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# **Coal: India's Energy Answer?**

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**A Research Paper**

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*NESA 87-10041  
September 1987*

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# **Coal: India's Energy Answer?**

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**A Research Paper**

This paper was prepared by  Office of  
Near Eastern and South Asian Analysis. It was  
coordinated with the Directorate of Operations.  
Comments and queries are welcome and may be  
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**Coal: India's Energy**

Answer? [Redacted]

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**Summary**

*Information available as of 1 September 1987 was used in this report.*

India intends to rely more heavily on coal to provide the energy to meet the 5-percent average annual GDP growth rate called for in its most recent five-year economic plan, which began in FY 1985. Stagnant domestic oil production, along with the government's aversion to becoming more dependent on imported oil, is prompting New Delhi's turn to coal. India expects demand for coal to increase by nearly 35 percent by 1990. [Redacted]

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India has sufficient coal reserves to meet existing energy needs, but it is unlikely to meet government-established production targets. Inadequate technology, power shortages, unproductive labor, and insufficient investment probably will hamper efforts to boost production, improve distribution, and increase use. India's failure to meet its goals for coal output and use will severely hamper its economic growth by widening the gap between energy supply and demand. [Redacted]

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New Delhi will continue seeking foreign assistance to exploit its coal. Currently the largest foreign participant in developing India's coal sector is the Soviet Union. Since 1957, Moscow has provided India nearly \$4 billion to finance the purchase of equipment to develop coal deposits. Britain, France, and West Germany also assist the coal-mining sector, but their input is small compared with the Soviet Union's. [Redacted]

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Key to increasing Indian coal production is the manufacture or purchase of state-of-the-art equipment for coal extraction, distribution, and use. The inability of the Soviet Union to provide mining technology suited to India's difficult geological conditions gives US and other Western firms opportunities to provide equipment and assistance. Because of the country's deteriorating foreign payments and reluctance to engage in commercial borrowing, however, foreign firms or countries will have to provide concessional financing, accept countertrade in place of payment, or engage in joint ventures to penetrate the Indian market. [Redacted]

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**Contents**

	<i>Page</i>
Summary	iii
Scope Note	vii
Status of the Coal Industry	1
Coal Industry Goals	2
Obstacles to Boosting Production	3
Inadequate Technology	3
Electrical Power Shortages	3
Low Labor Productivity	5
Insufficient Investment	5
Marketing Problems	6
Transportation	6
Poor Quality	6
Foreign Assistance Needed	7
Implications for India's Economy	9
Implications for the United States	9

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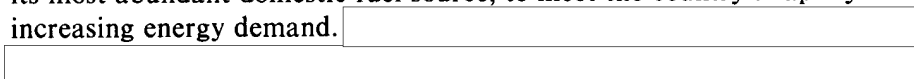
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**Scope Note**

Domestic energy supplies are a critical factor in India's economic development. To the extent that India can meet its energy needs domestically, more funds can be transferred from energy imports to finance the country's economic modernization. This paper looks at India's ability to exploit coal, its most abundant domestic fuel source, to meet the country's rapidly increasing energy demand.



