need to be fixed for successful policy implementation. Current domestic efficiencies could be compared with those of the world's best technologies available and the potential for conservation estimated. The variables considered could be planned capacity expansions, capacity utilisation, location, technology, raw materials used, their substitutability etc. Further the compatibility of the current raw materials available in the country to the current output mix could also be studied. Associated management issues in the industry can be simultaneously investigated. Required policy instruments can be determined keeping in mind both feasibility (technical and managerial) of the change as well as the economic consequences of the policy measure.

Also, commercially viable energy efficient technologies should be financed at concessional rates and made attractive through fiscal and pricing incentives and selective legislation. This would require a detailed study of the existing

legislation and incentives; reasons for non-acceptance by the industry or slow penetration, requirements of the industry itself; information dissemination as regards the incentives, database creation on energy efficient technologies, their economics and domestic availability.

Energy efficiency in lighting

Power systems at the state level face a shortage during the evening hours, generally from 6 to 9 p.m., which is when the power systems have their peaks. This is the time when there is a sharp rise in the demand for lighting.

With a view to achieving energy efficient lighting in areas relating to commercial, domestic, five-star hotels and street lighting, a task force was constituted in the Ministry of Power. ***This task force suggested a number of demonstration projects aimed at introduction of white fluorescent lamps, compact fluoresent lamps, triband lamps and accessories such as new design of ballasts, p.f. correction capacitors etc. The Committee is of the veiw that these projects need to be strengthened.***

Energy conservation in agriculture

Irrigation is one of the major energy intensive end uses in the agriculture sector. Table IV. I summarises the expected savings from various retrofit measures which should be considered.

Table III.3 : Expected savings from different retrofit procedures

Retrofit measures	Expected savings (%)
Involving subsystem components	
1. Replacement of foot valve and suction pipeline (R_1)	8-12
2. Replacement of foot valve, suction, and delivery pipeline (R_2) Involving subsystems	10-20
3. R_2 + replacement of pump (R_3) involving entire system	20-40
4. R_3 + change of motor (i.e. complete replacement) (R_4)	30-50

It is very improtant to monitor the actual effect of retrofits to the utility through feeder level monitoring of the energy consumption. ***Apart from replacement of pipelines or pumps, retrofit jobs should take into account a host of other factors. These could be:***

development of mobile teams of trained personnel, equipped with requisite instrumentation and tools to undertake site visits, decide on the exact nature of retrofits and execute the job in a professional manner;

suitable legislation may be formulated to make standard equipment and power capacitors compulsory in rural pumpset connections;

working out suitable incentives to encourage quality control and adherence to standards by the manufacturers (small scale units) of irrigation pumpsets.

There also exists ample scope for improving the design of centrifugal pumps for agricultural applications.

Issues Related to Energy Pricing

Although the commercial energy sector has been under state control for almost two decades now, energy pricing has been dealt with in a fragmented manner. Under the prevailing regime of administered prices, while the prices paid to the producers are based on the average cost approach, those charged to the consumers are generally guided by social and political considerations, often in conflict with other pricing objectives. ***The Committee has come to the view that the existing price policy coupled with inadequate administrative controls is neither able to subserve the social objectives nor is it able to achieve the desired inter-fuel substitution.*** These are examined in fuel specific terms subsequently.

Coal

The Committee would wish to comment on some disquieting features about coal prices in India.

there is no systematic principle adopted for inter-grade price differentials. A rational pricing structure should have an in-built allowance to adequately compensate the consumers for using lower quality coal;

the pithead prices have an in-built inefficiency in that the cost of production (on which they are based) is calculated with total disregard for the low output per manshift (OMS). An analysis carried out for this purpose shows that if the productivity (OMS) in case of all the less efficient mines was to rise to a level of average OMS for the more efficient mines, the cost reduction (on account of lower manpower costs) would be about 30%.

the pithead prices are determined on the basis of the industry-wide average cost of production with the result that some of the coal mining companies such as BCCL and ECL, which have old and high cost mine under their control, are not able to recover their costs.

Hydrocarbons

The Committee has to observe that in general, the Government has been guided by short term goals in making changes in the price of oil and petroleum products. These prices have been revised largely on account of one of the following factors :

mobilisation of resources for the petroleum sector or financing the planned development of the economy;

compensating for higher costs of imports either due to an increase in the international prices or the devaluation of the Indian rupee;

prices of some products have been increased to improve the balance of

payment position and to curtail demand.

The trend in domestic and imported crude oil prices shows that the :

the movement of indigenous crude oil prices has been fairly independent of the behaviour of imported crude oil prices;

there has been a consistent pattern which shows that the Government has been taking an increasing share of the sales revenue by increasing the rate of royalty and oil development cess components of the delivered price of crude oil at the refineries.

The base price paid to ONGC and OIL was kept unchanged from 1981 the revision in September, 1992.

In case of petroleum products a policy of cross subsidisation is adopted and the following general observations emerge :

prices of LDO and furnace oil have increased sharply as compared to those of LPG and kerosene, which are mass consumption products and diesel which is the primary fuel used for public transportation;

a differential pricing structure has been evolved whereby concessional rates are charged for naphtha and furnace oil for fertilizer production and for LPG for domestic use as against industrial or commercial use.

