

Indian energy sector: an overview

India: key economic indicators—2001/02 and 2002/03 (A)

	2001/02 (Q)	2002/03 (A)
Gross national product (at factor cost) (Rs in billion)		
At current prices	20 814.0	22 178.0
At 1993/94 prices	12 570.0	13 099.0
Gross domestic product (at factor cost) (Rs in billion)		
At current prices	20 940.0	22 361.0
At 1993/94 prices	12 654.0	13 207.0
Agriculture and allied sectors at 1993/94 prices (Rs in billion)	3 020.5	2 926.3
Index of agricultural production	177.1 (P)	156 (P)
Foodgrains production (million tonnes)	212 (P)	183.2 (P)
Index of industrial production	167.0	170.5
Imports at current prices (Rs in billion)	2 452.0	2 132.3
Exports at current prices (Rs in billion)	2 090.2	1 852.1
Real growth rates (percentage change over the previous year)		
Gross domestic product	5.6 (Q)	4.4 (A)
Agriculture and allied	5.7 (Q)	-3.1 (A)
Industry (mining, manufacturing, electricity, construction)	3.3 (Q)	6.1 (A)
Services (trade, hotels, transport, communication, community services)	6.8 (Q)	7.1 (A)

P - provisional; Q - quick estimate; A - advanced estimate

Source Ministry of Finance and Company Affairs (2003)

Introduction

After the first oil embargo in 1973, the energy sector emerged as a crucial and dynamic component of the Indian economy. Since then, the supply and demand trajectories of this sector have undergone changes in response to economic, demographic, and technological factors. While technological innovations increased market opportunities and suitable policy reforms have boosted the country's energy supply potentials; a rise in the national income, population, and enhanced economic activities have contributed to the escalating demand for energy. This chapter attempts to summarize the performance of the Indian energy sector over the past three decades.

Background

Energy consumption, economic growth, and population are interlinked. In the case of India, it has been empirically proved that causality flows from economic growth to energy consumption, even in

the long run (Cheng 1999). India's GDP (gross domestic product) grew at an average rate of 4.9% per year in the past three decades. Significant economic reforms in 1991 geared economic activities leading to an average growth rate of 6.7% during 1992-96. The South-East Asian economic crisis in 1997 put a brake on the accelerating growth rate, though in 1998 the economy revived, averaging 6.1% from 1997 to 2000.

India's population crossed the one billion mark in 2000, having grown at an average rate of 2.1% per annum over three decades. However, since then the population growth rate has declined and was estimated at 1.9% in 2001. Progressive decline in the TFR (total fertility rate) from 5.2% in the 1970s to 3.6% in the late 1990s has helped in slowing the population growth rate.

The country's TPES (total primary energy supply) over the decades has kept pace with the rising income and population. It has catapulted upwards

from a modest figure of 147.05 MTOE (million tonnes of oil equivalent) in 1970 to approximately 437.69 MTOE by 2001, thereby growing at an average annual rate of 5.19% (Table I). The share of commercial energy has risen over the years from nearly 41.02% to 68.23% of TPES in spite of the dominance of non-commercial forms of energy in rural India. True to the nature of a developing economy, the commercial energy intensity [TOE (tonnes of oil equivalent) per thousand rupees of GDP] that was as high as 0.16 in 1970 has stabilized at around 0.028 during 2000 (Figure 1). The energy consumption – GDP elasticity figures – also reflect this pattern. The elasticity was more than unity for the 1953–2001 period. However, the elasticity for primary commercial energy consumption works out to be less than unity mainly due to increasing efficiency in energy use.

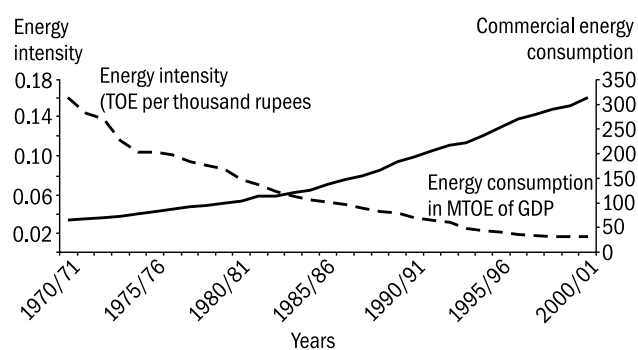


Figure 1 India's primary commercial energy consumption and commercial energy intensity

Source BP Amoco (2003), Calculations done by TERI

Past trends

The country has seen an expansion in the total energy use for the past five decades, with a shift from non-commercial to commercial energy sources. Hence the production of commercial sources of energy has considerably increased as indicated in Table II.

