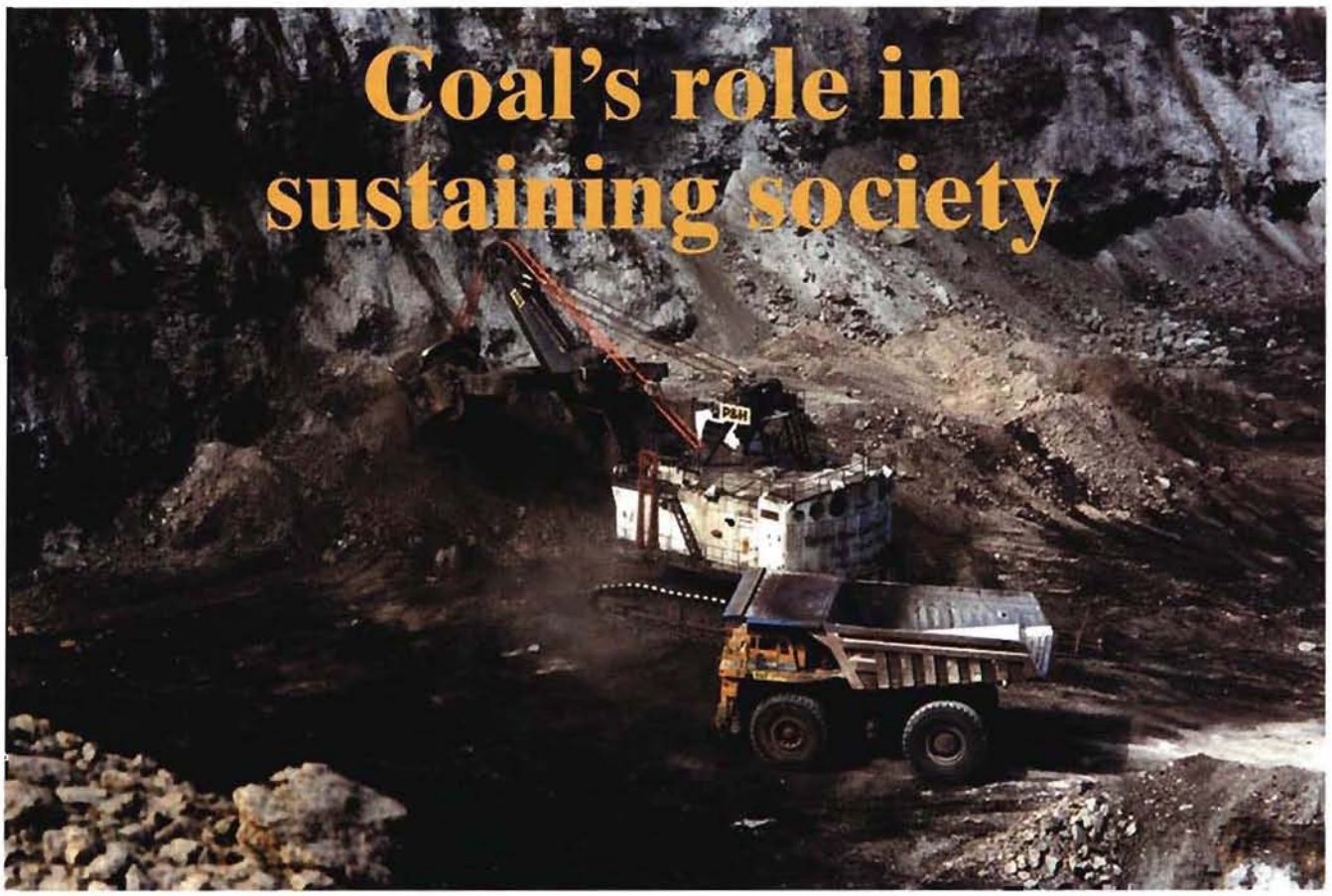
Coal's role in sustaining society



The public's image of the mining industry has been that it harms the environment, exploits workers and harms nearby communities. These continuing image problems are now affecting the recruitment of new miners into the industry. Some recent events, though, have converged to shape more effective public communication on mining's important role. Photo shows a shovel about to load a haul truck at a western United States coal mine.

The mining industry has searched for a message that will resonate with the public while focusing on the industry's positive contributions to society. So far, environmental groups remain unconvinced and the public is still largely uninformed. In the authors' opinion, a number of recent events and experiences have converged to help shape a more effective public communication on mining's important role. This article presents a perspective on coal's role in sustaining society by anchoring the message in a transparent way, including a material flow analysis, that links coal's impacts across a range of social and environmental aspects.