The Committee is therefore, constrained to observe that the prevailing pricing policy, guided by short term objectives coupled with inadequate administrative supervision has led to several distortions in consumption such as adulteration of diesel with kerosene in the transport sector with the target consumers' having to resort to black market purchases (due to shortages of kerosene) at 3-4 times the administered price of kerosene. There is diversion of domestic LPG for commercial and even transportation purposes and a lower substitution of naphtha and FO/LSHS by natural gas in the fertilizer industry owing to the concessional prices of the former.

Electricity pricing

Pricing of electricity by the SEBs has generally been based on the principle of recovering the average cost of supply. In practice, however, the Boards have been unable to recover their overall cost of generation and supply with the unit deficit rising over time. At the national level, per unit revenue loss has increased from 4.13 paise/kWh in 1974-75 to 8.67 paise/kWh in 1980-81 and further, to 24.7 paise/kWh in 1990-91

All the SEBs follow a policy of differential pricing for the supply of power to different consumer categories. Tariffs are more often set by social and political considerations than by financial and economic efficiency criterion, with revisions made usually in an *ad hoc* manner. With escalations in costs, the additional costs to be recovered are calculated first, based on which the extent to which the tariffs for high tension consumers can be raised is decided. The balance cost is then adjusted to

the extent possible from the low tension industrial, commercial and domestic consumers.

Electricity tariffs for agriculture

Electricity tariffs are generally the lowest for the agricultural sector. Over the years the gap between the cost of generation/supply and average realization from the agriculture sector has been widening. A utility-wise analysis shows that during the period 1985-90, out of 22 utilities in the country, electricity tariffs for agriculture consumers declined in 5 utilities and remained unchanged in 13 utilities. Consequently, the losses at the All-India level incurred on account of supply of electricity to this sector have increased at an annual rate of 25% during 1985-86 to 1990-91. One of the reasons for the decline in the average agriculture tariff since the mid 1970s is that all the SEBs have gradually changed over from metered supply to "flat-rate" tariff based on the connected load (HP of pumpset), largely to do away with the problems of administration, billing and collection.

The Committee addressed itself to this important question. Two factors standout. Electricity continues to be supplied to the agriculture sector at high rates of subsidy and mostly on the basis of flat rate tariffs. This in turn encourages a misuse of electricity for non-agricultural purposes, thus further adversely contributing to the financial health of the SEBs. Simultaneously, there is gross inefficiency in the supply of electricity to the agricultural sector. It is seldom made available for the required number of hours, with the required continuity or at such hours as are convenient for its gainful use. It is a common complaint of the agriculture sector that they are treated as the poor relatives, electricity is supplied to them on lower priority to industry, and almost always during inconvenient hours of the night. The SEBs are thus caught in the pincers of high subsidy, gross misuse and low consumer satisfaction.

Comparison of the economic price (EP) and market price (MP) of selected fuel

The Committee has found it necessary to address itself to this important question. Energy prices, as they currently set in India, do not reflect the true cost of supply to the consumers, nor do they take into account the impact of such a price structure in one energy sub-sector on the other energy sub-sectors. A comparison of the real resource cost of supply of coal, oil and electricity with the prevailing market prices reveals significant divergencies.

A discussion of these, with the base year of analysis being 1990-91, reveals :

the MP of non-coking coal and prime coking coal was estimated to be 20-25% higher than the EP, while the MP of medium coking coal was found to be twice as high as its EP indicating that all varieties of coal

are highly taxed. In a large measure, this tax is attributable to the transport costs and inclusion of royalty, cesses, excise tax and other levies in the delivered market price of coal;

at present, India is importing good quality coking coal for use in steel plants. However, if it were to import superior steam grade coal the representative border price would be that of steam coal imported from Australia. A comparison of domestic prices with the border prices shows that in case of both steel grade and steam coals, the border prices are observed to be about twice the MP;

there is a heavy subsidy on soft coke (about 50%) when its price is compared with the cost of supply of the smokeless fuel;

in case of petroleum products, it is observed that while petrol and ATF (for domestic airlines) are heavily taxed products with tax levels of the order of 133% and 111% respectively, the tax on FO (for non-fertilizer use) is relatively low in the range of 20-23%.

diesel, kerosene and LPG are subsidized with the level of subsidy being 20% on diesel and about 58-60% in case of both kerosene and LPG;

in case of natural gas, the EP based on the average incremental cost of supply of gas from the South Bassein gasfield is estimated to be lower than its MP. However, the use of gas as a substitute for other fuels/ feedstock in industry and other sectors may provide a different economic value (or replacement value) to the consumers. The replacement value of gas in major consuming sectors is estimated to be much higher than its cost of supply;

It is difficult to compare the MP and EP of electricity at the national level due to variations in tariffs across the states. The Committee would recommend that an exercise of this nature be undertaken by the Government.

Integrated analysis of energy prices

Briefly, this integrated analysis is aimed towards assessing the :

cost per unit of useful energy for each of the fuels in specific end-uses, and

extent of subsidies and taxes which result from the difference between the EP and MP.