Coal is the most abundant among all the commercial energy sources, and its production has increased at an average annual growth rate of 5.11%, during 1970–2001. Its share in the total commercial energy supply has, however, declined from a level of 60.47% (36.48 MTOE) in 1970/71 to 44.8% (133.89 MTOE) in 2001/02 (Table II) primarily due to increase in the share of inferior grade coal in the overall coal production. Indigenous coal has always been the most stable and least expensive option for meeting the bulk of India's energy needs, especially for power generation.

Table I Trends in supply of primary energy (in MTOE)

Sector	1970/71	1980/81	1990/91	2001/02*
Coal	36.48	56.96	94.68	133.89
Lignite	0.81	1.23	3.34	6.52
Oil	7.01	10.79	33.92	32.03
Natural gas	0.6	1.41	11.73	26.72
Hydro power	2.17	4.0	6.16	6.37
Nuclear power	0.63	0.78	1.6	5.15
Wind power	–	–	–	0.14
Total	47.67	75.19	151.43	210.82
Net imports	12.66	24.63	31.69	87.85
Commercial energy supply	60.33	99.82	183.12	298.67
Primary non-commercial energy supply	86.72	108.48	122.07	139.02
Total primary energy supply	147.05	208.3	305.19	437.69

* provisional

MTOE – million tonnes of oil equivalent

Source Planning Commission (2002)

The petroleum and natural gas sector has registered a robust growth in domestic production and supply over the years, though the country continues to depend heavily on crude oil imports. Domestic oil production has registered a growth of nearly 5.33% per annum during the 1970–2000 period, though India's net import of crude oil and petroleum products has increased from 12.43 MT (million tonnes) to 75 MT in the same time period (Ministry of Petroleum and Natural Gas 2002). This is because consumption of petroleum products across all sectors has increased manifold, especially in the industry and the transport sector.

The Indian power sector, the backbone of a nation's development, has gradually evolved over the years. After independence, India's installed generation capacity was a mere 1.3 GW (gigawatt), while today it is more than 100 GW. Annual gross generation in utilities has grown at an average annual rate of approximately 7.7%, during 1975–2001. Over the years, thermal power (power from coal, diesel, gas, and wind) has continued its dominance over the aggregate power generation, and its share has increased from 54% to nearly 81% during the same time period. Industry is the largest consumer of power and its consumption has grown at the rate of nearly 4.2% per annum in the last quarter of the 20th century.

Table II Trends in production of commercial energy

Title	Production			
	1970/71	1980/81	1990/91	2001/02*
Coal (MT)	72.95	114.01	211.73	325.65
Lignite (MT)	3.39	4.80	14.07	24.3
Crude oil (MT)	6.82	10.51	33.02	32.03
Natural gas (BCM)	1.44	2.35	1.79	26.69
Hydro power (BkWh)	25.25	46.54	71.66	82.8
Nuclear power (BkWh)	2.42	3.00	6.14	16.82
Wind power (BkWh)	–	–	0.03	1.70

* anticipated

Source Planning Commission (2002)

The present¹

Fossil fuels are the foundation of energy needs in India. In 2001, coal contributed to nearly 55% of the primary fuel demand in the country, while oil contributed 34% (International Energy Agency 2002).

Coal

Coal has taken centre-stage in India's energy scenario. Its dominance continues unabated primarily because power generation favours this fuel, given its abundant indigenous availability.

About 70% of coal produced is consumed by the power sector. In addition, other industries like steel, cement, fertilizers, chemicals, paper, and thousands of medium and small-scale industries also depend on coal for their process and energy requirements. In the transport sector, though direct consumption of coal by the railways is reducing due to the phasing out of steam locomotives, the energy requirement for electric traction is still dependent on coal (Ministry of Coal 2003).

Three quarters of the total coal reserves in India are concentrated in the states of Bihar, Madhya Pradesh, and West Bengal. The total coal resources of the country up to a depth of 1200 m – as per the exploration carried out by the Geological Survey of India – are estimated at 240.78 billion tonnes as on 1 January 2003. Out of this, 37.42% is in the proven category, 46.78% in the indicated category, and 15.8% in the inferred category. Coking coal resources are estimated at 31 977 MT (13.28% of the total resources) and non-coking coal resources are estimated at 208 771 MT (86.72% of

the total resources). During 2002/03 (up to December 2002), domestic coal production was 239.76 MT (provisional), while coal dispatch was 244 MT (Ministry of Coal 2003).

