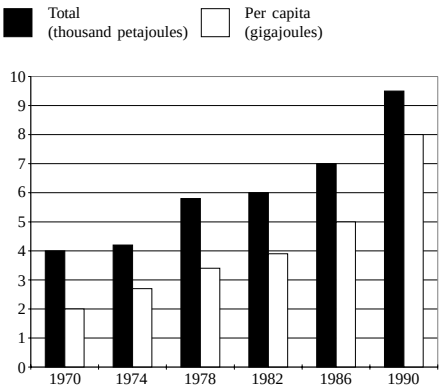
Geo Factsheet

Number 23

The Energy Mix In India

India is one of the largest energy consuming countries in the developing world and energy consumption has increased steadily over the last 20 years (Fig.1).

Fig 1. Total & per capita commercial energy use in India, 1970-90



India is 79% self sufficient in energy, 21% is imported, mostly as oil. Unless current demographic and energy consumption patterns change, India will surpass China in total population and equal it in both energy use and greenhouse gas emissions. At present however, it is important to keep things in perspective; per capita energy consumption in India is still only a fraction of that in the developed world (Table 1). The changing energy mix in India is shown in Fig 2 and Table 2.

Table 1. Energy consumption, India and United States 1991

RESOURCE	CONSUMPTION (MILLION METRIC TONS)		INDIA: U.S. PER CAPITA RATIO	IMPORTS (% OF CONSUMPTION)	
	INDIA	U.S.		INDIA	U.S.
COAL	185	672	1:3.6	3.0	0.5
PETROLEUM	53	666	1:12.5	45.0	43.6
NATURAL GAS (TERAJOULES)	397	21,400	1:53.9	0.0	9.0

Fig 2. Sources of energy (%)

A = Solids (76%)
B = Liquids (14%)
C = Gas (6%)
D = Hydro (3%)
E = Nuclear (0.9%)
F = Geothermal/Wind (0.1%)

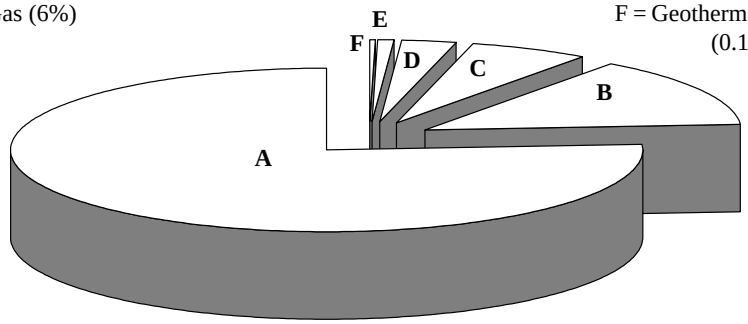


Table 2. Sources of energy (% increase since 1973)

Geothermal/ Wind	Hydro	Solids	Liquids	Nuclear	Gas	**Total**
-	160	211	284	500	1,838	**233**

In developing such an energy mix, the Indian government has tried to reconcile three aims:

- In the short term, the aim has been to maximise economic efficiency
- In the medium term, ensure security of energy supply
- In the long term, manage what are mostly finite resources.

Coal

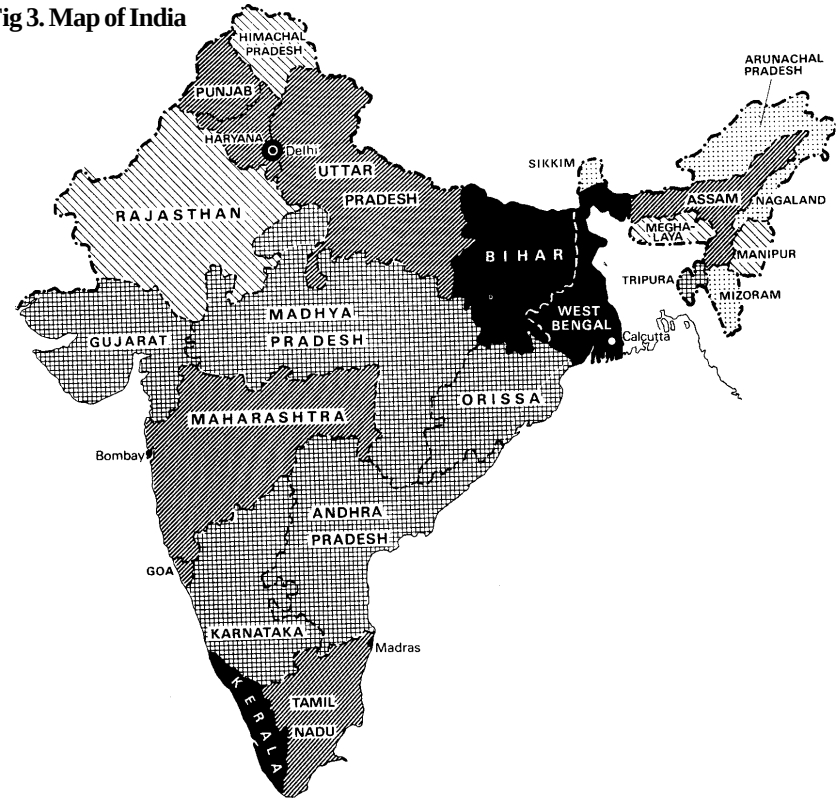
The coalfields of Bihar, west Bengal and Madhya Pradesh account for 90% of production (Fig.3 overleaf) and coal provides 40% of the country's energy requirements and 60% of its commercial energy. Coal production has dramatically increased over the last 20 years and India remains almost self-sufficient. Whilst Indian coal is low in sulphur, it contains 25-40% ash which reduces power station efficiency and creates disposal problems. The location of the major coal fields also causes difficulties as the rail network struggles to deliver from the eastern fields to the power stations of the west and south. Recently however this situation has begun to improve as coal-washing facilities, which reduce volume, sulphur and ash content, have been developed.