This entire analysis pertains to the year 1990-91. The important observations which emerge are :

all the commercial fuels consumed in the domestic sector are provided at a subsidized rate (except petrol, which in any case is used for transportation and hence included in the transport sector). In terms of price per unit of useful light output (measured in lumen hours.), electricity is the cheapest option and the energy efficiency increases almost five times if incandescent bulbs are replaced by fluorescent

tubes. The use of kerosene for lighting purposes needs to be discouraged.

For cooking purposes, the cost of electricity works out to be almost 2—2.5 times that of LPG, in terms of useful energy supplied.

For industrial process heating, the use of non-coking coal is found to be cheaper than furnace oil and natural gas, despite significantly higher efficiencies of the latter two fuels. This reinforces the findings of several committees which have pointed to the desirability of switching over to coal from fuel oil in the industrial sector.

all the three fuels — coal, fuel oil and natural gas in the industrial sector are taxed. The use of electricity in the commercial and LT-industries is subsidised marginally while it is taxed for HT-industrial consumers.

the cost of diesel-based rail transportation for freight movement is roughly one-sixth of the cost incurred if one were to move commodities by road. On the contrary, there is an increasing trend towards freight movement by road indicating the willingness of consumers to pay a higher price for an efficient and reliable transport service.

In case of passenger transportation this difference is not as marked. Here the use of electricity in rail transport is the cheapest option while the cost of passenger transportation by cars works out to be much higher as compared to other modes.

energy supply to agriculture is subsidised. Although, in gross terms diesel is cheaper than electricity, in useful energy terms electricity is significantly cheaper as compared to diesel use. Highly subsidised electricity has encouraged farmers to move over to electric pumpsets and diesel pumpsets are used as a stand-by.

on the whole, a comparison of the EP and MP of selected fuels shows the following levels of subsidy and tax on different consuming sectors.

Table III.4 : Total energy subsidies in different sectors

(Rs. crores) (1990-91)

Sector	Subsidy (+)/Tax (−)
Domestic	6026.15
Industry & Commercial	−7649.86
Transport	−672.63
Agriculture	5373.97

The total subsidy to the energy sector works out to be around Rs.3,000 crore at 1990-91 prices.

Recommendations

Accordingly, therefore, the Committee recommends the following for consideration of the Government for achieving an appropriate structure :

— *the price paid to SEBs and coal/oil companies should be based on the normative efficient cost;*

— *in the coal sector, price of coking coal must be linked to the border price and for non-coking coal while in the short to medium term the inter grade coal price differentials need to be rationalized, in the long run there is a need to move away from the present system of linking of non coking coal producers and consumers to mutually negotiated deals between the producers and the consumers;*

— *inter-grade price differentials of coal must be rationalised;*

— *in the oil sector, diesel and kerosene prices, mindful of their utilisation, have to be rationalised;*

— *kerosene distribution system needs to be strengthened;*

— *subsidy on LPG should be gradually reduced;*

— *natural gas prices should be linked to the replacement values in various end-uses;*

— *all electricity consumption should be necessarily metered;*

— *time-of-day electricity tariffs for some HT industries could be implemented;*

— *cross subsidisation should be within the consuming sectors (amongst consumption blocks), and not across sectors.*

CHAPTER IV

ENVIRONMENTAL ISSUES IN THE ENERGY SECTOR

The Committee is constrained to observe that generally there has been insufficient concern about environmental matters in energy planning and programme implementation in the country. As brought out in earlier chapters, the primary focus of energy policy has been meeting capacity and generation targets. Concerns relating to the environment have not received the same emphasis. Similarly, issues of sustainability of resource use (which would have a strong environmental component) have received inadequate attention, till lately, in policy discussions. Shadow prices of environmental parameters have rarely been used in project appraisals. Though concern about environment is being increasingly voiced, a meaningful incorporation of environmental parameters, reflecting social costs and benefits of using a particular resource is still not adequate. On the implementation side, while standards have been set and legislation introduced, the corresponding enforcement mechanism is unsatisfactory.

The Committee observes that this neglect of environment extends to the non-commercial sector where the use of traditional sources including biomass and dung is general. Biomass resources were for long not even recognized as a major energy source and the environmental problems associated with their use were neglected. It has become increasingly evident that the use of biomass based fuels is one of the primary reasons for resources degradation, especially of forests. Their use as a source of cooking energy has resulted in women and children being exposed to hazardous pollutants at high levels of concentration. The use of dung as fuel deprives the soil of important nutrients. This Committee would like to draw attention to this hitherto neglected sector and the problems associated with the use of biomass based fuels.

In this chapter, the Committee has not illustrated the points made above with specific examples but raised some general issues. These issues are discussed sector-wise. The recommendations follow the discussion of these issues.

Supply Sectors

Coal

Traditionally, mining of coal has invariably led to problems of land degradation. Increasing reliance on opencast mining, however, has necessitated a large scale diversion of forests and agricultural land. Apart from this direct loss, the poor record in managing land, and especially the

lack of appropriate reclamation measures, has degraded large tracts of land. Water pollution from mine wastes and air pollution from mining operations are two other problems. Though local and limited in geographical impact, these adverse effects have been severe in the affected areas.

Another major impact has been the displacement of people due to the acquisition of land for coal mining projects. While rehabilitation measures are meant to be an integral part of project plans, the record in resettlement has been poor.