Past and continuing image problems

In her 1994 paper, Nancy Bingham, with Caterpillar, outlined what the public thought about mining. Based on extensive interviews, the following results were found:

- The public believed mining harms the environment.
- The public believed mining harms people in nearby communities.
- The public believed mining exploits workers.
- The public believed mining has little personal benefit to the individual.

The past and continuing image problems are now affecting recruitment of new miners in a growing industry that has many workers ready to retire. This exacerbates the labor shortage.

Workforce issues. Miner health and safety in the 20th century was marred with a public image of death and sometimes deception, especially in the coal sector. From 1900 through the 1920s, more than 3,000 miners a year perished at work, with two-thirds dying in coal mines (Grayson, 1999). Grandfathers and fathers discuss the high number of fatalities. And some of them speak of events they survived that were caused by fires and explosions. Major disasters persisted through 1972. The memories and stories are still etched in the minds of families living in coal mining regions. They are a stigma on the industry's public image as well as a deterrent to recruiting new miners. The tragedies of 2006 have now resurrected a public outcry.

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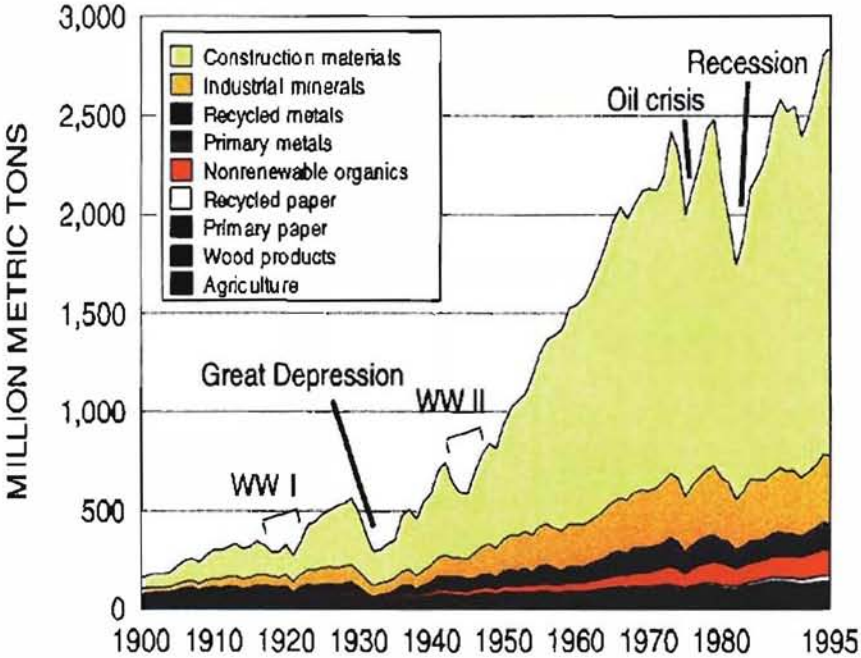
Another image stigma and recruitment deterrent is the history of miners succumbing to coal workers' pneumoconiosis and silicosis. Not until the Federal Coal Mine Health and Safety Act of 1969 were these problems significantly combated. And even today the diseases have not been eradicated. The public, especially in coal regions, is aware of the ordeal.

The great early-century "war" between owners/operators and miners' unions has not been forgotten either. Some grandfathers still carry buckshot from ill-fated organization drives. Battles between the two foes carried through the 1970s when strikes occurred during ineffective contract negotiations. These images, including gunfights at places like Matewan, were also indelibly written in history as negative public images of the industry.

FIG. 1

Measurement of the raw materials consumed in the United States, 1900-1995 (Matos and Wagner, 1998).

