A New Initiative to Promote Clean Coal

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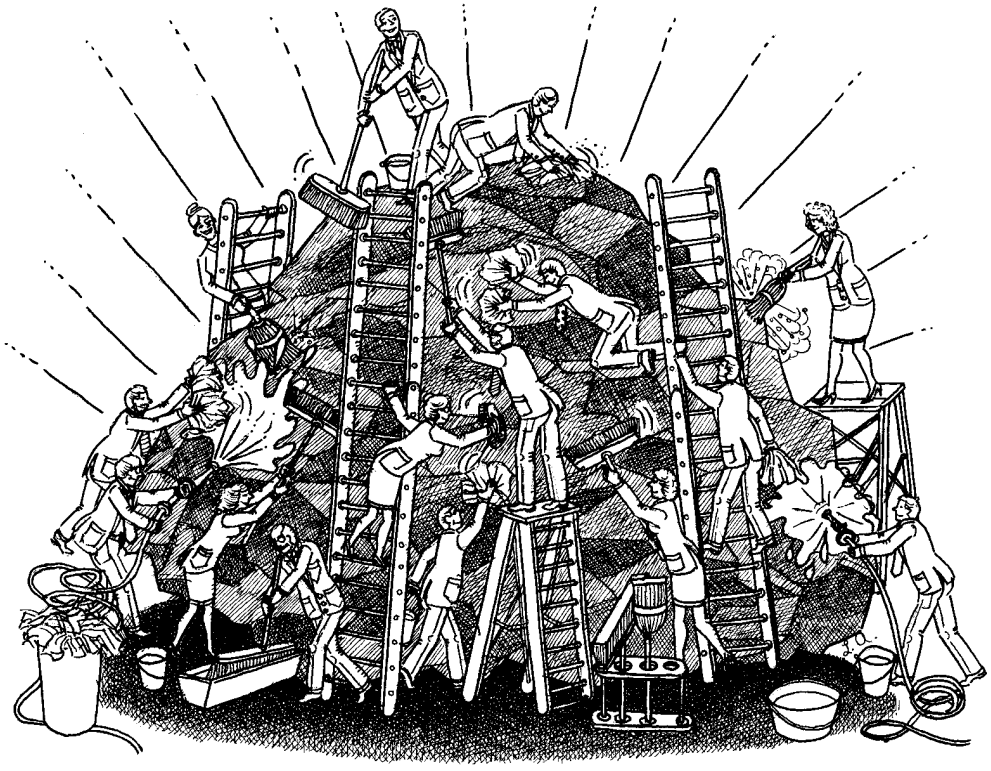
The production and consumption of coal are increasing in some developing countries, even as concerns about coal's environmental impact mount. The World Bank has launched a new initiative to encourage reforms that will lead to a cleaner and more efficient use of coal.

STAND IN the middle of Beijing, Delhi, Ankara, or Katowice on an overcast day at high noon and you are immediately engulfed in the heavy, polluted air, or even darkness. Half a century ago, you would have had a similar experience in Pittsburgh, Birmingham, or Chicago. Sooty smoke and sulfurous odors, the residues of coal burning in buildings, factories, power plants, and locomotives, hung in the air. Today, the air quality in US cities is vastly improved, not because the United States has abandoned coal as a fuel—it is second only to China in total volume of coal produced and used—but because it has learned to use it more cleanly.

Expertise in the clean, efficient, and economic production and use of coal has been acquired slowly, over time, in the industrial countries. To speed up the transfer of this expertise to developing countries, the World Bank launched its Clean Coal Initiative in 1996. Given the potentially adverse impact of coal use on the environment in the absence of appropriate abatement measures, and the high social and economic costs that can be associated with this abundant source of energy, the need for reforms in the coal sector is pressing. Forecasts indicate that coal will continue to be an important source of energy well into the twenty-first century.

The importance of coal

Access to energy is critical for economic growth. Developing countries, in particular, need greater access to energy if they are to achieve the high growth rates required to raise living standards and reduce poverty.