Hydrocarbons

Environmental problem arise during the production, transport and refining of oil and gas. These activities can result in pollution of air and water and in the degradation of land. As yet, these effect have largely been confined to small areas. The major issue in this sector has been the flaring of natural gas. Apart from the waste of resource, such a phenomena has led to pollution of air.

Power

Thermal power

Coal is the predominant fuel used in thermal power plants. Indian coal has a high ash (35%) and low sulphur (0.5% or less) content. This implies that the major environmental problem pertains to disposal of ash. Emission of gases is a relatively insignificant problem (unlike in Europe where for instance, acid rain became a major concern) except in areas with concentration of power units, as at pitheads or in ecologically sensitive areas.

Ash generated from coal based plants in technically simple, and relatively inexpensive to control. However, the lack of installations of suitable devices (especially in older power plants) and the lack of proper maintenance and operation has led to air pollution from thermal power stations being a major problem in many parts of the country. The levels of air pollution in many regions have far exceeded permissible concentrations resulting in increased health risks. Further, the conventional method of disposing ash collected requires large tracts of land and also results in air and water pollution.

Hydropower

While non-polluting and renewable, large hydro power projects have faced increasing protests and resistance (even leading to their abandonment in some cases) from local people and environmentalists. Large scale displacement of people has led to serious social dislocation. The construction of reservoirs and the associated loss of forests and agricultural land, and safety issues, relating to dams too, have come to the fore.

Nuclear energy

During normal operations, radiation from atomic power stations poses few safety problems. The major fear is from accidental release of large amounts of radioactive material. No such accident has taken place in India. The long-term considerations relate to the satisfactory disposal of wastes and the decommissioning of the plants after their useful life is over. Given the small scale and the recent nature of the nuclear energy programme, these have not become important concerns. They, however, need consideration.

Demand Sectors

Measures on the demand side, too, have a major role in mitigating environmental problems as when power is saved due to conservation measures. Examples of these from the transport sector are a shift from private to public mode of transport, or in a shift in the fuel used from petrol to CNG. These measures lead to a reduction in energy consumption and hence in pollution. In the industrial sector about 10-12 major industries account for the bulk of the power consumed. There specific energy consumption is far higher than the norm in other countries and also realisable potential in the country. Similar scope for savings exist in the agricultural, household and commercial sectors. Since these measures have already been discussed in Chapter III they are not repeated here. In addition to the economic/financial savings that accrue, their importance in reducing environmental damage need emphasis.

This Committee, however, does wish to highlight the use of traditional biomass fuels, large for cooking. There are three major problems associated with their use.

— indoor household air pollution due to the use of such fuels

— degration of forests

— loss of nutrients as dung cakes are diverted to combustion rather than put into the soil.

It is obvious the use of such fuels is likely to continue for a long time to continue. The Committee would like to reiterate the need for adequate attention to this sector.

Recommendations

The Committee has already made recommendations regarding the increased use of renewables, conservation measures, improvements in efficiency of resource use and promotion of new clean technologies. Such measures would bring in environmental benefits though the rationale for such efforts is not merely the environmental benefits that they brust. Since these have already been discussed earlier such recommendations are not repeated here.

The Committee, wishes to make the following additional recommendations for consideration of the Government:

- *Incorporate costs of environmental damage/mitigation measures into project appraisals. Adequate and comprehensive incorporation of environmental costs and benefits of using a particular technology or resource should form part of project analysis. This, the Committee, believes would lead to more rational choices in the energy sector.*
- *Device a comprehensive and humane policy for the rehabilitation of families affected by developmental projects. Such rehabilitation ought to precede, not follow the launching of projects involving displacement of people.*
- *Ensure that land management becomes an integral component of coal mining projects. Care should be taken to minimize adverse effects of mining operations, and reclamation measures should be undertaken to restore degraded land. Afforestation of degraded land and compensatory afforestation where forest land is diverted need special attention. Sufficient provision for these should be made at the planning stage.*
- *Ensure that adequate pollution control measures are undertaken and suitable devices installed, and more importantly operated and maintained in power plants and refineries.*
- *Promote the use of more efficient devices—biogas plants and improved chulhas—in respect of biomass-based devices to mitigate environmental problems in this sector.*
- *Examine and promote the use of effluents as raw materials, as in the use of ash for the manufacture of cement or bricks. The Committee, wishes to emphasize R&D, and demonstration projects in this regard. Suitable incentives to entrepreneurs need to be provided to promote such alternative use of effluents.*

It is obvious that while sufficient legislation has been introduced, enforcement is the weak link in the chain. This institutional mechanism for tackling, managing and enforcing environmental standards needs attention.

In this respect the Committee recommends:

- *Integrating the functioning of sectoral ministries, State Governments, local bodies and agencies responsible for planning implementation of development projects. Integrating environmental concerns more effectively in all policy areas and strengthening governmental and institutional structures dealing with environmental management, especially within the ministries concerned.*
- *Strengthen administrative arrangements for monitoring and enforcing of environmental standards; decentralise environment*

impact assessments and environmental law enforcement based on cooperation with local authorities.