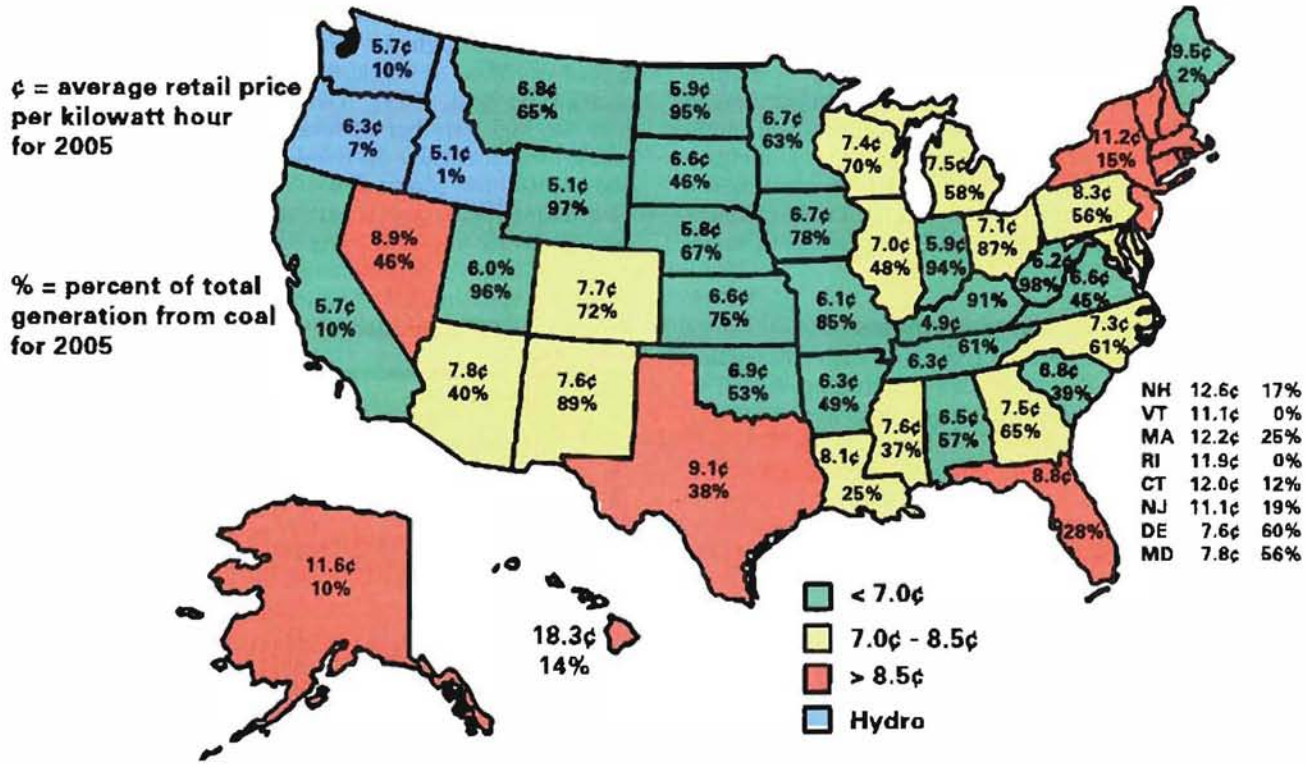


Environmental damage. Beginning in the 1960s and 1970s, environmental damage and indifference to its impacts began making its way to the forefront as a key issue marring the coal industry's image. Large gob piles dotted the landscape, particularly in Appalachia. And acid mine drainage fouled rivers and streams, often robbing the public of fish and recreation. Not until 1977 was any serious federal action taken to coordinate improvement of environmental performance. This is one of the key pillars of the fast-evolving sustainable development movement.

Community issues. Appalachian towns were poor in the early 20th century. Thousands of coal mines

FIG. 2

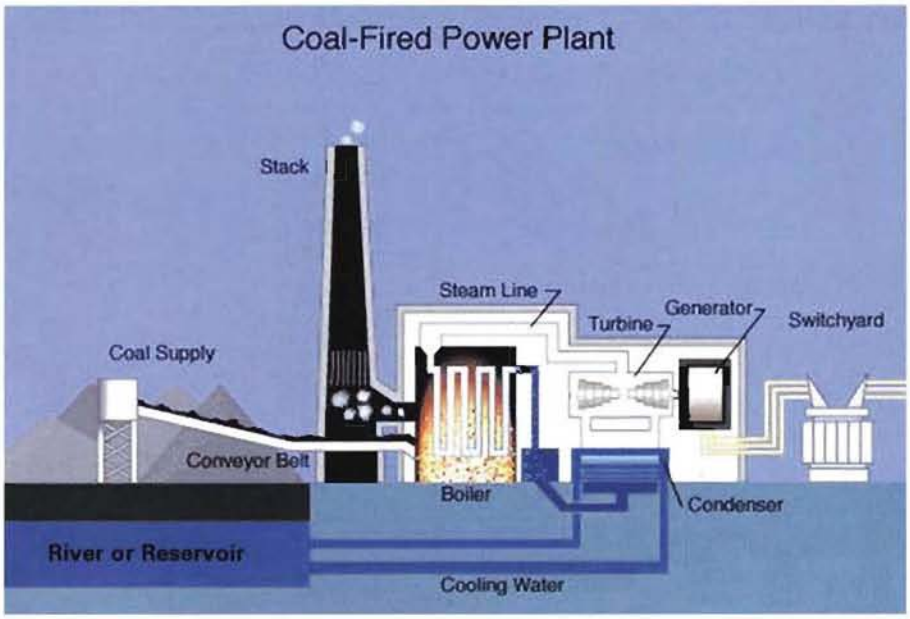
Cost of electricity per kWh and percent of coal generation by state (EIA, 2003).



helped change some of that, admittedly sometimes at a large human cost. By the 1960s, miners' pay was improving and today it is excellent. However, the investment in communities was little, except for tax revenues. So, when coal mines shut down, the revenue source ended and the towns reverted to poverty. This was a story repeated frequently. This syndrome led to major stories such as "The Curse of Coal" (Gup, 1991). Some of the press even predicted "The Death of Mining" (Atchinson, *Business Week*, 1984), hoping it would come true.