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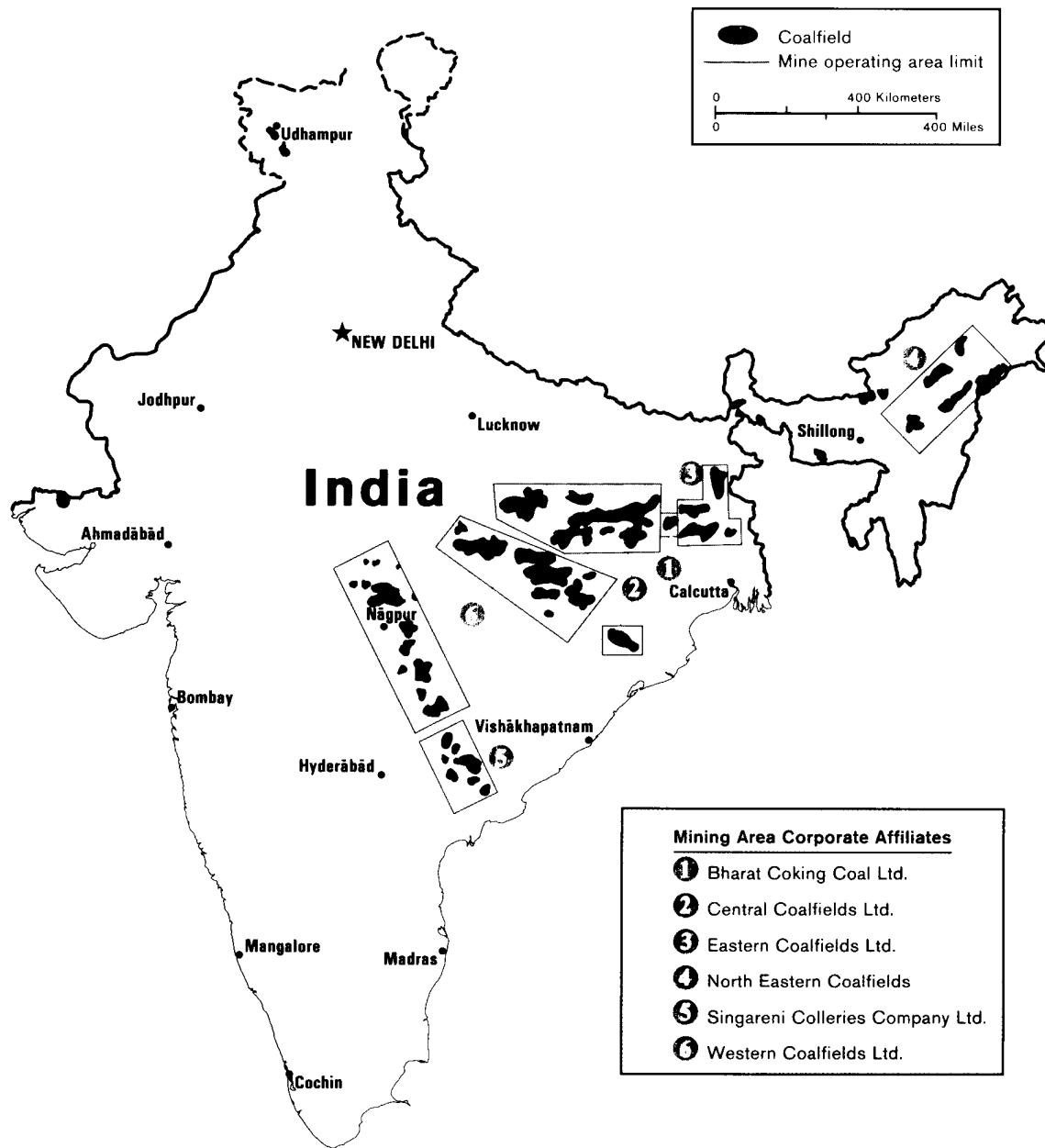
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Figure 1  
India's Coalfield Organization



Boundary representation is not necessarily authoritative

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### Coal: India's Energy

Answer? [Redacted]

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New Delhi's energy strategy for the next decade is to meet much of the nation's energy demand by expanding the use of coal. Because New Delhi expects little increase in domestic oil production, Indian planners are relying on coal to satisfy increased energy demand and to stem growing oil imports.<sup>1</sup> According to the government's most recent five-year economic plan, which began in 1985, a 34-percent rise in coal demand is projected by 1990, caused in large part by the need to fuel thermal plants producing electricity. New Delhi plans to meet this target by modernizing mine operations and improving management. [Redacted]

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#### Coal: Varieties and Uses

*The quality of coal is graded. The lowest grade of coal is lignite, followed in increasing order of hardness by subbituminous coal, bituminous coal, and anthracite. Coal is also broadly divided into two commodity classes, metallurgical and steam. The term metallurgical coal is often used synonymously with the term coking coal to designate certain grades of bituminous coal used to make coke, a high-carbon solid fuel that is used in the manufacture of steel. To be suitable for coking purposes, coal must have low sulfur and ash content.* [Redacted]

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#### Status of the Coal Industry

With an annual output of 169 million metric tons (mmt), India is the ninth-largest coal producer in the world. India's coal reserves are estimated at 127 billion metric tons (bmt), according to an Indian Government survey. About 17 bmt are proved reserves, and the remainder are indicated and inferred reserves.<sup>2</sup> About 80 percent of the reserves are non-coking coal, and the balance is coking coal that is used in steel production. The best quality coking coal resources, located mostly in the Central coalfields, are limited—an estimated 12 bmt. On the basis of the government's demand projections, we expect India's proved reserves of coking coal to last 50 years, while noncoking reserves are expected to last 100 years. [Redacted]

