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Environmental Constraints: Threat to Coal's Future?

Edward S. Rubin
Carnegie Mellon University, rubin@cmu.edu

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Edward S. Rubin
Carnegie Mellon University
Pittsburgh, PA 15213 USA

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Introduction

My assignment here is to address the question of whether environmental constraints pose a threat to coal's future. Certainly a clean and healthy environment is a fundamental desire among people of all nations; and certainly it is no understatement to say that environmental constraints are at the heart of most discussions about the use of coal today. But more important to this conference is what the future holds as we enter the 21st century.

Imagine if you will the year 2050. What will coal use be like then? Will world consumption have quadrupled to over 20 billion tons/year to serve a growing population, or might coal be only a fading memory in a world powered by new gas supplies, safer nuclear plants, or abundant solar energy? Certainly many factors will shape the destiny of coal. But unquestionably, a concern for the world's environment will be among the most prominent.

My goal in this paper is to outline the major environmental constraints now facing coal, and some sense of their relative importance. My "bottom line" is that environmental constraints *do indeed* pose a significant challenge to coal's future. But I also believe that coal can and will remain a vital source of energy throughout the world, continuing to fuel the economic development of nations large and small. The trick -- indeed, the major challenge -- will be to mobilize our technological talents and political will to confront the problems ahead. Later, I will propose five key strategies I believe are critical for enhancing coal's prominence in the future global energy mix.

Historical Overview

First, a brief historical perspective is useful to understand the situation today. Here in the western world we have been burning coal in significant amounts ever since the time of Marco Polo, about 700 years ago. About that time, coal rapidly began replacing firewood as a fuel for

heating and cooking as the forests of western Europe became depleted. Although coal supplies were cheap and plentiful, the sulfurous odors and black smoke that accompanied primitive combustion systems soon gave coal the reputation that has persisted for nearly seven centuries: that of a dirty fuel, with significant health and environmental insults.

Environmental objections to coal's future have been with us right from the beginning. Indeed, right here in the city of London, not far from this meeting site, one of the first of those threats was articulated rather bluntly by King Edward I, who was concerned about providing a clean environment during sessions of parliament around the year 1300. "Be it known to all within the sound of my voice," he proclaimed, "whosoever shall be found guilty of burning coal shall suffer the loss of his head." And so for those of you here who worry about the penalties of modern environmental laws, have heart: things could be a lot worse!

The key point to remember is that the world has had a love-hate relationship with coal throughout history. While coal's low cost and plentiful supplies have led to its widespread use to support economic development, the history of efforts to limit the use of coal because of its environmental impacts have historical roots that are just as deep. Environmental regulations have *always* challenged coal's future and that certainly will continue to be true.

Of course, we all know that the reduction in environmental impacts of coal wrought by modern technology in the last half of the 20th century has been nothing less than miraculous. A modern coal-fired power plant today emits less particulate matter, sulfur dioxide and nitrogen oxides in its entire lifetime than earlier generations of power plants emitted during a single year. As we will be hearing throughout this conference, new technology innovations -- what we have come to call "clean coal technologies" -- offer the potential for even lower emission rates and lower costs.

So what, then, is the environmental threat to coal's future? There are two types of concerns: one is the great disparity that still remains between coal use technology in developed and less-developed countries. The second is a continuing trend toward new regulations that may impose higher costs and limitations on the use of coal. Let me elaborate briefly on these two issues.

Environmental Constraints

Most coal today is burned in large combustion units, principally for electric power generation and industrial steam. The earliest environmental requirements addressed the most visible effects of coal combustion, namely soot and flyash emissions. Today, of course, modern electrostatic precipitators and fabric filters can remove virtually all of the particulate matter from coal combustion gases.

But there are still many regions of the world where such controls have not yet been widely installed, and where emissions of coal dust and smoke still pose significant health hazards. The same is true of uncontrolled emissions from coal used for manufacturing processes, transportation and domestic heating and cooking. Until these vestiges of out-dated coal technology are replaced or modernized, local environmental constraints will continue to impede expanded coal use and tarnish the modern image of coal we would portray. I shall return to this point shortly.