FIG. 3

Schematic of a coal-fired power plant (Tennessee Valley Authority, 2006).



Sustainable development and mining

The concept of sustainable development and its principles grew from early writings on environmental transgressions and land ethics (Leopold, 1949; Darling, 1955; Carson, 1965). As a growing number of countries responded to the issues, international conferences began to focus on them, as described by Moffatt (1996). The most famous definition of sustainable development came from the Brundtland Commission (World Commission on Environment and Development, 1987). It stated sustainable development as "... a notion that there may be limits to growth and that society must be reorganized to protect the interest of future generations." This is a simple definition and is easily understood by the global public. However, many government and nongovernment organizations as well as industry have different, sometimes widely divergent definitions.

Not long after the Brundtland Report, the environment was no longer viewed as an externality to economic matters. More businesses have adopted sustainable development and its principles as guiding aspects in their planning and execution of operations. Sustainable development was also galvanized on the political agenda of numerous countries. And it has been at the forefront of global gatherings ever since the 1992 Rio Earth Summit and its Agenda 21, and the 2002 World Summit on Sustainable Development in Johannesburg, South Africa.

By 1998, nine of the largest mining companies embarked on a new initiative aimed at achieving a serious change in the way their industry deals with ongoing problems. The Global Mining Initiative (IIED and WBCSD, 2002) was a joint research project executed by the International Institute for Environment and Development (IIED). It focused on finding "a more informed understanding of the industry's actual and potential contribution to sustainable development." The industry partners agreed "it is no longer enough to argue that because society needs its products, it must tolerate whatever occurs in their production." Further, it is not "enough to play to a public audience conditioned to expect the worst from mining or other minerals industries." Finally, the initiative's partners noted that "we need to define what higher performance amounts to, and create sanctions and incentives to achieve it."

A set of guiding principles for the four "pillars" of sustainable development were specified early in the study and used as a framework for issues to be addressed. The four pillars, each with three or more subprinciples, included the following major spheres. These spheres are to "be applied in an integrated manner in decision-making:"

- Economic sphere.
- Social sphere.
- Environmental sphere.
- Governance sphere.

The report specified important key challenges that must be met in order to achieve the major goal. The nine key challenges include: the viability of the mineral industry; the control, use and management of land; minerals and economic development; local communities and mines; mining, minerals and the environment; an integrated approach to using minerals; access to information; artisanal

FIG. 4

Emissions reductions from coal use (Guarriello, 2004).

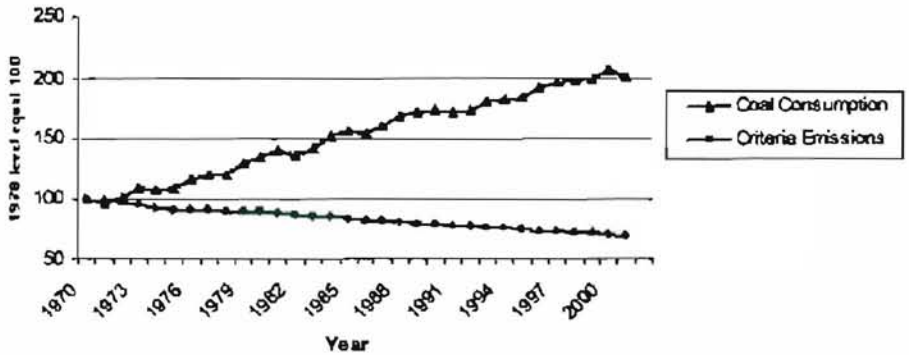


FIG. 5

Effective graph for emissions reductions (National Mining Association, 2006).

Year	Coal Use for Electricity Generation	Coal NOx Emissions	Coal SO_2 Emissions
1980	569	6.12	16.1
1985	694	5.24	15.8
1990	783	5.64	15.2
1991	784	5.58	15.1
1992	795	5.58	14.8
1993	832	5.74	14.5
1994	838	5.64	14.3
1995	850	5.58	11.6
1996	897	5.60	12.2
1997	921	5.64	12.6
1998	937	5.44	12.5
1999	941	4.91	11.8
2000	988	4.56	10.7
2001	964	4.21	10.6
2002	978	4.10	9.7
2003	1,005	n/a	n/a

COAL USE UP 77%

COAL NOx EMITTED DOWN 33%

COAL SO_2 EMITTED DOWN 40%

and small-scale mining; and sector governance: roles, responsibilities and instruments for change.

