India's energy and transportation sectors need a priority effort

by Ramtanu Maitra

If there is one subject that brings unanimity of views in India, it is the demand for energy. Here the Punjabi farmer agrees entirely with his Tamil counterpart, and the Gujarati industrialist echoes the complaints of his Keralite competitor. Power is the single most urgently needed ingredient to speed up India's economic growth.

There are three basic sources of power generation in India: coal, hydroelectric, and nuclear. Some wasteful expenditure is made under the guise of developing non-commercial, non-conventional, renewable energy sources. But even those who are trying to pull the wool over others' eyes will admit on questioning that the effort is going nowhere. Some efforts are also afoot to generate electricity from natural gas. Since natural gas will remain the most important raw material for producing fertilizers, such a policy is unwise, and only a part of the "crisis management" approach to which a section of planners and officials has resorted.

Although India's coal reserves are sufficient to maintain energy independence over the coming two decades, after which nuclear fission must play a major role for generating electricity, the quality of Indian coal is hardly suitable for burning, because of its high ash content. While arguments can be made for developing furnaces to suit the Indian coal, the Indian planners are now also correctly looking toward using coal to produce fertilizers. Today, the cost of cleaning up the mined coal is excessive, and the process involves a great deal of handling time.

While India's hydroelectric potential is about 100,000 MWe at about 42% load factor (average capacity utilization), the general topography and other conditions in various parts of the country, particularly in the sub-mountainous regions, are such as to restrain development of a large part of it. Some of it may not even be considered economical under present conditions. So far, less than 15% of this potential has been exploited.

The one fuel source which India identified in the early fifties and has since been developing for large-scale commercial use, is uranium. Although the contribution of nuclear power, based on fission of uranium fuel, is less than 3% today, it is going to be India's prime energy source in the future.

Dr. Homi Bhabha, a cosmic ray physicist, was given charge of the Department of Atomic Energy by Prime Minister Nehru in the early 1950s. A visionary, Bhabha developed a long-term strategy for nuclear power in India, which took into account what he saw as the future political ramifications of nuclear power. He realized that India's uranium reserves were meager as compared to those of the rest of the world, but on the other hand, deposits of thorium were abundant. Bhabha established that nuclear power strategy in India should aim at using up the uranium, while at the same time moving toward greater consumption of, and ultimately reliance on, thorium. This is the strategy that was subsequently pursued.

Dr. Bhabha's program involved three stages. The first was establishing a chain of nuclear power stations, using natural uranium as fuel and heavy water as the moderator. The stations were based on a Canadian design popularly known as the "Candu" reactor type. These reactors serve dual purposes: They produce electricity and at the same time convert the non-fissile uranium 238 into fissile plutonium 239.

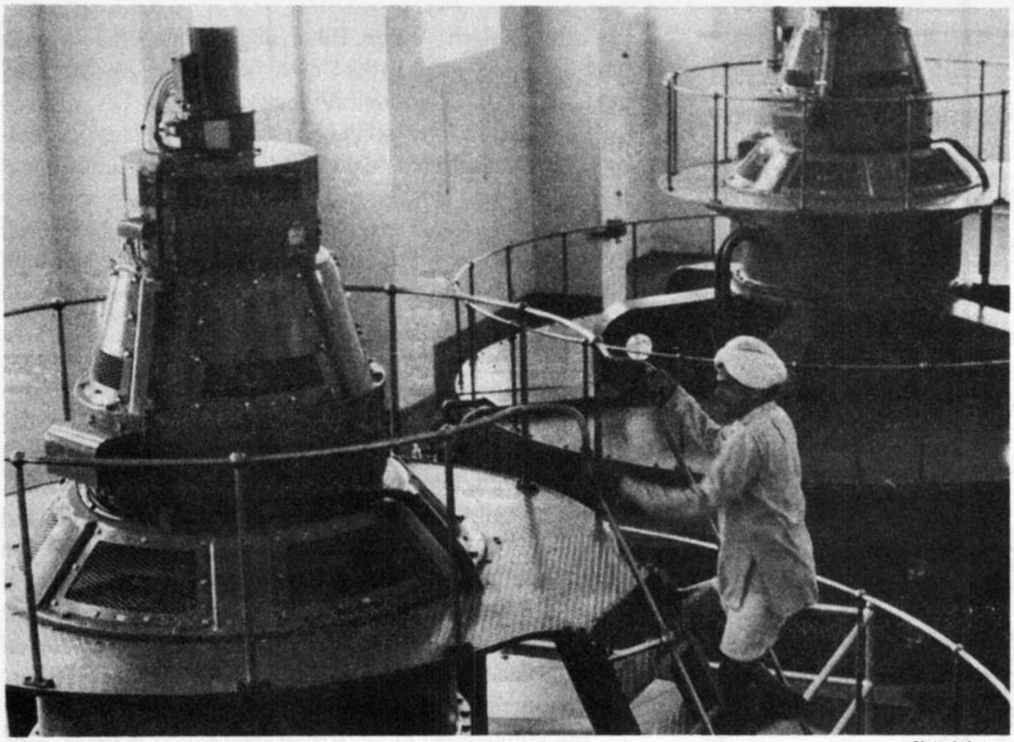
The second stage calls for developing fast breeder reactors. The breeder reactors also have a dual role: Besides generating electricity for commercial use, they convert thorium 232 into uranium 239. Plutonium 239, obtained from the "Candu" reactors in operation, would fuel the breeders.