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The use of renewables—wind and solar-based energy, for example—is growing rapidly, but renewables are unlikely to become a dominant energy source in the near future. And although efforts at conservation have intensified, and dependence on natural gas and oil is increasing, projected demand for energy is expected to grow even faster.

Coal is often the only alternative when low-cost, cleaner energy sources are inadequate to meet growing energy demand. Developing countries use about 55 percent of the world's coal today; this share is expected to grow to 65 percent over the next 15 years. The World Energy Council projects that even as late as 2050, coal will account for more than 20 percent of the world's primary energy.

The challenges presented by growing coal use are related not only to the quantity of coal that will be used but also to how it is used. Almost all coal use in industrial countries is in large power plants and industrial heat units where distribution and pollution-abatement costs benefit from economies of scale. In developing countries, in contrast, coal is used not only by large facilities but also by consumers who need only small quantities and are highly dispersed. Dispersed coal users—residences, commercial buildings, locomotives, and boats, for example—typically have high fuel-distribution and pollution-abatement costs.

Impacts of coal use

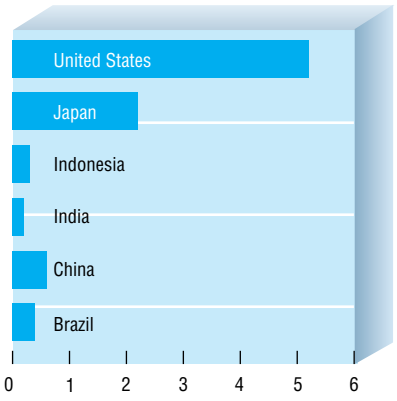
As coal use grows, the associated adverse health, social, and ecological impacts will worsen if special measures are not taken to mitigate them. At the local level, soot, smoke, and other pollutants produced by uncontrolled coal burning in urban areas have the most obvious impacts. Air pollution is especially severe in many cities in China, the countries of the former Soviet Union, Eastern Europe, and Turkey, and it is a growing problem in parts of India. In Beijing, the health effects and social costs of air pollution caused by the burning of coal are estimated to be approximately equal to the cost of the coal itself. Other concerns at the local level have to do with the potentially heavy social costs associated with coal mining. The occupational dangers inherent in mining, the displacement of persons living on potential mine sites, and the overemployment and large-scale redundancies common in older, often remote, mining regions must be managed.

The primary concerns at the regional and global levels have to do with the ecological impacts of coal use and the costs of mitigating these. "Acid rain" has a damaging effect on regional ecosystems and is the product of excess levels of sulfur dioxide and nitrogen oxide—two of the gases emitted by burning coal without appropriate abatement measures—in the atmosphere. The severity of the impacts of acid rain and the cost of mitigation vary depending on the quality of the coal (determined primarily by its sulfur content) and the quantity used. Although technologies already exist that can reduce emissions, even in the most severe cases, the cost can be substantial.

Chart 1

Carbon dioxide emissions per capita in six major countries, 1991

(metric tons)



Source: World Resources Institute, *World Resources 1994–95.*

From a global perspective, increasing dependence on coal raises the question of how to equitably manage carbon and methane emissions, major factors in global climate change. Worldwide, coal burning accounts for more than 40 percent of total carbon emissions from fossil fuel use and an estimated one-third of total carbon emissions. The industrial countries, which have substantially higher per capita emissions of carbon dioxide than developing countries (Chart 1), have set themselves goals for reducing greenhouse gas emissions and are now considering strengthening those goals. Developing countries, however, have made no binding commitment to reducing greenhouse gases. Power plants and industrial boilers in developing countries typically consume 15–30 percent more primary energy (coal) per unit of final energy produced (for example, electricity) than industrial countries. By achieving greater thermal efficiency, developing countries could further reduce their per capita carbon dioxide emissions.

Incentives

In many developing countries, incentives to lower the costs of coal and to use coal more cleanly and efficiently are lacking or are undermined by poor policies and weak legal, regulatory, and institutional frameworks. Policies such as pricing and allocation controls and production subsidies reduce competition in the coal sector; producers, transporters, sellers, and even buyers of coal may be state-owned monopolies, and private investors may be discouraged from entering the coal market. Anti-pollution measures may be enforced only sporadically or not at all, and firms may not have the capital to invest in clean coal technologies. A study on China found that even a relatively low-cost improvement—coal preparation—can help reduce coal costs and emissions simultaneously, but incentives to make such an improvement are weak (see box).