— *To provide funds, qualified staff and other facilities like laboratories, equipment to implementing organisations.*

— *To provide professional training in operation and maintenance of pollution control treatment devices and laboratories; in setting standards; in management of hazardous waste; and in modelling, data processing legal aspects to the staff concerned.*

CHAPTER V

CONCLUSIONS & RECOMMENDATIONS

The Committee hold that an analysis of the energy policies, the programmes derived therefrom, and their implementation suggests that policy pronouncements have progressed little beyond statements of intent. There has been little or no action to fulfil the objectives as set out in the polices. While there have been many specific deficiencies, the major ones are:

— the inability to meet the energy needs (in a dependable and low-cost manner) of millions of people in the country;

— the failure to conserve the natural resource base and avoid the widespread environmental degradation that has taken place.

The Committee are of the view that the formulation of these policies, themselves, has left a lot to be desired. More often than not, policies have ad hoc, emerging as responses to crises rather than as well-thought out strategies. There is no evidence of a considered, long term, strategic plan for the energy sector and its role in the developmental process in the country. There is a need for greater thrust to meet challenges in a pro-active fashion rather than respond to them as has hitherto been the case.

While the policies have at different times emphasized various concerns the most serious ommission must be the neglect of the issue of "sustainability." Given that the use of energy is pervasive, and impacts on virtually every human activity. (which in turn is impacted by such activities) planning for any developmental process must have energy as a key component. Looking at the range of problems from the global issue of climate change, to a micro one such as the lack of cooking fuel, it is obvious that current trends cannot continue and issues of sustainability must find a central role in energy planning and policy.

It is critical to ensure an appropriate supply-mix of the various options, given the natural resource endowments of the country and the needs of the people. Any policy has to be directed to the long term and must encompass considerations of sustainability of the process. Optimality of the supply-mix, efficiency in resource use and conservation of natural resources while ensuring adequate supplies to meet the demand for energy. Thus pricing and investment policies are the fit instruments to meet these objectives. The critical need for sustained R&D cannot also be overemphasised.

The Committee wishes to emphasize the indispensability of the above

considerations. At the same time, it also recognizes the need to take action in the short run on immediate problems. A few such specific measures deserving the highest priority are listed below, again details being in the relevant sections of Chapter III.

Major Recommendations

Supply Sectors

Coal

The major recommendations of the Committee are:

— Improve the productivity of labour by upgrading their skills and by rationalising rehasilitating or resettling the deployment of surplus manpower;

— improve the productivity of capital by better capacity utilization of existing equipment; further mechanise the mining and loading operations; and adapt (to local conditions), rather than transplant the technology acquired from other countries;

— ensure satisfactory quality of coal supplied by installing coal handling plants; promote beneficiation and improved washing technology;

— promote the use of coal as a domestic fuel;

— ensure adequate inter-grade price differentials to reflect quality differences;

— provide greater thrust on R & D efforts for clean coal technologies including for gasification and IGCC. It is important that this be an area for continual work; demonstration projects should be undertaken and adequate incentives be provided to investors to encourage wider dissemination of such technologies;

— incorporate enironmental consideraions in planning for coal production as well as its utilisation.

— avoid over-exploitation of mines at the cost of human safety.

Hydrocarbons

The Major recommendations of the Committee are:

— Steps be undertaken to encourage exploratory and drilling activities. The price of crude oil should be so fixed as to allow for adequate internal resources generation for undertaking such activities. As for mobilizing private Indian or foreign capital participation, timely decisions should be taken keeping in view the national interest;

— Indian Private Companies that have been given exploration rights be encouraged to develop available blocks and should not be placed at any disadvantage vis-a-vis, foreign companies. The entire process of awarding blocks must be wholly transparent;

steps be undertaken to achieve enhanced oil recovery from existing wells and to reduce refinery losses;

prices of products should reflect the economic cost of supply. This is particularly important if private sector marketing of products is to be promoted;

immediate steps be taken to first reduce and subsequently eliminate flaring of natural gas. It is also important to determine the role of natural gas in the competing sectors of power production, fertilizers and petrochemicals while regional gas grids already exist, techno-economic suitability and advisability of establishing a national gas grid in the sub-continental country like India needs to be closely examined. The advisability of gas imports from the Gulf or from neighbouring countries also needs serious consideration;

encourage the use of CNG as a replacement for conventional fuels in the transport sector.

Power

The major recommendations of the Committee are:

improve the efficiency of operations of thermal power plants in respect of thermal efficiency, plant load factor, peaking capacity, reduction in forced outages and in auxiliary consumption of power. The impact of the ongoing R & M programmes need to be monitored and reviewed on a regular basis;

a shift in emphasis from additions to generation capacity to the performance of T & D network so as to reduce the transmission and distribution losses by 5% by 1996-97;

rationalise the supply mix so as to restore an optimal thermal-hydro mix;

rationalize tariffs to ensure adequate resource generation for utilities and to promote efficient use of electrcity; in particular, for the agricultural sector the tariffs should be pro-rata and not a flat rate. While tarrifs must be based on normative costs of supply this must be done by ensuring that consumers do not have to pay for the high cost, low efficiency operations of power plants;

adequate and all needed budgetary support be provided to meet the target of 10,000 MW in respect of nuclear power by 2000 A.D.