With the industry's approach to sustainable development outlined, the point must now be made that mining cannot have sustainable development of itself. Rather, mining plays an important role in sustaining society by provision of raw materials. That role must be pursued in consonance with sustainable development principles.

Coal's role in sustaining society

Because of historical accounts, the public believed that the industry sustained itself at the expense of people and the environment. There is much to be done to reverse the negative perceptions and to build trust among all constituencies. There are ways of doing it but it will take time. Placing the new message in the context of the nine key challenges outlined in Breaking New Ground could make a difference. And there is some evidence that it works in changing the public image of the coal industry.

Viability of the industry. When presented the facts on coal's role as an energy source (23 percent), no one will deny it. Most of the population does not realize how much coal is used or that it most often has the competitive advantage.

On the other hand, most of the population is familiar with the emissions from coal, calling it dirty. But it is not familiar with clean coal technology. When told that more than 910 Mt (1 billion st) of coal is produced in the United States, primarily to generate more than 50 percent of our electricity, people are often stunned.

If presented in a picture similar to Fig. 1, which shows the 'materials mountain' infused into the U.S. economy, coal's role would quickly come into perspective. Adding coal and other energy sources to this figure would emphasize its role in the economy. It would also build the case of coal's economic viability, which can be reinforced by Fig. 2, especially when the coal production states are highlighted.

The case is made definitively when the strong negative correlation (-0.64) is noted between the cost of electricity in a state and the percentage of coal used for generating it in a state, and (-0.72) for all states except the hydro power ones (Washington, Oregon and Idaho). Handling the environmental impacts effectively will need to be discussed to convince the public that it is the right choice without significant negative tradeoffs. The crowning point, and possibly the most persuasive argument for coal's sustained use, is the large reserves that can fuel electric power in the United States for another 200 to 250 years. Inevitably, a stable supply will maintain a stable price and therefore a stable economy.

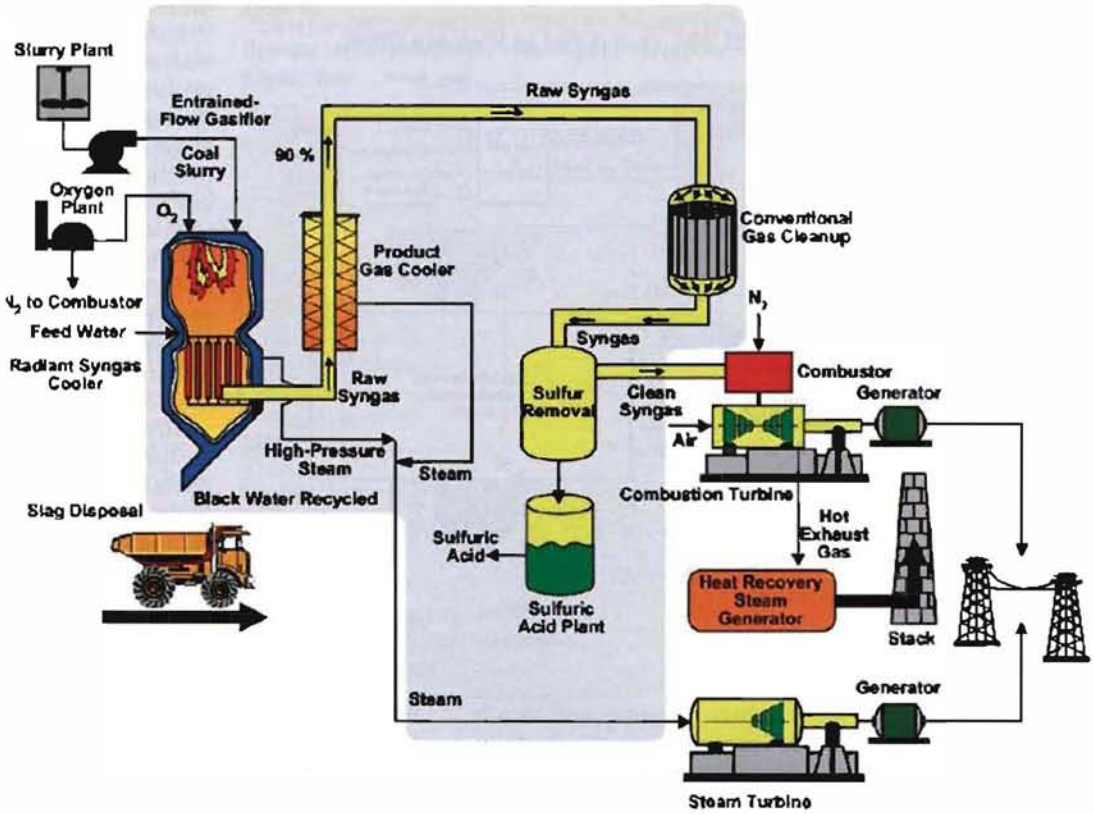
Most of the population does not realize how much coal is used or that it most often has the competitive advantage over other fuels. Photo shows an underground longwall in operation at an eastern United States coal mine.