*Steam or noncoking coals are burned in steam boilers of electric utilities to generate electricity. Industrial users, such as cement plants, also use steam coal for thermal generation. Virtually any grade of coal may qualify as steam coal, but lignite, due to its lower heat value, is more expensive to transport and requires larger, more expensive boilers.* [Redacted]

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electricity generated by hydroelectric and nuclear facilities supplies 7 percent. Coal production, however, has lagged behind demand targets. In FY 1987,<sup>4</sup> India produced 169 mmt of coal against a demand of 208 mmt, with the gap bridged by imports of coking coal and by stockpile reductions, according to government energy officials. [Redacted]

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Coal is a close second to oil as a source of India's commercial energy consumption,<sup>3</sup> providing about 45 percent of the total. Oil provides 48 percent, and [Redacted]

The coal industry has been almost entirely in the public sector since 1972. In 1975 a government holding company, Coal India, Ltd., was formed with six wholly owned operating subsidiaries. The Coal India group accounted for 90 percent of India's coal production in FY 1986, according to press reports. Seven percent is supplied by Singareni Collieries [Redacted]

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<sup>2</sup> Indicated coal reserves are estimates based partly on sample analysis and partly on the geological conditions in the area. Inferred coal reserves are estimates of unexplored extensions of demonstrated resources. The estimates are based largely on the geological characteristics of the coalbed or region. [Redacted]

<sup>3</sup> Commercial energy consumption includes fuel used by the industry, transportation, and energy sectors. It excludes domestic uses such as cooking and heating. [Redacted]

<sup>4</sup> India's fiscal year is 1 April through 31 March. [Redacted]

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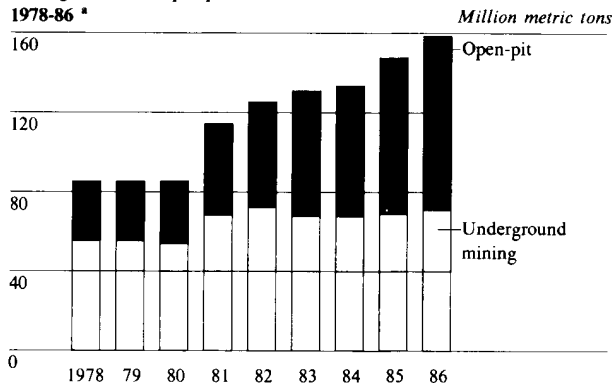
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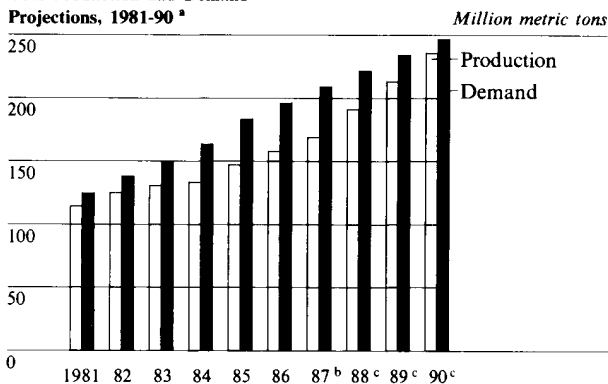
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**Figure 2**  
**India: Total Coal Production**

**Underground and Open-pit, 1978-86**  
**1978-86 \***

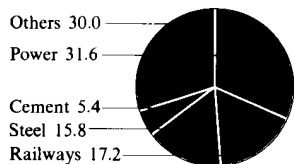


**Coal Production and Demand Projections, 1981-90 \***

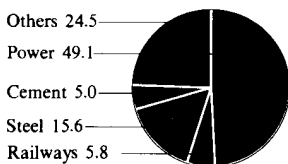


**Coal Deliveries by Sector, 1976 and 1986 \***

**1976**  
Total: 85 million metric tons



**1986**  
Total: 158 million metric tons



<sup>a</sup> Data for fiscal period ending 31 March of the stated year.

<sup>b</sup> Projected.

<sup>c</sup> Estimated.

Company, Ltd., a joint venture between the central government and the Andhra Pradesh State government. A few mines owned by the private Tata Iron and Steel Company produced the remaining 3 per-cent.