In contrast, the past two decades in North America, Japan and Western Europe has seen an explosion of new environmental regulations that has totally transformed the way we do business. In the United States, for example, more than 40 new federal environmental laws have been enacted in the past 20 years, roughly four times more than in the preceding century. Together with state and local requirements today's laws and regulations address virtually all aspects of environmental quality. This is having profound implications for the way we utilize coal.

Emissions of sulfur and nitrogen oxides from large combustion units are the environmental problems we have been grappling with most intensively in recent years. SO_2 and NO_X are of concern because of their effects on human health and welfare and, in the case of NO_X, its indirect role in producing photochemical smog, which also affects health. More recently, SO_2 and NO_X have been held accountable for the regional problem of acid rain. Again, coal was the main culprit.

Modern SO_2 regulations now require either switching to low sulfur fuels or the widespread installation of flue gas desulfurization systems, or scrubbers. Reductions in NOx emissions are being required largely through combustion modifications or, as in Japan and Germany, extensive use of more efficient selective catalytic reduction systems. Thus far, however, historical data show that coal use for power generation has continued to grow in spite of new environmental requirements. Data from the OECD, for example, show that utility coal use in the US has grown by over 75 percent since 1973, while in Japan, where environmental controls are even more stringent, utility coal use in the past 18 years has nearly doubled.

Certainly this is not to say that SO_2 and NO_X controls do not add significantly to the costs of using coal, or that such requirements do not adversely affect some coal markets. Still we must remember that it is the base price of fuels, more than environmental control costs, that dominate energy choices in most parts of the world. Technology innovation already is beginning to significantly lower the costs of environmental controls, and that trend clearly will continue in the future.

How much of a problem, then, do SO_2 and NO_X emission controls pose to the future use of coal? I believe if there is any long-term concern it will stem from new limitations on total emissions to the atmosphere. For example, the acid rain provisions of the new Clean Air Act adopted in the US less than five months ago established for the first time an absolute ceiling on the total

quantity of SO_2 that can be discharged from all US power plants combined. This is somewhat similar to the "bubble" requirements of the European Community, except that for the US, overall utility emissions must be reduced by about 50 percent and then maintained at that level indefinitely.

From an environmental point of view a limitation on total atmospheric loading makes sense. If adverse effects on lakes, forests and human health are to be avoided the total deposition of acidic species must be limited. The trick, of course, is to set the right limits.

In the US, the new cap on SO_2 emissions is now forcing utilities and industrial users of coal to examine carefully their long-term expansion plans, and to analyze rigorously a host of emission reduction options that extend well beyond conventional environmental control systems. In the short term, the availability of low sulfur coals and high efficiency scrubbers will guarantee coal's place as the predominant fuel for power generation. For the longer term, environmental regulations cannot help but exert some downward pressure on the expanded use of coal. How significant that pressure turns out to be will depend to a large extent on how well many of us here do our jobs.

The situation I have just described with regard to SO_2 is but a microcosm of what is clearly the most significant long-term threat to the use of coal, namely the problem of global climate change. Fully a third of the presentations at this conference are devoted to this topic, and there is today perhaps no other subject which so dominates international meetings on environmental issues.

Global climate change, of course, is an extraordinarily complex problem with enormous uncertainties. Like the acid rain problem, it is driven by total environmental loadings. As human activity effectively funnels more and more materials out of the earth's crust and up into its atmosphere, it appears we *may* be on the brink of altering natural patterns of temperature change,

precipitation, storms and other climate variables which could have unpleasant implications for many parts of the globe. Just how unpleasant nobody yet knows; predictions range from minor to catastrophic.