Coal and the environment. Using pictures to illustrate how coal is used can also be helpful (Fig. 3). Coupling the picture with facts on emissions reductions and other pictures on new clean coal technology makes the case that air quality does not have to be compromised when coal is used for electric power generation. For example, the reduction of criteria emissions (carbon monoxide, lead, nitrogen oxides, ozone, particulate matter and sulfur dioxide) since 1970 has been tremendous despite dramatic growth in coal consumption (Fig. 4). Another convincing illustration of emissions reductions is shown in Fig. 5.

Further assuring the public that good science is directed at even better

FIG. 6

Tampa Electric's integrated gas combined cycle process flowsheet (U.S. Department of Energy, 2006).



reductions is important. Showing diagrams of new clean coal technology plants and the associated pilot project outcomes gives a clear picture of progress and protection of public health. For example, Fig. 6 shows an integrated gasification combined cycle (IGCC) plant that was tested in Florida. It achieved a 95-percent removal of SO_2 and keeping NO_x below 0.27 lb/ million Btu.

Ultimately, public awareness of various treatments and their ultimate effects provides the comprehensive information needed to build confidence in coal as the primary source for power generation. For example, it is now known that limestone injection, low-NO_x burners, selective catalytic reduction, dry precipitators, wet scrubbers, and wet precipitators can give the following results:

- 98 percent removal of SO_2 (0.167 lbs/million Btu).
- >80 percent removal of NO_x (0.09 lbs/million Btu).
- Particulate removal of 99.9 percent.
- Mercury removal up to 90 percent (more work is needed).
- Sulfuric mist removal of 98 percent.

A stronger commitment to demonstrating clear improvements in reducing coal waste disposal and acid mine drainage are important points to be made as well. News articles on new power generation facilities that use coal waste and remove gob piles can help. Demonstrating through facts the return of fishing to once-polluted streams and rivers also helps. Success stories like the improvement of the Monongahela River in Pennsylvania and West Virginia will also help make the case. Verifiable numbers are needed.

Coal's role in economic development and relationships with local communities. In the past, the industry focused on showing the correlation of coal production with growth in the gross domestic product (GDP). This does not resonate with the public. It focuses on what the industry will do for its local economy.

Peabody Energy and Arch Coal are focusing on build-

FIG. 7

General scheme for economywide material flows accounting illustration (Eurostat, 2001).

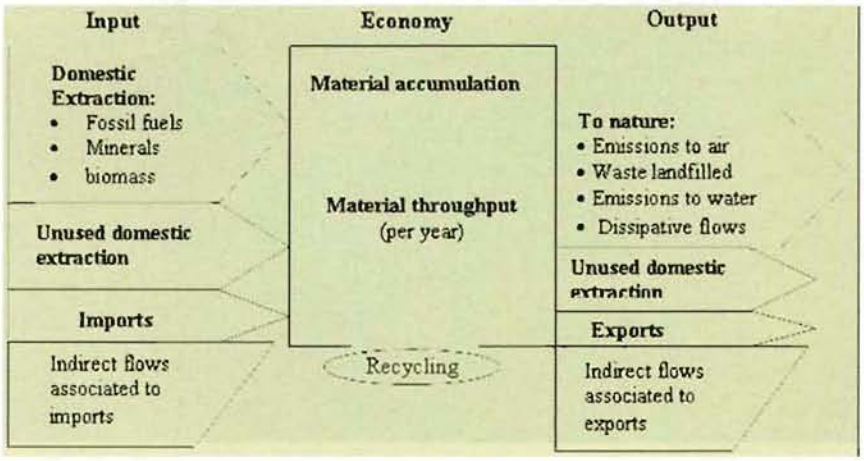
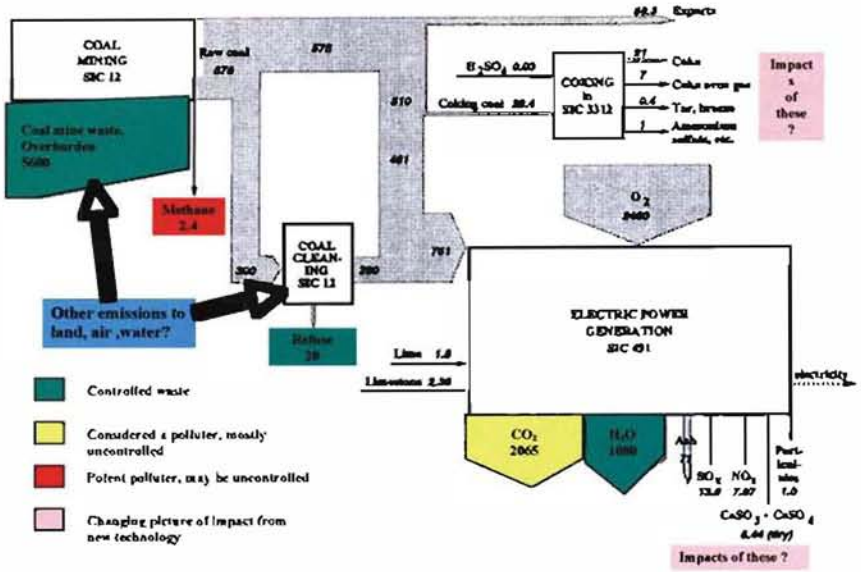