In the third stage, technology would completely change over to a thorium-uranium fuel cycle, in which fissile uranium 233 will be bred from thorium 232 and commercial power would be generated.

Although a chain of nuclear power stations, as envisioned by Bhabha and Nehru, has not been established yet, India scientists have succeeded in building a 40 MWe breeder test reactor scheduled to be ready for power generation in August 1985, and are now running the world's only thorium-uranium cycle reactor at Trombay. A 500 MWe breeder reactor is now under construction and will be commissioned in the 1990s.

The inadequate power plan

India's present power generation capacity is around 43,000 MWe. According to the recent announcement of the Minister for Irrigation and Power, B. Shankaranand, an addition of



United Nations

Hydroelectric generators of the Tilaiya Dam, on India's Damodar River.

4460 MWe to capacity will be achieved in 1985-86. The long-term planning shows that India's total generating capacity will be 100,000 MWe by the year 2000—a measly amount for a nation that is going to sustain one billion people by that time. 100,000 MWe by the year 2000 will bring per-capita consumption of electrical power to approximately 0.53 kwh annually, which is about 5% of what is consumed in Japan. There is no doubt that unless a radical change in thinking with regard to electricity-generation is made, the future of Indian power production will remain dim.

Aside from the fact that planned installed capacity is too small to bring about rapid agro-industrial growth, there are other strains. Transmission losses that average 20-23%, an abysmally low average plant load factor of 41.5%, and perpetual diverting of power in one area to feed another, have taken a heavy toll on the agro-industrial sector. Anyone who is familiar with fertilizer production, heavy water manufacturing, etc., is well aware what catastrophic effects such diversions can have on equipment and machinery. Aluminum, which could play a significant role in the basic industries, is a large consumer of raw electricity, and therefore has taken the brunt of power cuts. To aggravate the situation further, small and economically inefficient power plants, mostly diesel-fired, are cropping up everywhere, to protect, at whatever cost, capital investments which have already been made.

One may argue that such cost-inefficient power plants are better than nothing. However, any energy-inefficient mode of production is a net drain on the economy. While it is obvious that the transmission losses can be brought down and the plant load factor can be raised through modernization and better maintenance of plants, the plan to keep electricity-generation capacity low is dangerous indeed.

The nuplex concept

Since India has not developed a comprehensive nation-wide electrical grid, the distribution system becomes unstable whenever a large power station goes out of operation or a new one is hooked up into the distribution system. Besides going all out to develop such a stable grid, the authorities should adopt what Dr. Vikram Sarabhai—the eminent scientist who headed the Department of Atomic Energy following Dr. Bhabha's sudden death in 1965 and who, with Bhabha, developed the space program—had outlined in the sixties. Sarabhai outlined a method to establish large agro-industrial complexes at suitable locations, where a cluster of nuclear power stations would provide the essential electrical power. This would eliminate the problems of transmission and distribution, which amount to almost 12% of total capital cost, and of grid instability. It would also facilitate development of large areas, by building new cities with modern facilities.