Oil and Gas

As the economy grows, demand for hydrocarbons escalates. The transport sector consumed nearly 23.24 MT of petroleum products, while the industrial sector consumed 12.32 MT, during 2000/01 (provisional). Petroleum products to the amount of 5 MT (like high speed diesel, light diesel oil, fuel oil, and low sulphur heavy stock/HHS) were used for power generation. The agricultural sector (including plantation and other food) consumed nearly 7.7 MT (Ministry of Petroleum and Natural Gas 2002).

India's balance recoverable reserves of crude oil and natural gas stood at 732 MT and 763 BCM (billion cubic metre), respectively, by March 2002. Crude oil and natural gas production were 32 MT and 29.7 BCM, respectively, for 2001/02. The import dependency reached 73.3% as the country imported 78.7 MT of crude oil for refinery throughput of 107.2 MT. However, the effects of global slowdown were reflected in the Indian economy too and manifested in postponement of several planned refinery capacity additions/pipelines, and work-in-progress of grassroots refineries. The demand for petroleum products declined by 0.6% from the previous level of 100.75 MT, and the country exported 3 MT of petroleum products.

The discovery of 7 TCF (trillion cubic feet) of natural gas by Reliance in its KG-DWN-98/3 block in the KG (Krishna–Godavari) basin was the highlight of 2002. It not only improved the energy security of the country by boosting possible gas production by 50%, but also raised the prospects of Indian sedimentary basins in the international arena.

Power

India has at present (January 2003), an installed generating capacity of nearly 107 GW (Central Electricity Authority 2003). This comprises 70% of thermal (coal, gas, liquid fuel); 25% hydro; 3% nuclear; and 2% wind. Out of the total installed capacity, 90% is owned by the public sector (60% under state governments and 30% under the Central Government) and the balance of about 10% by the private sector.

The capacity addition of 19 015 MW during the Ninth Plan represents 47% of the targeted addition (Planning Commission 2002). At the beginning of

¹ Please refer to the respective chapters in this publication for details

the Ninth Plan, the energy shortage was 11.5% and peak deficit 18%. The actual power supply position as on March 2002 indicates energy deficit of 7.5% and peak deficit of 12.6%. This improvement is partly due to a marked improvement in PLF (plant load factor) of thermal plants as well as higher inter-regional transfer of power through the national grid in spite of major shortfalls in the capacity addition during the Ninth Plan period.

Renewable energy sources

Due to depleting fossil fuel resources, renewable energy sources such as solar, wind, biomass, small hydro power, etc. are emerging as alternative energy options. The potential for expanding the use of RETs (renewable energy technologies) for energy generation is vast in India and awaits exploitation. As on 31 December 2002, renewable sources of energy contributed to 3818 MW against a potential of nearly 100 000 MW. Against an estimated potential of 12 million biogas plants, about 3.44 million family-type plants have been set up so far, thereby saving 4.4 MT of fuelwood per year. SPV (solar photovoltaic) systems, with an aggregate capacity of 107 MW have been deployed to enable minimum electrical energy needs of rural and remote areas. The gross potential of wind power has been reassessed at 45 000 MW and presently India ranks fifth in the world with an installed wind power capacity of 1700 MW. As far as power from small hydro projects (up to 25 MW capacity) is concerned, only 1463 MW has been set up so far against a potential of 15 000 MW. Though environmentally friendly, the high initial cost of RET has been a major deterrent in harnessing the renewable resources.

The future

Projecting fuel-wise energy demand is by no means an easy task. With rapid changes in the relative availability and price in the fuel sector, coupled with technological innovations and new policies, the underlying assumptions forming the basis of any projection vary from time to time, thereby revising the estimates.

Globally, fossil fuels are likely to dominate the energy mix in the years to come and India is not an exception to this pattern. The primary commercial energy demand of the country grew at an annual rate of 6% from 1981 to 2001 and similar trends are also projected for the forthcoming years. By the end of the present Plan period (2006/07) and end of the next Plan (2011/12), one might expect the demand to grow at an average rate of 6.6% and 6.1%, respectively (Tenth Five-year Plan 2002–07).

Going by the estimated energy demand figures provided by the Planning Commission (Table III), one cannot possibly miss the fact that the demand for coal contributes a lion's share in the total commercial energy demand in India. The terminal years of the two consecutive Plan periods would see the share of coal declining only marginally from 46.13% to 46.04%. Coal being a relatively inexpensive source of energy compared to oil and gas, would continue as a dominant fuel in power generation. Although combustion of coal is environmentally not benign but with the deployment of advanced technologies, like clean coal technologies for power generation, that reduce the level of carbon dioxide emission per unit of output, its appeal as a generating fuel will remain intact in the long run.