Industrial country experience

Some people erroneously believe that the environment is cleaner because industrial countries no longer produce or use coal. On average, coal represents about 20 percent of the primary energy supply in Organization for Economic Cooperation and Development (OECD) countries. In fact, since the early 1970s, 15 OECD countries have increased their coal use by about 50 percent—while reducing the environmental impacts. More recently, they have also reduced the economic costs of coal and of the energy produced from it. Their experiences provide insights on how developing countries might accommodate growing energy and environmental needs.

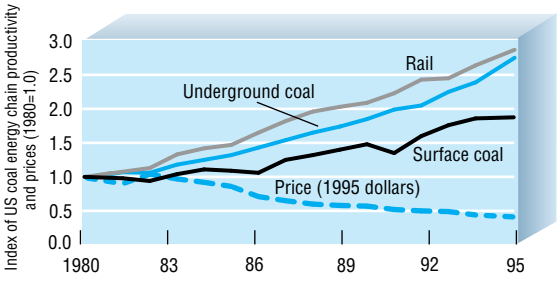
Economic incentives. Between 1985 and 1995, the cost of coal delivered to private US electricity-generating plants fell by more than 50 percent in real terms (Chart 2). This decrease represents about $30 billion in annual savings—one-sixth of the nation's total electricity bill—and is the result of productivity gains in coal production and transportation. It demonstrates that the right incentives can drive down costs.

For coal consumers—primarily power plants—some of the incentives came from increased competition in the electricity markets, which forced them to demand better-quality coal at lower prices from their suppliers. And competition increased among coal producers and processors as they responded to customer pressure to lower costs. By improving management and operations or deploying technology—or some combination of these—coal producers were able to double their productivity in only 10 years. Examples of such managerial and operational improvements

include selective mining (special equipment or better use of equipment to reduce the volume of dirt recovered with the coal), changes in shift deployment, enhanced maintenance programs, and labor rationalization. Improved technologies included longwalls for underground mines, and larger trucks and shovels for surface mines. As a result of these improvements, the sub-bituminous (surface) coal producers in the western United States, which produce about one-fourth of the nation's coal—a share that is continuing to grow—were able to reduce their prices by more than 70 percent in real terms (about $0.65 per million Btu) between 1985 and 1995.

Chart 2

Increased productivity in coal production and rail transport leads to lower prices



Sources: US Energy Information Administration; and Fieldston Company Inc.

Complementary changes occurred downstream. Coal processors responded to customers' demand for coal of better quality and for reductions in the volume of coal to be transported by sizing coal for industrial users and reducing ash, sulfur, and moisture content. Regulatory changes increased competition in the transportation sector, creating incentives for transporters to improve management and operations, invest in technology, and lower their rates. Some of the most productive transport investments included high-powered locomotives, high-axle-load wagons, and upgraded rail track. As productivity rose, transportation costs plummeted. Average rail rates for coal from the western United States fell by about half in the 10 years ending in 1995, saving the customer $0.60 per million Btu. In time, some generators that had traditionally depended on coal from the eastern United States found the West's coal to be a competitive option—even after shipping it a thousand miles or more.

Environmental incentives. While coal use increased, environmental laws and regulations adopted in OECD countries over the past fifty years have also created incentives to reduce emissions. Effective regulations are typically based on the principle that the polluter pays—that is, that environmental costs are a cost of doing business and therefore should not be transferred to the public. Thus, the polluter (the coal customer) will be motivated to minimize emissions and find the lowest-cost abatement strategies allowed by law.

The legal and regulatory framework has changed over time, as have the incentives. In the 1940s and 1950s, the emphasis was on controlling smoke and poisonous smog. In the 1970s and 1980s, many countries switched to more stringent pollution-abatement regulations. Those regulations, however, often mandated specific environmental-control technologies with relatively high costs. In the 1990s, the United States adopted integrated, cross-sector approaches that have helped to reduce the cost of pollution abatement. For example, the Clean Air Act of 1990 allows cost-reduction measures such as emissions trading (giving a polluter with high control costs the option of paying a second polluter whose pollution-abatement costs are lower to reduce the first polluter's emissions) and fuel switching (switching to a coal with lower sulfur content).