FIG. 8

Coal material flow analysis for 1993 (Mt), as modified by Warneke (2004).



ing energy campuses. Such efforts resonate well locally. The economic multipliers for the region are clearly delineated and generate buy-in by the communities involved.

Permitting at the state level is another matter, and still difficult, but the community buy-in creates an atmosphere of political support, which has influence. By embracing the long-term existence of the energy campus and its synergy through community building, the case is made convincingly of a community-based partnership.

An integrated approach to using coal. Data and information exchanged on the various aspects discussed so far are helpful. But, if provided alone, there are gaps in understanding by the average citizen. Without an integrated linking of the economic, environmental and social impacts, gaps in knowledge and understanding ultimately occur and lead to gaps in acceptance and mistrust. So presenting information in a way that cultivates full understanding of the issues would pay large dividends.

Material flows analysis is a way of presenting interrelations among physical aspects of coal flows in the U.S. economy and their potential impacts. The impacts may be quantified as well in an associated analysis of flows to the environment. Economic impacts may be quantified by linking the physical flows with associated monetary flows. In essence, a material flows accounting system is an analog of a monetary flows system. This has been in existence for decades to help guide governmental fiscal policymaking. Linking material flows accounts with associated financial flows accounts expands the understanding of nonfinancial impacts.

A general economy-wide material-flows-accounting system is shown in Fig. 7. The key focuses are on physical inputs to and outputs from the economy. But diagrams also track the buildup of materials in stock (in infrastructure primarily). Imports, exports, both used and unused extractions, and indirect (or hidden) flows associated with material extractions are shown. Such diagrams may be modified to show exactly where flows go to the environment (air, land and water). Environmental disturbances generally occur on the materials extraction and storage side as well.

Figure 8 shows an early (1993) material flows analysis for the U.S. coal industry done by Ayres and Ayres (1998), as modified by Warneke (2004). It shows the paths of consumption as well as various emissions that occur. Added to the diagram are colors representing the potential impacts on the environment. Much of the data is generally available through the U.S. Energy Information Administration, but much of it is not. For example, considerable work is required to make a reasonably accurate calculation of the coal mine overburden disturbed, other emissions from extraction, the amount of refuse generated from coal cleaning and the emissions from coking and power generation. In fact, Warneke (2004) noted several discrepancies with the previous 1993 analysis.

Beyond the material flows analysis picture, which the public generally will understand, is a description of the ultimate impacts the flows have on people. These impacts can be illustrated through the use of Driving Force-Pres-