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**Coal Industry Goals**

New Delhi is relying on expanded coal output to reach its target of 5-percent average annual GDP growth in the five-year plan that ends in FY 1990. Coal demand is projected to increase to some 250 mmt in FY 1990. Power generation will account for an increasing share of the total, and steady growth is anticipated in the use of coal in the steel and cement industries. New Delhi projects that coal will meet more than half of India's commercial energy consumption in the next decade. The remainder will come from petroleum, nuclear, and hydroelectric sources.

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To meet the demand for more coal while reducing production costs, Coal India, Ltd., plans call for:

- Greater emphasis on mechanized surface mining.
- Modernization of underground mining operations.
- Greater reliance on indigenously produced equipment.

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New Delhi plans to continue to emphasize increased production from surface mines, and its efforts to boost output from these mines have met with some success. The output from surface mines accounted for just over half of total coal production last year compared with only 28 percent in 1977, according to Indian Government statistics. By 1990, New Delhi projects that surface mining will account for more than 60 percent of coal output.

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New Delhi calculates that surface mining has a much higher recovery rate at a considerably cheaper cost. More than 90 percent of the coal in the bed can be recovered from a surface mine compared with about 50 percent from an underground mine. It costs roughly twice as much to mine a ton of coal underground as from the surface, according to Indian Government statistics.

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Figure 3. Indian surface mine.



Figure 4. Long-wall mining.

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In contrast to surface mining, output from underground mines has been stagnant. The production of 71 mmt in 1986 was only 4 percent higher than in 1981. Some 55 percent of India's coal reserves, however, lies in seams more than 1.5 meters in thickness at a depth of 600 meters or more. As a result, officials of Coal India, Ltd., which owns most of the underground mines, are urging the use of modern equipment and technology to increase the output of those mines.

[redacted] new techniques, particularly long-wall mining,<sup>5</sup> will boost production from underground mines by 10 percent annually by 1995. [redacted]

#### Obstacles to Boosting Production

India's coal sector faces many production constraints including inadequate technology, power shortages, low labor productivity, and underinvestment. Although New Delhi has taken steps to overcome these obstacles, progress has been slow. [redacted]

<sup>5</sup> Long-wall mining machines shear coal from a long, straight coal face (up to about 200 meters) by working back and forth across the face under a movable, powered roof support system. [redacted]

#### Inadequate Technology

New Delhi must adopt up-to-date technologies before coal output can expand to meet the demands of the next decade. According to Indian estimates, 95 percent of underground mining is done by manual techniques—hand-picking or drilling. Loading is also by hand into baskets carried to small mine cars. Difficult geological conditions in India's underground mines (sandstone roofs, spontaneous combustion, thick seams, and gasiness) probably will preclude the use of some modern mining techniques and hamper modernization efforts, according to the press. New Delhi would prefer to use indigenously manufactured equipment so as to reduce costs and to provide domestic employment opportunities. Domestic firms, however, have difficulty supplying high-quality equipment on time due to resource allocation problems and transportation bottlenecks. [redacted]