Nuclear power plants possess substantial economies of scale, which could be taken advantage of in supplying power to those regions where demand is concentrated in a small area. Case studies and feasibility reports were prepared to show the economic benefits of nuclear power. One detailed case study was done for a large-scale agro-industrial complex in western Uttar Pradesh (**Figure 2**). Such studies should also be prepared for developing agro-industrial complexes in east-

FIGURE 1

Share of consumption of commercial energy

(percent)

Sector	1953-54	1960-61	1965-66	1970-71	1975-76	1978-79
Household	21.3	20.6	18.0	18.0	14.8	13.7
Agriculture	3.0	3.6	4.3	4.6	7.2	10.6
Industries	37.3	39.2	41.4	38.7	40.3	38.5
Transport	35.8	33.8	33.8	32.7	33.8	31.7
Others	2.8	2.8	2.5	6.0	3.9	5.5

Source: Planning Commission, Government of India

FIGURE 2

Design for a nuclear/agro-industrial complex in western Uttar Pradesh

	Capacity	Cost*
Power plant	1,100 MWe	300
Fertilizer plants	1.46 × 10 t/yr	176
Aluminum plant	5 × 10 t/yr	73
	Total:	549

Area to be irrigated	1.5 million hectares
Number of shallow tubewells	13,000
Number of deep tubewells	13,000
Annual income/hectare	$1,100*
Net annual profit/hectare	$ 645*

* 1976 prices

Source: Department of Atomic Energy, Government of India

FIGURE 3

India's low investment in infrastructure

(percent of total investment)

Year	Total Infrastructure	Railways	Electricity	Mining
1960-61	13.2	6.8	4.8	1.6
1965-66	18.1	7.8	9.2	1.1
1967-68	14.3	4.5	8.1	1.7
1969-70	12.7	2.7	7.9	2.1
1971-72	13.5	3.8	7.8	1.9
1973-74	10.1	2.7	5.5	1.9
1975-76	16.2	2.6	9.3	4.3
1977-78	16.2	2.2	9.8	4.2
1979-80	15.5	2.6	9.5	3.4
1980-81	15.5	2.8	8.6	2.1

ern Uttar Pradesh, Assam, Bihar, and Madhya Pradesh—the least developed areas in the Union, with great agro-industrial potential. It is not without difficulty that India has, over 20 years, built up a fully indigenous mastery of nuclear technology. This gives the nation the capability to make radical shifts in policy away from perpetual energy shortage and slow growth. Unless such measures are taken, it is unlikely that there will be any substantial increase in productivity within the Indian economy.

Transportation woes

In the same category as the energy sector is India's transportation system. At present the transportation system depends heavily upon railroads and roads, with water transport playing a negligible role.

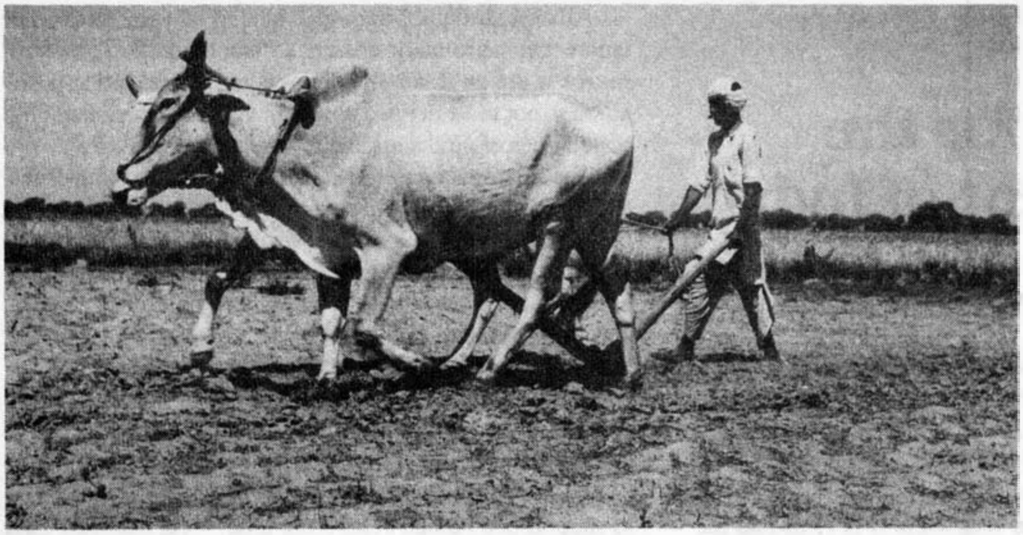
India's railroads are the main artery of the nation's inland transport, extending over 38,400 miles, of which 10% are electrified. The railroads employ about 1.8 million people and a have budget close to $7.5 billion. The railway network is the largest in Asia and fourth-largest in the world. Indian railroads handle 3.7 billion passengers annually, besides carrying more than 250 million tons of freight.