The cost of controlling emissions has turned out to be lower than predicted. For example, the cost of complying with the limits established in 1990 for sulfur dioxide emissions in the United States, initially expected to be $430 per ton of sulfur pollutant removed, is now typically less than $100 per annual ton. Faced with greater competition, coal users applied the lowest-cost pollution-reduction techniques they could find, including regular maintenance programs, process controls, and cleaner fuels. In fact, fuel switching has come to be a more widely used method for complying with sulfur dioxide standards than retrofit technology.

Cross-sector approaches to pollution abatement recognize that the coal energy chain is an integrated system, with the cost and environmental performance of the entire chain determined by the performance of each individual sector (production, preparation, transportation, and conversion). These types of approaches create incentives for potential polluters to select cost-effective strategies.

Despite the preference for fuel switching, technology is the lowest-cost solution in many situations. Competition has driven

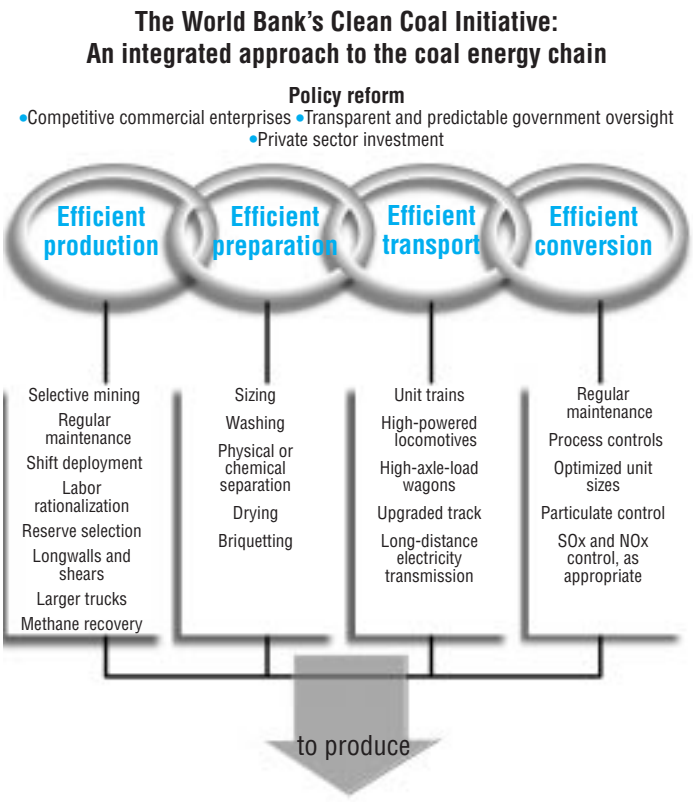
Coal preparation in China

Studies carried out over the past several years have shown that if China could increase its coal-preparation capacity, it could reduce the negative impact that expanded coal production would otherwise have on its transportation capacity, solid waste disposal systems, and air-pollution levels. Coal preparation improves the quality of coal and consists of processes ranging from simple mechanical sorting (to obtain pieces of uniform size) to treatment of the coal with water, chemicals, or physical forces to remove ash, sulfur, and moisture.

A study on China's transportation system carried out jointly by the State Planning Commission of China and the World Bank indicated that by increasing the proportion of prepared coal from the current level of 7 percent of all coal consumed to 16–19 percent (225–265 million tons of today's mine production), China would see savings of $3.8 billion (in 1993 prices) over 15 years, net of mining and preparation costs. These savings would result from lower costs for transport, ash disposal, and boiler maintenance. When the benefits accruing from reduced sulfur and ash residues are taken into account, a doubling of preparation capacity from 32 percent to 38 percent of total coal production could be justified.