Oil and gas

India spends 25% of its foreign exchange earnings on the import of oil which accounts for about a quarter of commercial energy consumption. Home production, mainly in Gujerat, Assam and offshore near Bombay, increased rapidly during the 1970s and 1980s but then actually fell in the mid 1980s and has since stagnated.

Exam Hint *- In considering the term energy mix, candidates should focus on what and why. Candidates should show that they appreciate the very rapid changes which can take place in the pattern of production and consumption but all of this should be firmly supported by actual data*

Fig 3. Map of India



85% of oil consumption is used in the transport and domestic sectors but the aim is to substitute renewables in these areas and to reduce remaining oil consumption by the development of mass transit systems in major cities.

Natural gas supplies 10% of India's commercial energy but, ironically huge amounts are still burned off because of a lack of the infrastructure required to distribute it from associated oil fields. Gas supplies actually exceed oil reserves.

Fuelwood

Traditional fuels such as wood contribute 40% of total energy supplies and 75% of domestic supplies.

Fuelwood collection is a major task for most rural families (Table.3)

Table 3. Time spent gathering fuelwood 1982 (hours/day)

Southern India	Gujarat
1.7	3.0
Women 0.7 hours Children 0.5 hours	In family of 5, one person spends entire day collecting wood.

In addition to fuelwood, forests provide fodder for livestock and are increasingly exploited for paper and construction timber. Over the last 15 years, sharp increases in the price of commercial fuels such as coal, charcoal and kerosene has forced millions of urban dwellers to use fuelwood for cooking. Increasing demand for fuelwood around urban areas has caused huge price increases

This has had two impacts:

1. It has stimulated demand from rural areas, increased shortages there and accelerated deforestation.
2. Forest cover around major cities has been seriously damaged.

Many urban people still rely almost solely on fuelwood collected from the surrounding rural areas and widespread deforestation around Indian cities has caused huge increases in the prices of fuelwood.

Hydro

The development of new large scale hydroelectric plants has met with fierce resistance on environmental salinisation (habitat destruction) and social (incidence of malaria displacement) grounds. Recently however, microhydro projects have been enthusiastically developed. Hydroelectricity is the main source of energy in several states e.g. Himachel Pradesh, Jammu and Kashmir.

Solar

India has the largest solar cooking program in the world and solar collectors heat industrial and domestic water supplies and generate electricity for over 10,000 villages.

Wind

Wind power in India has a number of great advantages; it is non-polluting, operation and maintenance costs are low, windfarm construction is rapid and can occur on a small and decentralised scale, reducing transmission and distribution facilities and losses. 250 wind turbines have been established at 12 sites. Present generating capacity is 45MW, but the national target is 3000MW by 2000. Although the development costs of windfarms are almost equal to equivalent capacity fossil fuel plants, the cost of the former are expected to fall dramatically as technology improves, whilst the cost of the latter will increase.

Besides reducing oil dependency, increasing use of non-commercial energy sources is seen as an important method for reducing global pollution problems. Energy generation from non-conventional sources is shown in Table 4.

Table 4. Energy generation in India from non-conventional energy sources

Source	During 1995-200 in Million Tonnes of Coal Replacement
Biomass	24.236
Wind	7.28
Solar system	2.84
Small hydro	5.356
Improved chulhas	43.89
Biogas plants	27.93
Plantations	28.50
Sewage sludge	0.156
Solar thermal system	12.00
Photovoltaic pumps	0.048
Wind pumps	0.012
Small battery chargers and stand alone systems	0.024
Distillery	0.0946
Municipal solid waste	0.402

Nuclear

India has eight operating nuclear power stations but the nuclear industry has met with strong environmental resistance. Uranium deposits are found at Udaipur in W. Madhya Pradesh and in Orissa.