Certainly the problem of global warming is not due only to coal. All forms of fuel carbon are involved as well as non-energy sources of methane, CFCs, nitrous oxide and other greenhouse gases. But I believe it would be naive to think that coal will not be singled out as a villain in the global climate debate. Alternatives to coal use already are being loudly advocated by many partisans that debate, and the argument that coal used for power generation accounts for only 8% of the global warming problem so please leave us alone and go worry about more important things simply will not carry sway in a world where growing environmental concerns are increasingly being voiced through political action and regulatory change.

Because coal does release more CO_2 per unit of energy than other fossil fuels, proposed carbon taxes to mitigate greenhouse gas emissions would fall most heavily on coal and could cripple its growth by the middle of the next century. I believe more innovative and efficient coal use technologies offer the best prospect for sustaining coal use in the face of climate change issues. But a lot will be riding on public policy developments over the next decade.

Other environmental issues loom on the horizon as well. One is the problem of hazardous and toxic air emissions. The new US Clean Air Act lists 189 different chemical species of concern, including trace elements, organics and radionucleides. It calls for special studies of the electric utility industry over the next 3 to 4 years with regard to the risks of exposure from any combination of these species, and the costs of their control. The key emphasis here is on the concept of environmental risk. While this remains a tricky business subject to lots of uncertainties, the philosophy of risk assessment and risk management is likely to guide many environmental developments in the years ahead.

Nor must we forget that environmental risks occur throughout the coal use cycle not just combustion. Environmental constraints on the mining, transportation and disposal of coal wastes remain as significant problems that will be exacerbated as coal use expands. The added burden of solid and liquid wastes produced by air pollution control systems is among the new environmental issues that require urgent attention.

Some regulatory agencies also are beginning to quantify the costs of environmental "externalities." These are the costs to society not reflected in conventional market prices. For a coal-fired power plant, the externality costs might include the damages due to air pollution emissions that escape control, to the solid wastes that are produced, and, yes, to the CO_2 emissions that contribute to global warming. In the state of Washington, for example, the externality costs of a new coal-fired power plant that already meets stringent federal air pollution control standards can add up to 50% to the base plant cost as calculated by an electric utility. This new arithmetic can profoundly affect the attractiveness of coal relative to other energy options.

Profound changes also are taking place with regard to how energy options and environmental impacts are evaluated. The concept of "least cost planning" is requiring some US utilities to evaluate not only the costs and impacts of conventional supply-side options such as coal, nuclear or gas, but also conservation and end-use efficiency improvements that reduce the demand for energy at lower cost. Finacial incentives are being established to encourage utilities to provide energy services, not just energy. While these types of programs are still in their infancy, they point to a future where more vertical integration of coal supply, conversion and end use demand may make sense.

A final item on my list of environmental issues has nothing to do with coal in particular, but with electric power systems in general, and that is the emerging issue of health risks from electric and magnetic fields. Despite the absence of any conclusive evidence, the suggestion of increased cancer risks from exposure to power transmission lines, distribution lines and electric appliances already has begun to color the actions of some state and local regulatory agencies in the US. It is also having a major influence on the research agenda of the US electric utility industry. While this issue is not yet getting significant attention outside of the US, its potential impact on power generation technologies of all kinds, and indirectly on coal use, certainly makes it an issue worth watching.

So where does all of this leave us? The message is that in the highly developed countries of the world environmental constraints on coal remain real and are growing in complexity. Environmental risks throughout the fuel cycle are being scrutinized, and concerns over total environmental loadings are emerging. Issues of energy supply and energy demand increasingly are being coupled.

But what of less industrialized nations that have not yet adopted stringent environmental standards? Do environmental issues pose a threat to coal's future in these countries as well?. Understandably, the pressing economic needs and severe capital limitations of many nations push environmental controls far down the list of priorities. But certainly the desire for a clean and healthy environment remains strong among peoples of all nations, and the long-term direction remains just as clear. Indeed, if we have learned anything in this century about economic development and environmental quality it is that in the long run the two must go hand in hand if either is to be sustained successfully.

The Challenges Ahead

So how, then, can we best meet the challenges to coal's future that environmental constraints and impacts impose? Let me suggest five elements of a broad strategy to insure coal's prominence as a clean and strategic fuel for the future.