Renewables

The major recommendations of the Committee are:

provide incentives to renewable energy technologies that are at least on par with those provided for conventional sources of supply;

give R&D efforts a renewed thrust and a focus; and involve the industry in such efforts;

involve non-governmental organisations in dissemination programmes especially in respect of devices used in rural areas.

Demand side

As identified in this report the savings on account of demand side management run into thousands of crores of rupees. Not only are they low cost, they have a short gestation period implying a quick pay-back. The most prominent of these are:

a shift from road to rail in freight movement;

a shift from private to public means of transport;

need for comprehensive traffic management schemes;

enhanced efficiency in lighting by the use of more efficient lamps and fixtures;

improving the efficiency of motors and pump-sets in the agricultural sector;

conservation measures in the industrial sector.

A majority of the measures outlined above, can be implemented in a relatively short period of time, Steps should be taken to ensure that conservation measures identified are implemented and that they do not remain on paper. Over the long term, it is important to ensure that institutions are strengthened and capabilities built-up to deal with the challenges and realities emerging in the energy sector.

The Committee find it necessary to reiterate this aspect.

Mobilisation of Resources & Institutional Changes

It is the opinion of the Committee that to meet future energy demands, additional resources for expansion and upgradation of the energy supply system would have to be ensured by means of:

internal resource generation by the supply companies; and

inviting investment capital from the private sector.

It is important that energy producing companies are able to earn a fair rate of return on their investments so as to enable them to self-finance or part of the investment required for augmenting energy supply in the future. In order to ensure their financial viablility immediate attention needs to be directed towards:

improving the prerformance of the coal and oil companies and electricity boards; and

rationalisation of the energy prices paid to them, based on normative efficient costs.

In addition, resources would have to be mobilized from the private sector, both from within and outside the country.

This would require:

identification of areas, the development of which could be completely entrusted to the private sector, such as service activities related to production of crude oil and natural gas, washeries for non-coking coal, SSF/coal briquette units, and T&D operations in the power sector;

in view of the lukewarm response from the private sector there is a need to continuously review the incentive package for encouraging private sector participation.

Privatisation, though inescapable, ought not to become an indiscriminate free for all.

Considerable restructuring of the institutions involved in the energy sector appears as vital for a re-orientation of the country's energy policy. The Committee suggests as follows:

an Energy Commission headed by the Prime Minister for evolving and integrated energy policy and to ensure balanced development in an environmentally and socially sustainable fashion. The Commission should draw participation from various Ministries (Power, Coal, Petroleum and Natural Gas, Environment and Forests, Non-Conventional Energy Sources), the Planning Commission and State Governments.

an autonomous regulatory body may be established which could draw participation from the producers, consumers, government, industry and other experts to discharge the following functions:

(i) assist in drawing up medium term plans of energy supply by boards/companies;

(ii) set prices based on the normative efficient costs so that the cost of inefficiencies in the supply system are not passed on the consumers;

(iii) ensure an integrated approach to energy pricing to achieve an optimal energy consumption and desired inter-fuel substitution.

This autonomous body may be in the form of an Energy Pricing Commission, with statutory powers to set and regulate energy prices for the producers and consumers, while ensuring transparency in its operations.

An *empowered committee* should be set up to expedite decision making on the proposals submitted by the private sector for oil and gas exploration and production, marketing of petroleum products, transportation and supply of natural gas, power generation and its T&D, etc.

In a similar manner, an *autonomous non-governmental body* with representatives from industry, consumers and other interest groups should

be constituted to draw up a National Energy Conservation Plan, for each of the energy intensive industries.

This would help in achieving the full energy conservation potential. It is proposed that the National Energy Conservation plan be drawn up in the manner similar to the country programme for India for phasing out Ozone Depleting Substances (ODS) under the Montreal Protocol. Such a programme would require the joint effort of the Government and the industry to bring about a more concrete and well defined sense of purpose in the implementation of the programme.

In the rural areas, specific institutional requirements could include:

(i) strengthening panchayats or creation of village cooperatives for energy management;

(ii) forwarding fiscal incentives and soft loans to rural entrepreneurs to disseminate renewable energy technologies (biogas, gasifiers, briquettes) on a commercial basis;

(iii) creation of training infrastructure at the district level for better implementation and monitoring of the energy programmes;

(iv) supporting R&D infrastructure at the state level to develop location specific eco-suitable technologies.

With particular reference to the renewables sector. It is felt that CASE (Commission for Additional Sources of Energy) needs to be revived and strengthened. The revitalised CASE enlarged to include representative from the industry and the R&D community, should focus on:

(i) developing detailed programmes of research in different technologies;

(ii) fixing specific technology development goals and finite time frames;

(iii) determining the scope of R&D institutions and industry involvement in achieving the set goals, and

(iv) recommending structural changes within the RET sector to the EPAC.

The role of Ministry of Non-Conventional Energy Sources also has to evole further as facilitator of rapid commercialisation. Emphasis should lie on creating a demand-pull approach and avoiding the technology-push approach since the visualised scale of use of renewables cannot be fulfilled without a market driven demand, which in turn requires the involvement of industry. The need to take the industry into confidence by those formulating plans for technology development cannot be over-emphasised. The process of initiating and encouraging industry would require venture and risk capital. Strengthening and creating risk capital financing institutions for financing the commercialisation of RETs will have to be one of the strategies.