Energy efficiency

The energy efficiency of industrial production is notoriously low; integrated steel plants (the steel industry is India's largest energy consumer) presently use 45-53 gigajoules per metric ton of steel produced, more than twice the amount of energy used to produce a similar tonnage of steel in the US. 20% of all electricity generated is lost during transmission and distribution.

India has recently concentrated on improving the sophistication of its integrated resource electric planning or least-cost planning strategy. This is basically an attempt to acquire the energy for each end use at the lowest possible cost. This may involve increasing the efficiency of supply e.g. by reducing transmission losses or involve fuel or power station substitution.

To fully appreciate the complex pattern of domestic energy consumption in India it is necessary to look at the huge income distribution of its 1 billion people (Table.5).

Table 5. Income distribution in India

Income per year (Rupees/Household)	Rural	Urban	Total
	% of population		
Up to 12,500	67.34	37.14	58.84
12,501-25,000	23.89	34.76	26.95
25,001-40,000	7.07	17.89	10.11
40,001-56,000	1.16	6.46	2.66
Above 56,000	0.54	3.75	1.44
All classes	100.00	100.00	100.00

When the urban and rural population is grouped into three categories (the top 10%, the middle 40%, and the bottom 50%) very different energy consumption patterns emerge.

Table 6. Per capita consumption of energy 1991 (Rupees/yr)

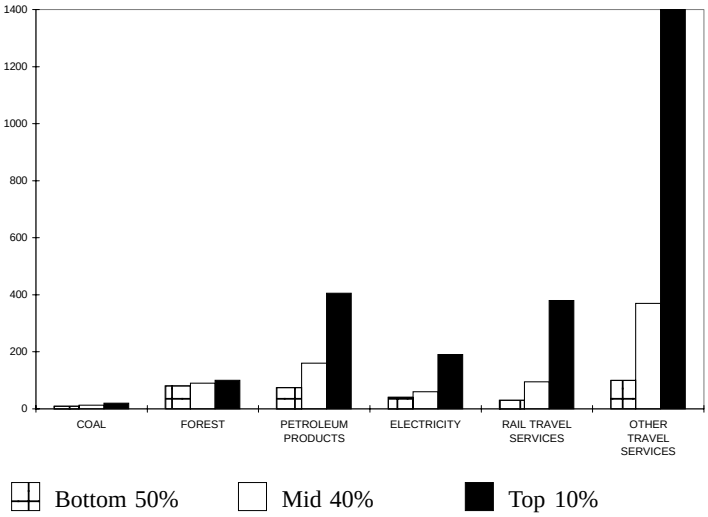
	Rural			Urban		
	Bottom 50%	Mid 40%	Top 10%	Bottom 50%	Mid 40%	Top 10%
Coal & Lignite	22	37	81	40	94	237
Crude petroleum and natural gas	40	66	139	76	186	497
Electricity gas and water supply	81	137	264	150	346	831

At each income group, urban people use more energy than rural dwellers and in general, disparities between the top 10% and the bottom 50% are greatest in urban areas.

For some end-users, the per capita consumption of the lowest income group is almost negligible when compared with the level of consumption of the highest income group (Fig 4).

The greatest disparities occur in the transport sector which reflects both the relative isolation of the lowest income groups and their dependence on mass transport.

Fig 4. Indian per capita consumption, energy and transport



The future

Despite the huge costs involved, the national plan is to fund huge increases in energy generating capacity. This will involve:

Encouraging the privatisation of some parts of the energy sector - it is accepted that this will inevitably lead to price increases.

Increasing the national production of natural gas and its use via a national gas grid in order to reduce oil imports and to increase electricity generation. Natural gas fired power stations are both cheaper to build and more efficient than coal-fired plants.

Development of industrial cogenerating facilities which will burn a wide range of biomass fuels-crop residues, quick-growing plantation timber etc. Family-sized biomass gasifiers already supply 2 million rural homes with biogas. Community-sized biogas digesters which can be used to generate electricity for pumping water and for lighting are, at present, rare but are expected to grow rapidly in number through government led subsidies.

Huge expansion of other renewables, especially solar and wind generation. It is estimated that solar energy could contribute 20% of rural supplies and 50,000MW are expected from wind power by 2010. The Indian Renewable Resources Development Project has attracted $12.25 million from international and bilateral sources which will be used to accelerate production from microhydro, wind farm and solar photovoltaic supplies. The Ministry of Non-Conventional Energy Sources has proposed that all government buildings should be fitted with solar powered hot water systems and energy audits look set to become compulsory under the National Energy Conservation Act. For example, the Indian Ministry of Non-Conventional Energy Sources has as part of the Eighth Five Year Plan invited proposal from the private sector for the establishment of solar power plants.

Acknowledgements;

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