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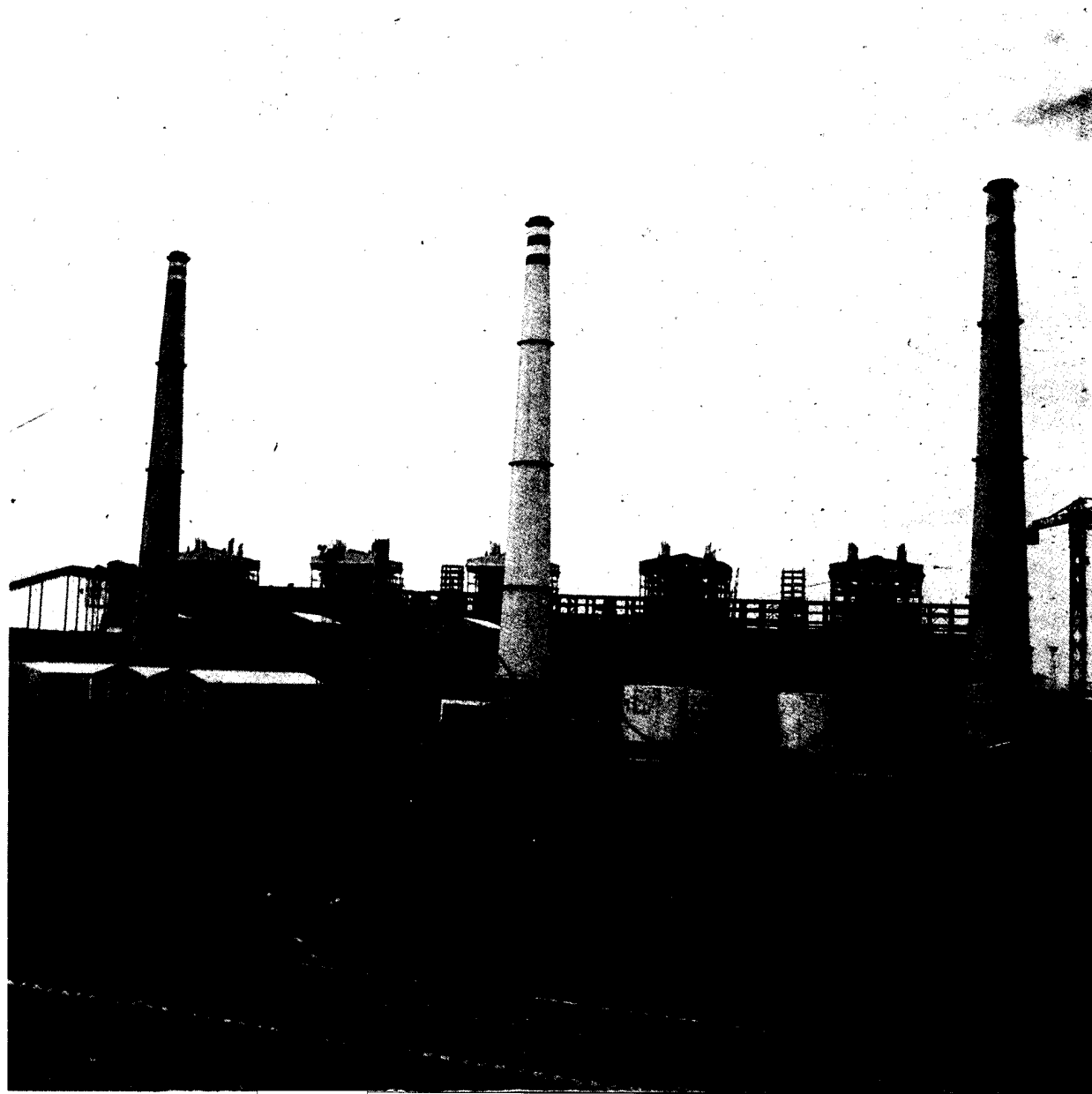
#### Electrical Power Shortages

Frequent interruptions in the supply of electrical power have been a major constraint on coal production. At the same time, the lack of sufficient coal

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*Figure 5. Captive power plant.*

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supplies has stymied the production of electricity. The availability of electrical power in some mines in the Bihar and Bengal areas has been boosted by the construction of a few small power facilities, or captive power plants, specifically for mine use. We believe, however, that New Delhi will have to build additional units—now under consideration—to provide sufficient power to enable existing coal-mining equipment to function at capacity. Some of the shortages could be alleviated by the installation of high-voltage transmission lines. Twenty-two percent of India's electrical energy transmitted through the country's grid is lost because of inefficient equipment, according to Indian statistics. [redacted]

**Low Labor Productivity**

The growth in coal output has been slowed by inadequate training, overstaffing, rampant absenteeism, and poor labor relations. India's coal sector productivity, which is measured in terms of output per manshift (OMS), is low compared with other major coal-producing countries. In West Germany, for example, the OMS in surface mines averages more than 3.3 tons compared with 1.2 tons achieved by Coal India, Ltd., in 1985, according to press reports. Even mines that have a high degree of mechanization suffer low output because the equipment is in use only about 15 percent of its desired operating time, according to US Embassy reporting. Much of the equipment's excessive downtime is caused by a combination of poor planning and deployment and a lack of skilled operators and repairmen. We believe shortages of mining engineers and technicians able to cope with more sophisticated equipment have resulted from management's failure to train or retain qualified personnel.