But comparable to the size of the railway network is its decrepit state. All the problems basically relate to lack of modernization: Eight thousand of some 12,000 locomotives are still steam-driven; over 12,500 miles of track require urgent replacement; the standard wagon carries only 22 tons because many sections of track are incapable of taking heavier wagons; most railroad crossings are manually operated, and there was not any computerization of passenger reservations or goods booking until a few months ago.

The other principal problem is the assortment of existing rail track. Three incompatible gauges exist in India—broad gauge, meter gauge, and narrow gauge. Goods have to be expensively trans-shipped from one gauge to another. Over half the track consists of narrow- and meter-gauge lines which were cheap to build (all of it was built by the British) but uneconomical to operate. Meanwhile, the number of wagons is decreasing. The fleet of 405,000-odd wagons registered in 1980 declined to 383,500 by 1983.

The railways today constitute one of the worst bottlenecks in the economy. They have failed to transport enough coal to the power stations, which causes further power cuts. These power cuts bring the railroads to a halt wherever the tracks are electrified. Cement plants, fertilizer factories, and textile mills are among the worst hit. All these add up to further reduction of productivity.

What has happened to the railroads is not too different from what caused the power sector to become inefficient. Under-investment in the railroads was combined with gross neglect of the maintenance of the existing capital stock. The impact of slowdown in public investment on the railroads was probably the most pronounced of all sectors of the national economy. After increasing rapidly in the early sixties,



The leap from backward farming to modern agricultural technologies will require investment in energy and infrastructure. The ''nuplex''—a large agro-industrial complex fueled by nuclear power—is ideal for India.

investment in the railroads began a decline. Beginning in 1966-67, the share of railroads in public investment never exceeded 4.6%. From 1973 to 1981, the share was always less than 3% (**Figure 3**).

India's road system can at best be described as inadequate. For a country which imports more than 40% of its oil requirements, road transportation is neither profitable nor reliable. Yet road transportation has burgeoned because of the inefficiency of the railroads and the increasing amount of goods that need to be moved. Moreover, for short distance hauls, road transport is becoming more attractive because of the flexibility it affords.

India has a large number of major rivers. Although most of them travel from east to west, a great deal of potential exists to develop the water transport system. Besides carrying millions of tons of freight, it can also carry passengers. However, comprehensive planning is necessary to work out the feasibility of such a system and then, to train the rivers. Blueprints exist for using the Ganges River from Allahabad to Haldia and the Narmada River for inland water transportation. It is essential that these plans be given serious consideration, since water transportation remains today the cheapest mode of transporting bulk commodities.

Problems of implementation

The infrastructural weakness is like a double-edged sword. First, it does not allow the existing industrial facilities to function at their full potential. Second, it prevents the infrastructural development from taking place smoothly. A case in point is India's energy sector: As many as 38 hydroelectric and thermal power projects, slated for completion during the Sixth Plan period (1980-84), have spilled into the Seventh Plan (1985-89). According to a calculation made in August 1984, these projects, originally estimated to cost about $2.7 billion, are now expected to involve a sum of $6.5 billion—a rise of 140%. Even the latest figure is considered a conservative estimate. It is unofficially stated that the projects could eventually cost over $7.5 billion.

Such cost and time overruns are scarcely a new phenomenon in India. The report of the Rajadhyaksha Committee on Power, published by the Government of India in 1982, showed that the minimum time overrun for hydro power projects was two years, and the maximum nine years. The cost overruns were typically 100% and exceeded 400% in two cases. In the case of the Loktak project, the cost overrun was close to 700%. The cost overruns for thermal power projects are typically about 80%, although the Obra project showed a cost overrun of 137%. It was revealed in March 1982, that all the thermal power plant projects which were under construction then, would together incur a $5 billion cost overrun, and out of 114 units under construction, only six units were expected to be completed on time. For the others, anticipated time overruns ranged from a few months to six years.

Although such facts can be found in almost every sector, the delay in infrastructural projects hurts more, since those involve large capital outlays and at the same time hold up installation of many productive facilities.

Among the factors that stand out behind the poor implementation are the following: inadequate mobilization of funds; shortage of essential raw materials like steel and cement; delays in supply of plant and equipment; delays in construction and commissioning; change of scope of work in midstream. The problem of fund shortages—so-called resource constraints—is deceptive. When a project is delayed and incurs cost overruns, money allocated to another project is then shifted to fund the ongoing project. The victimized project is in turn delayed. This process goes on, resulting in cost and time overruns in every single case.

Further, some projects are used as political plums, to employ and therefore to appease certain political factions and leaders. These projects cause a massive drain upon the nation's funds.