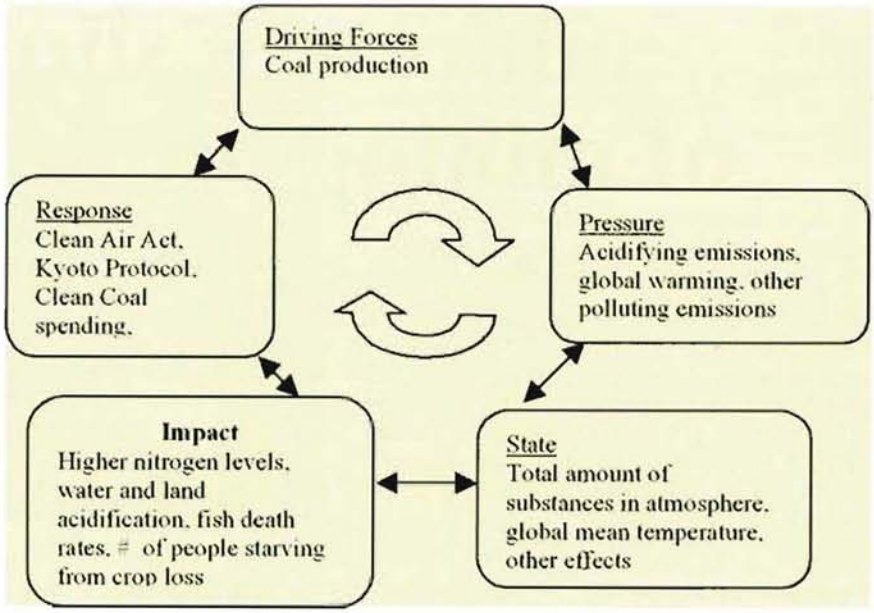
A stronger commitment by the industry to demonstrating clear improvements in reducing coal waste disposal and acid mine drainage are important points. Photo shows stripping and blasting operations at a western United States coal mine.

sure-State-Impact-Response models (Petruzela et al., 2000). Figure 9 (Warneke, 2004) shows one possible model for emissions from coal utilization. The driving force in this instance is the production of coal itself, while pressures are exerted on the environment by acidifying, global warming and other polluting (CO, NO_x, SO_2 and PM) emissions. The state resulting from the pressures relates to the total amount of substances in the air as well as the mean temperature and other effects of the various emissions.

The ultimate impacts people and society care about relate to their survivability, their health, availability of food and potable water, and aesthetically pleasing recreational areas. As negative impacts occur at an unacceptable level, the public response eventually influences government policy. Laws are then passed or regulations revised to reflect the desire for reduced negative impacts.

FIG. 9

Driving force-pressure-state-impact-response model for emissions from coal production.



Transparency of information. For the integrated approach to work in building trust among the public constituencies, information must be available for anyone to examine. One of the best examples of this approach is the commodity flow information developed and shared by the U.S. Geological Survey (USGS, 2005a; USGS, 2005b). This data is open to public access but, at the same time, it protects proprietary information of data providers.

Companies wishing to build public trust and indicate social responsibility as stewards of the communities in which they work, the environment and of sustainable development principles will need to share their data and information, too. Transparency of data equates to improved trust that the data and information will tell the true state of affairs.

Small mine and contractor issues. A lingering issue in the United States and elsewhere is the small mine and contractor health and safety performance. Worker health and safety is one dimension of sustainable development. It is an important one that cannot be neglected. Elevated fatality rates for small mines and contractors operating in the United States are a persistent issue and they must be addressed soon. This issue was addressed in a paper at the 2006 SME Annual Meeting (Grayson, 2005). Other countries, like Australia, are taking action now to solve the problem with contractor safety (Wran and McClelland, 2005).

Addressing sector governance. In a perfect industry world, no government intervention would be necessary to ensure that sustainable development principles are addressed effectively. Instead, the industry would police itself. It would work with government to rid the industry of "bad players," including those who blatantly pollute the environment, subject workers to poor work conditions, or exploit workers or are devoid of any community responsibility (alienate the social contract). Unfortunately, no perfect industry world exists and self-policing at present is only a good idea. Consequently, government intervention through regulation and enforcement will continue until the time that industry truly begins to self-enforce.

Conclusions

Looking at Bingham's article once again, all is not lost, according to the public. She notes: "The good news is that the most common beliefs about mining are not strongly held and are quite susceptible to change." It was clear from the study that "the information people do have comes mostly from movies and entertainment television, rather than textbooks or documentaries." This situation opens the door for good, integrated communication about the mining industry. This will lead to a change in public attitude about mining.

Although mines cannot be sustainable unto themselves, mining will play a major role in sustaining society in many ways. Pursuing the principles of sustainable development has already begun to develop a new, integrated message for the industry that the public and government will understand. And they will often buy-in.

The historical stigma attached to the coal industry is now slowly being reversed, as the industry expands in the 21st century. Through a concerted effort using a well-integrated message, the industry can make the change a permanent one. Those who work at mines or supporting operations are sustaining the massive U.S. economy, are nurturing communities and workers, and are strong stewards of the environment. One day the industry will be self-enforcing as well and the need for more regulation will diminish because of prevailing good-faith efforts. In the meantime, the industry must be diligent in pursuing the principles of sustainable development and place strong peer-pressure on all operators to do so. (References are available from the authors.)