[redacted]

**Insufficient Investment**

The inability of the domestic coal industry to generate sufficient investment capital will be a major obstacle to financing the new technologies needed to increase production. Because the government has kept prices artificially low to satisfy consumers, the industry is suffering severe financial losses and cannot meet its operating costs, let alone generate investment capital. Higher coal prices would promote more efficient coal use and mobilize resources for investment, but we believe popular opposition to higher prices will prevent

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**Labor Troubles Persist**

*Law-and-order problems pervade the coal industry in eastern India and continue to hamper New Delhi's plans to increase production. According to US Embassy reporting, the coal sector employs more than 700,000 workers, and the government estimates that more than 25 percent are unproductive. Politicians and party officials featherbed by pressing industry to hire workers to develop voting blocs for themselves, according to press reports. Links between local labor unions and the political parties hamper efforts to deal with overstaffing as well as other labor problems. Local union officials, who are not always coal miners, are sometimes obstinate because they seek prominence that can further their political careers, according to the press. For example, feuding among state-level parties has started or prolonged strikes, and disputes by Communist-led unions have sometimes been initiated to embarrass New Delhi.* [redacted]

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*Strikes and slowdowns are a major obstacle to improving mine production. Between 1983 and early 1986 the loss of potential production of coal was more than 500,000 metric tons because of strikes, according to government statistics. Rivalry among small unions and competition for leadership within larger ones encourage militant demands and make minor disputes over wages, bonuses, working conditions, or productivity requirements more difficult to resolve. Management's ability to enforce labor discipline is limited by the absence of support from government authorities.* [redacted]

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*Violence among competing labor groups—prompted in large part by an Indian "mafia"—has not only reduced output and interfered with rail transport but also victimized workers and led to hundreds of murders a year, according to press reports. Union leaders profit personally from lending out union funds and acting as labor contractors for construction and transport projects in the coalfields. They bribe police, arrange the transfer of bureaucrats who want to clean up corruption, and obtain political protection from state and central government politicians.* [redacted]

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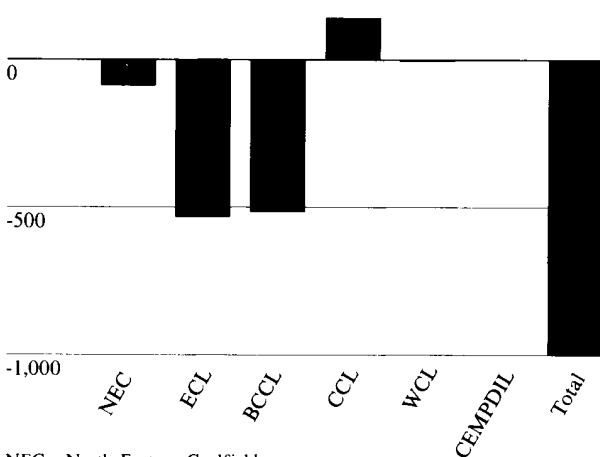


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**Figure 6**  
**India: Coal Sector Operating Balances**  
**Before Subsidies, 1985<sup>a</sup>**

Million US \$

500



NEC - North Eastern Coalfields  
 ECL - Eastern Coalfields Ltd.  
 BCCL - Bharat Coking Coal Ltd.  
 CCL - Central Coalfields Ltd.  
 WCL - Western Coalfields Ltd.  
 CEMPDIL - Central Mine Planning & Design Institute Ltd.

<sup>a</sup> Data for fiscal period ending 31 March of the stated year.

[Redacted] 314155 9-87

New Delhi from increasing them significantly. Growing government budget deficits make it unlikely that sufficient public funds will be available to provide the investment necessary in the coal sector. [Redacted]

Annual government investment in the coal sector would have to increase substantially from the present level of \$950 million if New Delhi is to fulfill its plans for coal development. On the basis of government statistics, we estimate \$25 billion will be required by the year 2000 to fund necessary surface mine development, machinery, and supplemental power. Even in the unlikely event that this level of funding were available, it would be difficult for Coal India Ltd. to efficiently absorb and use such a large increase in capital investment. [Redacted]

**Marketing Problems**

We believe that solving India's coal production problems is only half the battle. To use the additional coal, New Delhi also must eliminate transportation bottlenecks and compensate for poor coal quality, efforts that will require considerable investment. [Redacted]

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**Transportation**

India's transportation network cannot handle the quantity of coal currently being produced, according to press reports, much less cope with planned increases in production. Three-fourths of India's coal is shipped by rail, and railroads will have to increase their capacity by roughly 10 percent annually to move the additional coal India plans to produce. New Delhi is taking several steps to improve the railways' performance, including electrification of lines, construction of new train routes that can more efficiently move coal, and construction of high-capacity cars for bulk materials like coal. [Redacted]