There is a need for a comprehensive document which brings out information and statistics on various aspects of energy including resource availability, supply, consumption, pricing and the environment. Several governmental and non-govermental organisations do bring out such information on a regular basis, however, the Committee believes that there is a need for a document which would at one place provide relevant information on all issues of energy. Hence, the Committee recommends that the Government bring out every year a comprehensive report on energy and lay it in Parliament for the benefit of members and the public.

PROJECTIONS OF ENGERGY DEMAND AND SUPPLY ASSUMPTIONS AND METHODOLOGY

General assumptions

GDP grows at an average real rate of 5% per annum.

The population growth rates estimated by the Standing Committee of Experts on Population Projections (Planning Commission). October 1988 were used with some modifications. Population grows at an annual rate of 2.01% between 1992-2002 and 1.81% during 2002-2010.

Urbanization at the national level increased from 27.5% in 1991 to 29.5% in 1996-97, 32.5% in 2001-02 and 37.5% in 2009-10.

Scenario specific assumptions

Base case

Energy demand

in agriculture sector the output would grow at an annual rate of growth of 3%. This is in consonance with the Planning Commission projections up to the year 2000.

only energy intensive industries were considered and their growth rates were assumed as follows:

(i) low growth industries (3-6% per annum)—textile, fertilizer, iron and steel.

(ii) medium growth industries (6-10% per annum)—aluminium, cement, chemicals and petrochemicals.

high growth industries (10-12% per annum)—electrical and non-electrical machinery;

in the transport sector the rail: road mix (in %) which was 20:80 in 1988-89 is expected to be 13:87 in 2001-02 in case of passenger transport and 48:52 to 35:65 over the same time period in case of freight transport. The Steering Committee on Perspective Planning for Transport Development had worked out these shares for 1987-88 and projected them for the year 2000. In the absence of firm numbers, the shares considered for 2009-10 are assumed to be the same for the year 2001-02.

in the urban residential sector, by fitting a log-normal curve the income distribution of population was projected assuming there would

be a decline in the incidence of poverty. The survey information collected by TERI for energy consumption in urban areas in 1987-88 were used.

in the rural domestic sector, the norms of energy consumption derived by compiling data collected from a number of rural energy surveys, conducted from 1952-92 in India to create a Rural Energy Data Base (REDB), was used.

Energy supply

Power

In case of the power sector, the capacity additions envisaged for the Eighth Plan, based on projects which have been sanctioned or are ongoing and those cleared by the CEA, were used. These have been modified to take into account the projects which will not materialize due to delays or financial constraints. The capacity additions for 2007-10 were based on extrapolation of trend between 2001-02 and 2006-07.

The aggregate capacity addition was assumed to be 20,009 MW during the Eighth Plan (as against 30,538 MW envisaged by Government), 37,437 MW during the Ninth plan period and 73,806 MW during 2002-10

Power generating capacity as at the end of the Eighth Plan, Ninth Plan and the year 2009-10 (MW)

	As on 31.3.1992	As on 31.3.1997	As on 31.3.2002	As on 31.3.2010
Hydro	19,279	24,821	39,686	69,992
Thermal (coal)	44,934	55,042	72,362	102,224
Gas turbine	3,177	6,657	9,029	18,275
Nuclear	1,800	2,680	5,560	9,952
Total	69,190	89,200	12,6637	2,00,443

The other assumptions were:

There will be an improvement in the plant load factor of thermal, nuclear and gas turbine power plants.

The auxiliary consumption will reduce in case of thermal and nuclear power plants.

The specific fuel consumption of coal and fuel oil in case thermal power plants will also get reduced.

Coal

The production of coal is based on the projections made by the Planning Commission (for the Eighth Plan and Ministry of Coal (for the

Ninth Plan). No firm data are available for the year 2009-10 and the production figures shown below are only estimates.

Production of raw coal (mt)

	1996-97	2001-02	2009-10
Coking	60.0	72.0	141.8
Non-coking	248.0	298.0	431.5
Total	308.0	370.0	573.3

The share of open cast mines will increase from 64% at the end of the Seventh Plan to 71% in the terminal year of the Ninth Plan and 73% by the year 2009-10.

Petroleum

The domestic production of crude oil would not be adequate to meet the entire demand for petroleum products, leading to imports of both crude oil and petroleum products at the margin.

Availability of crude oil (mt)

	1996-97	2001-02	2009-10
Crude oil production	41	50	70
Refining capacity	65	85	n.a.
Crude import	24	35	n.a.

Conservation scenario

Energy demand

In the agriculture sector energy conservation would be achieved by retrofitting of agricultural pumpsets, and adoption of more efficient irrigation practices such as drip irrigation for crops such as sugarcane, cotton and oilseeds and sprinkler irrigation for maize and gram. Both these measures have much high application efficiencies, in the range of 85-95% as against the present application efficiency of less than 50%.

Energy conservation measures were analyzed in the case of three industrial sub-sector, namely:

(i) iron and steel

(ii) cement

(iii) chemicals and petrochemicals.