First and foremost is technology innovation. New and improved technologies that reduce the cost of using coal in compliance with environmental requirements in different parts of the world represent the best long-term solution for the sustained growth of this industry, and we must pursue such developments aggressively. I use the term "technology innovation" broadly to include a host of approaches that range from new methods of mining, transporting and upgrading coal quality; to new and improved combustion methods; advanced flue gas treatment systems; integrated power systems based on coal gasification; and new concepts such as advanced coal refineries producing electricity, chemicals and other useful byproducts.

The technological challenge of these efforts will be not only to minimize costs and emissions but also to maximize overall energy and resource efficiency. Presentations at this conference will demonstrate that we are making impressive progress toward these goals. But the pace and productivity of those efforts must be accelerated if the rhetoric and promise of clean coal technology is indeed to become the reality and new image of coal that the world actually perceives.

Apropos of this, the second major need is for technology modernization. This will demand concerted and sustained efforts to upgrade or replace as quickly as practicable all of the remaining antiquated and inefficient coal-processing units throughout the world. I include here most of the small-scale combustion facilities still widely used in the industrial, transportation and residential sectors of many nations, as well as outdated processes using coal as a feedstock or raw material.

This task will require extensive efforts within our own national borders, and sustained international cooperation to provide technical and economic assistance where needed. Creative solutions will be required to overcome institutional and political barriers and to create new incentives that achieve both economic and environmental objectives. Certainly, I do not mean to underestimate the magnitude or difficulty of this challenge; but the long-run benefits that will accrue from a sustained program of technology modernization go far beyond the immediate reduction in environmental impacts, and the sooner we get on with it the better.

The third need is to focus the research agenda for global climate change. As I indicated earlier, this issue, perhaps more than any other, has the potential for truly significant impacts on the long-term use of coal. While there are substantial scientific research efforts world wide to better understand the nature of global climate change, there is also good reason to believe that many of these research programs simply will not provide the kind of insights and timely information needed to inform key policy decisions. Indeed, recent US experience with its 10-year acid rain research program underscores the fact that large scientific research efforts may in the end fall far short in addressing the key concerns of policymakers.

Given the potentially profound social and economic implications of policies to mitigate global warming, it is essential that we understand, as best we can, *all* of the implications of any actions. It is important, therefore, that all key actors with a stake in this problem be involved in shaping the research agenda to be as relevant as possible to the policy debate. I would especially urge the need for a comprehensive integrated assessment focused broadly on identifying those uncertainties that matter most for key policy decisions, and the research, both basic and applied, best suited for reducing those uncertainties. This should be an iterative process designed to provide better, more relevant and more timely answers than would otherwise be the case.

In the absence of more definitive information on the environmental risks of coal-related emissions, I would urge that coal producers and users take a leadership role in helping to identify and do those things that are environmentally prudent and have merit in their own right. For example, many energy efficiency improvements across the spectrum of coal use activities are both environmentally beneficial and cost-effective, whether or not global warming or acid rain are high on your list of concerns. An action program of "no regrets" initiatives can, at the very least, strengthen your image and reputations as good citizens, and in many cases will earn you money as well as goodwill.

My last point is one not often heard at conferences such as this, but is perhaps most critical in the long run. And that is the need to expand the training and education of the next generation of engineers, scientists and technologists whose work will shape the long-term viability of coal. From my own perspective at a major university I can tell you that there is intense competition for bright, talented people, and that careers related to innovative coal technology are not generally at the top of the list. Sustained government and private sponsorship of scholarships and cooperative research throughout the world can help attract many more of the best and the brightest into this field. That, ladies and gentlemen, is perhaps the most important investment needed for the long-term future of coal, and one that I urge you consider.

In closing, let me offer a final word of thanks to the World Coal Institute for inviting me to speak here today. This conference offers impressive testimony to the importance the coal industry places on confronting the environmental challenges to coal, and of insuring coal's vital and strategic role in the 21st century. I look forward to joining with you in meeting those challenges.