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The government is attempting to use means other than the railways to move coal, but prospects for widespread use of these alternatives are dim. New Delhi is urging the use of road and coastal shipping and has implemented a pilot project to transport coal in slurry form by pipelines. These improvements, however, will require years to implement and do not offer India's present transport system immediate relief. The great distances between India's mining operations and the urban centers that use coal also make these measures an unlikely alternative over the medium-to-long term. [Redacted]

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**Poor Quality**

Most of India's coal is poor in quality and low in energy value—either lignite, often with high moisture content, or subbituminous coal with high ash content.<sup>6</sup> As a result, more coal is required to generate a given amount of heat. Because larger quantities of lower grade coal are required, additional burdens are placed

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<sup>6</sup> High ash content causes increased erosion of pressure parts, coal pipes, and burners and also reduces the caloric value of the coal. [Redacted]

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**Facing Electricity Shortages**

*More than 60 percent of India's electricity is supplied by coal-fueled thermal generating plants. Demand for coal in India's power sector is expected to increase 15 percent annually over the next three years to meet the needs of India's expanding industrial sector, according to India's most recent five-year economic plan.*

[redacted]

*Electrical shortfalls are already hampering manufacturing. According to press reports, some industries have received less than 75 percent of their power requirements for weeks at a time. Frequent unscheduled power cuts do even more harm because they also damage machinery as well as limit production.*

*Medium- and large-scale industries have been installing standby diesel generators to ensure uninterrupted power. Although comprehensive national data are not available on small-scale electricity capacity or generation, we believe the investment in alternative sources of power supply is extensive. Power from these small units costs about three times as much as that from utilities, according to government statistics.*

[redacted]

on the transportation system. We believe that India's emphasis on increasing surface mining will aggravate this problem. [redacted] coal produced by surface mining methods is lower in quality than coal produced by underground mining techniques. Coal mined by surface methods often contains higher quantities of dirt and other extraneous material that must be removed. [redacted]

We believe that the metallurgical and electric power industries, in particular, will have to acquire and use modern burning technologies if they are to make use of additional domestic coal supplies. Low coal quality has caused major problems for these industries, the main coal users. Many power plants have had to supplement coal with oil because of the low energy value of the Indian coal being supplied to them,

according to press reports. At a large number of power plants, the poor coal quality has caused breakdowns of key equipment, forcing plants to shut down for repairs. [redacted]

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Additional investment will be needed in coal processing plants to enable lower quality coal to be used more efficiently. With the share of coal produced by surface mining expected to grow over the remainder of the century, more funds will have to be allocated to coal processing projects that remove dirt and ensure a consistent quality and size of coal to consumers. [redacted]

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**Foreign Assistance Needed**

We believe that foreign technology and equipment, training, and financing will play a growing role in India's effort to exploit its coal reserves and will become a major factor affecting the pace of Indian coal development. New Delhi has already sought foreign assistance for advanced mining technology and equipment. Joint projects with foreign companies include preparing feasibility studies, providing technical assistance, training Indian engineers in foreign countries, and purchasing mining equipment not available in India. [redacted]

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The Soviet Union is the largest foreign participant in India's coal sector. The Soviets have recently undertaken 15 coal mining projects in India and have agreed to help modernize a washery where coal is cleaned. In addition, Moscow has agreed to assist India establish facilities to teach coal processing and mine construction techniques, according to Embassy reporting. The Soviets have made three loans to India totaling nearly \$3 billion to finance the foreign exchange requirements of the projects under their assistance. India is also receiving assistance from Poland and East Germany. [redacted]

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West Germany, France, and Britain are the major Western countries involved in assisting India's coal-mining sector. The assistance from Britain is mainly confined to the purchase of equipment using a \$20

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**Confidential****Technology Options for Indian Coal Development**