Subsequent studies indicate that the costs of air pollution attributable to the burning of unprepared coal may approach the cost of the coal itself. In addition, burning coal of poor or inconsistent quality can cause operational problems in power plants and lead to reduced output. The increase in output associated with the proposed level of coal preparation may be equivalent to a 1,500-megawatt power plant with capital costs of $1 billion.

Despite the strength of these findings, investment in coal-preparation facilities has not increased because of the many barriers created by poor policies and weak institutional and regulatory frameworks. For example, the railroad decides where and to which buyer the producer's (seller's) coal will be delivered. As a result, buyers and sellers of coal cannot readily negotiate coal quality and other conditions. In addition, environmental regulations that would increase sensitivity to coal quality are not universally enforced. Ultimately, these and other factors result in coal prices that do not reflect coal quality. Without quality-based pricing, there is little incentive to produce or buy prepared coal.



equipment manufacturers to lower their costs. Some of the most popular and available technologies add little to the cost of compliance; they include selective mining, coal preparation, and low-nitrogen oxide burners. In situations where additional abatement is needed, sulfur dioxide-scrubbing equipment or circulating fluidized bed combustion can be appropriate options. And wet flue gas desulfurization systems, whose capital costs have dropped by 40–50 percent, have become more affordable over the past decade.

The Clean Coal Initiative

The World Bank's Clean Coal Initiative is based on the premise that an efficient policy framework provides the incentives for managers to improve the productivity of their enterprises and reduce emissions and is thus a precondition for sustainable environmental improvements. The initiative encourages the implementation of policies that increase competition and create incentives to improve the efficiency of each sector in the coal energy chain, as well as the efficiency of the chain as a whole; adoption of cost-effective environmental regulations that will lead to the development of low-cost emission-control strategies; and installation of pollution-abatement technologies that are appropriate for local and regional environmental needs.

China and India are planning reforms of their coal sectors based on the principles of the Clean Coal Initiative. Both countries will use an integrated approach in addressing the economic and environmental challenges associated with increasing coal use. They will first review their current energy and environmental goals and policies, compare them with those of countries that are successfully producing and using coal, and identify reforms and restructuring options for each sector in the coal energy chain that will enable them to achieve economic, energy, and environmental goals simultaneously. In subsequent phases, the Chinese and Indian governments expect to conduct case studies, set benchmarks, and implement pilot projects to improve the performance of the coal energy chain.

While the general approaches of the two countries are similar, each has designed a program that fits its unique situation. With the assistance of the World Bank and international experts, China is planning to prepare a strategic framework for the coal energy chain as a whole and to identify reforms that will enable the country to meet its growing energy needs with increased thermal efficiency; improved environmental performance; and effective use of cleaner, more efficient technologies. India, in contrast, will focus on the incentives affecting the coal production and preparation sectors and their effects on the coal energy chain as a whole. For the production sector, the emphasis will be on the establishment of laws, regulations, and institutions that provide incentives for producers to meet growing coal demand at acceptable economic and environmental costs and on the removal of barriers to investment—including private investment—in coal production. The government will also identify measures that can pay for themselves in terms of economic or environmental savings by examining how existing laws, regulations, and institutions affect coal quality and how coal quality, in turn, affects the coal energy chain.

Coal is the most labor intensive of all energy resources. Miners and transport workers often benefit when coal production is increased. At the same time, increased dependence on coal can adversely affect health and the quality of life in the communities and regions where it is produced and used. It can also have global effects when emissions contribute to climate change. Modern mitigation strategies ranging from management improvements to pollution-reduction technologies can reduce these effects, but often at a cost. Some of this additional cost will be offset by efficiency improvements when incentives to find the lowest-cost alternatives are in place, but not all, making other, environmentally more desirable, energy sources competitive.

Conclusion

Expanding production and use of coal while improving environmental performance is a challenging task for developing countries. Many believe that limited resources present a major barrier to achieving this dual objective, but experience shows that policy changes can help to reduce the resources required. At the most basic level, policy changes encourage efficient operations, a precondition for low-cost improvements in environmental performance. Appropriate policies can also enable polluters to select low-cost pollution-abatement strategies and efficiency improvements. And policies that encourage competition can help to reduce the costs of providing the energy needed to fuel economic growth. F&D