With the economy striving towards an ambitious growth rate, there will be an obvious increase in mobility across the country, and oil is expected to be the most favoured fuel for land, sea, and air transportation. Thus the demand for oil is expected to grow at an average annual rate of 3.6% over the next five years, thereby remaining above the 2.1% average growth of the global energy demand (Planning Commission 2002).

Table III Estimated energy demand

Primary fuel	Demand in original		Demand (MTOE)	
	2006/07	2011/12	2006/07	2011/12
Coal (MT)	460.50	620.00	190.00	254.93
Lignite (MT)	57.79	81.54	15.51	22.05
Oil (MT)	134.50	172.47	144.58	185.40
Natural gas (BCM)	47.45	64.00	42.70	57.60
Hydro power (BkWh)	148.08	215.66	12.73	18.54
Nuclear power (BkWh)	23.15	54.74	6.04	14.16
Wind power (BkWh)	4.00	11.62	0.35	1.00
Total commercial energy	–	–	411.91	553.68
Non-commercial energy	–	–	151.30	170.25
Total energy demand	–	–	563.21	723.93

Source Planning Commission (2002)

The *India Hydrocarbon Vision 2025* of the government identifies natural gas as the fuel for the future, and the recent discovery of gas in the KG basin holds a great deal of promise in this context.

Renewable sources of energy have mass appeal worldwide due to obvious reasons. Despite being abundant and environmentally friendly, high initial

capital costs and skewed distribution across the country (77% of the hydro potential is in the north and north-eastern region) act as major deterrents in the path of its becoming a viable energy source. Besides harnessing the traditional wind, solar, and hydro energy; the MNES (Ministry of Non-conventional Energy Sources) is implementing programmes on chemical sources of energy, hydrogen energy, alternative/biofuels for surface transportation, geothermal energy, and ocean energy. Potential for generating about 1500 MW of power from urban and municipal wastes and about 1000 MW from industrial wastes exists in the country (MNES 2003).

Emerging energy concerns

Coal

By the end of the Tenth Five-year Plan period, domestic coal production is expected to touch 405 MT against an estimated coal demand of 460.5 MT excluding 5.24 MT of washery middlings. This implies a supply deficit of 55.05 MT, a part of which is proposed to be met through import of 17.18 MT of coking coal and 3.3 MT of non-coking coal (Planning Commission 2002). A further shortfall of 35.02 MT still exists which might lead to production constraints in other sectors that are contingent upon availability of coal.

Power

The legacy of agricultural subsidies in the form of cheap power, water, seeds, and fertilizers was initiated with the intention of making the Green Revolution more adoptable. Initially, the rationale for subsidy was provided by the 'infant industry argument', but even after several years of its introduction, the policy seems more of a bane.

In particular, the practice of subsidizing power for irrigation has come under close scrutiny since its effectiveness in increasing agricultural productivity is doubtful. A World Bank (2002) study, based in the states of Haryana and Andhra Pradesh, reveals that cheap power for farmers entails many hidden costs. Very often the benefit of low power tariffs is outweighed by the cost that they have to bear on account of erratic power supply and frequent motor burnouts due to fluctuating voltage. A striking result provided by the study is that the small and marginal farmers in Haryana have shown the willingness to pay for improved reliability of power supply.

This reinforces the futility of continuing with the uneconomical power subsidies, and instead calls for a better quality of power supply, even if at higher prices.

Oil and gas

Domestic crude oil production has not kept pace with the requirement, and hence our import dependency has risen to 73.36% in 2001/02. The *World Energy Outlook 2002* (International Energy Agency 2002) projects a 94% oil import dependency for the country in the year 2030, *ceteris paribus*. Apart from a massive foreign exchange drain on account of such large imports, high import dependency is also associated with risks of disruption in supplies that will have serious repercussions on the economy, given the high oil intensity of the economy and relative inelasticity of demand for hydrocarbons.

Strategies consisting of intensive domestic exploration efforts to add to the reserve base and acquiring of equity oil abroad are in place. Nevertheless, in the wake of volatile crude oil prices and highly unstable political configuration of the oil-exporting nations, the high import dependency of the Indian economy is a matter of grave concern.