	<b>Applications</b>	<b>Advantages</b>	<b>Drawbacks</b>	<b>Status of Soviet and Western Technology</b>
<b>Mining Technology</b>				
High-volume surface mining equipment	Can be applied to different grades of coal. The geology of certain regions limits its effectiveness.	Least costly approach to large-scale production.	Capital-intensive, demands good mine planning, implementation, and maintenance to maximize equipment utilization.	Soviet technology is not as sophisticated as the West's, but Soviets have access to East German equipment.
<b>Transportation and Electrical Transmission</b>				
Coal slurry pipelines	Transportation of good-quality coal.	Lowers transportation costs, eases rail bottlenecks. Advanced slurry combustion technology could improve boiler operations.	Present technologies cannot handle low-quality coal. Mine source must be close to industry.	Soviet technology at low level, especially for direct burning systems. In the West, technology for 50-percent slurry system proven commercially.
Coal methanol slurry pipelines	Transportation of all coals.	Potential advantages over water slurry: low-temperature operation; lower moisture increases energy value.	Sizable investment in development and facilities, construction.	Little worldwide use due to major engineering hurdles in dealing with corrosive effects of methanol.
UHV electricity transmission	Large power transfers medium to long distance.	Lower costs, cuts losses on long-distance transmission. Can improve the quality of electricity supply to users.	Requires electrical components of superior quality, often of new design.	Technology would most likely be secured from the West. Soviet Union has virtually no field experience.
<b>Combustion</b>				
Coal and oil mixtures used as boiler fuel	Combustion of all coals.	Improves the combustion of poor-quality coals. Also cuts potential oil use by 40 to 50 percent.	Although this technology sharply cuts growth in oil use, oil consumption will still increase. Adds to fuel supply problems.	Technology currently available from both Soviet and Western sources.

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million grant. France is helping India with 11 projects, mainly exploiting deep underground seams. West Germany is supporting modernization efforts in three operating underground mines as well as helping India develop three new underground mines. A credit agreement for \$225 million has been signed with Bonn and is available for financing these projects. Because India faces growing foreign payments strains and insists on concessional aid, we believe it is reluctant to turn to the United States for equipment and technology. [redacted]

The World Bank has extended a \$340 million loan to fund two projects, the Gevia and Sonepur Bazahi mines, which are expected to boost coal output by 10.5 mmt per year. India's declining access to multi-lateral concessional development aid, however, will probably prompt it to actively seek additional bilateral assistance from the USSR and Eastern Europe as well as from the West. [redacted]

**Implications for India's Economy**

We do not expect New Delhi to come close to meeting its ambitious goals for coal production by 1990:

- Political pressures are too strong to initiate labor reforms or to raise coal prices to provide sufficient funds to modernize the industry.
- Foreign exchange constraints will limit New Delhi's ability to acquire sufficient foreign technology and equipment.
- Improvements in rail transportation to move the coal to consumers and equipment to enable India to use its poor-quality coal cannot be put in place in time. [redacted]

In our judgment, India's failure to boost coal production sufficiently to meet output targets, along with the problems hampering better distribution, will slow its economic growth by widening the gap between supply and demand for power. We believe that an increase in the frequency and duration of power shortages during the late 1980s and 1990s will lower the output of key

metallurgical, defense, and, to a lesser extent, agricultural facilities. We expect that many power plants burning coal as their primary fuel will have to continue using more fuel oil than planned, hamstringing Indian efforts to free oil for alternative domestic uses. Shortages of coking coal will be a drag on steel production, adversely affecting Gandhi's modernization programs and adding another import item to the trade bill. [redacted]

**Implications for the United States**

India's desire to exploit its coal reserves and get maximum output from its current operations will present US and other Western companies with a potential market (albeit limited) for the sale of high-technology goods and services. Coal India Ltd.'s lack of success with British long-wall techniques is prompting it to look elsewhere for long-wall technology. India also will be a good market for less sophisticated but necessary mining equipment such as draglines, blast hole drills, and shovels. Countries with developed mining sectors can provide India with consultancy services with a view toward helping the coal sector adapt mining techniques to overcome difficult mining conditions. [redacted]

The decreasing quality of India's coal, resulting from a greater reliance on surface mining, will boost India's demand for coal processing and cleaning equipment. In addition, Indian companies will be looking for new coal-burning technology to accommodate the high ash content in the poor-quality coal. [redacted]

The foreign payments strains facing New Delhi, however, will make it difficult to increase purchases of US equipment and services. We believe the government will limit imports from Western countries to stem the growing criticism from political opposition groups over the burgeoning trade deficit. Unless India can secure more US aid and concessional financing to assist in the development of the coal sector, it is unlikely that the US role will increase quickly. [redacted]

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