In the transport sector, the impact of four specific was considered. These are:

(i) a shift from road to rail transportation for both passenger and freight traffic. For passenger transport the rail:road mix was assumed to improve to 30:70 in 2001-02 and 40:60 in

2009-10, and for freight transport the shares would be 61:39 and 72:28 in the two years under review.

(ii) improvement in road conditions which would entail widening of low grade section, strengthening of two lane pavements, etc. These measures are estimated to achieve a 10% fuel efficiency improvement.

(iii) introduction of more efficient public buses (called urban buses) for intra-city passenger transportation, leading to an efficiency improvement of 10%.

(iv) urban rapid transit system for nine cities with a large population.

Efficiency improvement measures considered in the domestic sector included:

(i) for cooking and water heating, the efficiency of stoves using LPG and soft coke was assumed to improve by 5-10%.

(ii) for lighting purposes there will be a substitution of incandescent bulbs with fluorescent tubes.

(iii) energy efficiency of selected electrical appliances, such as refrigerators, fans and air-conditions would improve. In addition, from 2002 onwards about 25% of the old stock of refrigerators would get replaced by mare energy efficient refrigerators.

Energy supply

Compared to the base case, the conservation scenario assumes higher efficiency improvement in the power supply system. However, there would no change in the efficiency of supply of coal and oil.

Methodology

Agriculture

Energy demands were estimated for two different end-uses, irrigation and land preparation for foodgrains and non-foodgrains separately. Based on the GDP growth rate and sectoral growth rates, the likely cropped area was projected. The energy requirement for irrigation was determined on the basis of the requirement of ground water which is a function of the gross cropped area.

Energy demand for soil preparation depends on the number of tractors used which again was related to the gross cropped area. The tractor population, the average horsepower rating of the tractors, the overall annual usage and consequently the average fuel consumption norms were used to arrive at diesel consumed by tractors for land preparation.

Industrial sector

In order to estimate energy demands, the outputs of various energy intensive industries were projected into the future and specific energy consumption norms and norms of fuel shares were applied to compute energy consumption. Besides, a 10% energy conservation at the national level was assumed. Energy demand projections for industries with a heterogenous output were made simply by taking the product of the existing intensities of fuel consumption per unit of value added and value added projections for different terminal years.

Transport sector

The basic parameters in case of passenger traffic were passenger transport demand and the level of population. The logarithm of total passenger movement per capita was regressed on time (for the time period 1960-61 to 1984-85) to establish a relationship, on whose basis the values of passenger traffic per capita for the future were worked out. These were, in turn, used to compute the total passenger traffic for the corresponding population levels. The quantum of energy consumed in passenger traffic by rail and road was estimated by taking into account the volume of traffic handled by the alternative modes and the fuel intensity of each which is given by the National Transport Policy Committee (May 1980). As in the case of passenger traffic, the past data on the volume of freight traffic from 1960-61 to 1984-85 was used for projecting future freight carrying requirements. The projection was done on the basis of a linear relationship between the total tonne kilometres carried and 'GDP at factor cost'. The demand for energy for carrying freight by rail and road was calculated on the basis of the volume of traffic handled by each mode of freight transport and intensity of fuel consumption (the latter again taken from the Report of the National Transport Policy Committee) (GOI, 1980).

Urban domestic

The demand for energy in urban residential sector is a function of several demographic and economic factors such as population, urbanization, household income and savings and distribution of population by income class. A per capita energy consumption norm, estimated from a survey undertaken by TERI (1987), was used to determine the energy demand from this sector. These norms pertain to specific end-uses such as cooking, lighting, water heating, space heating & cooling, and use of other electrical appliances.

NEW DELHI;
2 March, 1994
11 Phalguna, 1916 (Saka)

JASWANT SINGH
Chairman
Standing Committee on Energy.

ABBREVIATIONS

Bbbl	—	Billion barrels
bcm	—	billion cubic metres
bmt	—	billion metric tonnes
EPAC	—	Energy Policy Advisory Council
kWh	—	kilo Watt hour
mmt	—	million metric tonnes
MNES	—	Ministry of Non-conventional Energy Sources
Mtoe	—	Million Tonnes of Oil Equivalent
MW	—	Mega Watt
n.a.	—	not available
ODS	—	Ozone Depleting Substance
RETs	—	Renewable Energy Technologies
tcm	—	trillion cubic metres
TWh	—	Tera Watt hours (10^9 kWh)

Conversion factors for various energy fuels to mtoe are as follows:

Coal	1 mt=0.49 mtoe
Natural gas	1 million cu.m.=856.8 toe
Hydro power	12000 GWh=1 mtoe
Nuclear power	12000 GWh=1 mtoe
LPG	1 mt=1.059 mtoe
Naphtha	1 mt=1.029 mtoe
Mogas	1 mt=1.029 mtoe
ATF	1 mt=1.020 mtoe
Kerosene	1 mt=1.010 mtoe
HSD	1 mt=1 mtoe
LDO	1 mt=1 mtoe
Fuel oils	1 mt=0.956 mtoe
Other pet pdts	1 mt=1 mtoe

1 mtoe=10.2 x 10^{12} kCals

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