Renewable energy sources

Renewable energy sources have a mass appeal but no mass application. This is primarily due to the fact that RETs are still primitive (Guru 2002) when pitted against the fossil fuel technologies. While the average capacity of coal- and gas-based power plants are in the order of 200 MW and 100 MW, respectively; that of wind, solar, and small-hydro lag behind at 0.50 MW, 0.25 MW, and 1.50 MW in the same (Guru 2002). Also, in terms of capacity utilization, fossil fuels show an impressive figure of anything ranging from 50% to 80%, while 55% to 65% for small hydro power is reasonably good, followed by wind and solar in the 10%–20% range (Guru 2002). Thus the advantage of free material costs for renewable sources are virtually outweighed by poor economies of scale and low levels of capacity utilization (Guru 2002).

Given such plethora of reasons, RETs can emerge as a viable option only in the wake of continued research that promises affordability for the masses.

Bridging the gap

Living in a world that is politically volatile, India's import dependency, which is showing no signs of decline, is worrisome. Some serious efforts need to be made in designing and implementing management practices of demand and supply.

If increased research and development, exploratory activities and technological innovation can promise additional supply, then efficient fuel pricing pooled with increased use of efficient appliances,

tamper-proof metering, compulsory energy audit in industry and inter-fuel substitution would ensure sustainable use of the existing resources.

Several policies incorporating the above recommendations are already in place and others are in the making. Perhaps a more relevant consideration at this stage is the successful implementation of these policies that can be achieved via fiscal incentives, institutional reforms and private participation (Box 1).

Box 1 General policies/options

Fiscal

- 1 Removal of subsidies
- 2 Use of policy instruments such as energy tax, carbon tax

Inter-fuel substitution

- 1 Switching over to cleaner fuels
- 2 Electrification of railways
- 3 Accelerated use of renewable sources of energy

Technology-related issues

- 1 Improving energy efficiency and energy conservation
- 2 Improving the public transport system
- 3 Increasing the movement of passengers and goods by the railway system
- 4 Promotion of information technology to reduce travel

Source Planning Commission (2000)

The road ahead

Presently India ranks sixth in the world in terms of energy consumption, accounting for 3.5% of world primary energy (commercially traded fuels only) consumption in 2002 (BP Amoco 2003). With a GDP growth of 8% set for the Tenth Plan period, the energy demand is expected to grow at 5.2%. Accordingly, the Tenth Plan strategy for the energy sector includes the following.

- Increasing the production of coal and electricity
- Accelerated exploration of hydrocarbons
- Equity oil abroad
- Introduction of reforms through restructuring/deregulation of the energy sector to increase efficiency
- Demand management through introduction of energy-efficient technologies/processes and appliances
- Emphasis on pollution abatement processes
- Integrated energy approach.

The following chapters of this publication touch upon the components of the Indian energy sector in greater details with emphasis on past trends, current happenings, and future outlook.

References

- BP Amoco. 2003
BP Statistical Review of World Energy 2003
London: BP Amoco
- CEA (Central Electricity Authority). 2003
Monthly review of power sector performance
New Delhi: CEA
- Cheng B. 1999
Causality between energy consumption and economic growth in India: an application of cointegration and error-correction modelling
Indian Economic Review 34: 39–49
- Guru S. 2002
Renewable energy sources in India: is it viable?
[Working Papers Series]
New Delhi: Julian Simon Centre for Policy Research, Liberty Institute
- IEA (International Energy Agency). 2002
World Energy Outlook 2002
Paris: IEA
- MoC (Ministry of Coal). 2003
Annual Report 2002/03
New Delhi: MoC, Government of India
- Ministry of Finance and Company Affairs. 2003
Economic Survey 2002/03
New Delhi: Ministry of Finance and Company Affairs, Economic Division, Government India
- MNES (Ministry of Non-conventional Energy Sources). 2003
Annual Report 2002/03
New Delhi: MNES, Government of India
- MoPNG (Ministry of Petroleum and Natural Gas). 2002
Indian Petroleum and Natural Gas Statistics 2000/01.
New Delhi: MoPNG, Government of India
- MoPNG (Ministry of Petroleum and Natural Gas). 2003
Annual Report 2002/03
New Delhi: MoPNG, Government of India

Planning Commission. 2000
Energy Policy Committee Report [Draft]
New Delhi: Power and Energy Division, Planning
Commission

Planning Commission. 2002
Tenth Five-year Plan 2002-07.
New Delhi: Planning Commission, Government of India

The World Bank. 2002
***Power Subsidies: a reality check on subsidizing
power for irrigation in India*** [Note No. 244]
New Delhi: Private Sector and the Infrastructure
Network, The World Bank