COAL:

America's Past
America's Future?

President Bush's Plan and the Risk of Global Warming

A Study for:
World Wildlife Fund

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Coal at the Crossroads

Summary

President Bush and some Congressional leaders see coal as the answer to our energy problems. They are crafting policies that would increase subsidies and make us even more reliant on coal as the foundation of our electricity-using economy. There's a lot of wishful thinking about "clean coal," but an examination of the coal supply chain makes it clear that the "clean coal" is a distant hope. Attempting to achieve it could be a costly diversion from sensible alternatives. In the meantime, our huge fleet of existing coal plants, plus new ones on their way, will pump yet more carbon dioxide into our atmosphere and further increase the risk of catastrophic global warming.

- **Good money after bad.** Common sense suggests that instead of subsidies for highly polluting fuels such as coal, we should use tax dollars to promote promising clean technologies. The Bush administration appears to think otherwise. President Bush has proposed $2 billion in new coal subsidies on top of the $2 billion already squandered on the Clean Coal Technologies program, which has been plagued by mismanagement and overruns. Over the past 25 years, the coal industry has already benefited from billions of dollars to increase coal use by financing promotion of new coal products such as synthetic fuels and coal-based chemical feedstocks. Yet these efforts have not borne fruit, and have largely been financial and technological failures. These "clean coal" subsidies come at a time when funding for *truly* clean renewable and energy efficiency technologies are slated for deep cuts by the Bush Administration in its Fiscal Year 2002 budget. While claiming that renewables and energy efficiency are important parts of its energy strategy, the Bush Administration has proposed to cut substantially the funding to develop and deploy renewables and new efficient technologies.

- **Going against the flow.** The US already produces and consumes roughly a quarter of the world's coal supply, and consumes roughly 4 tons of coal per person a year, a rate far beyond the per capita average for the industrialized world. Coal accounts for 55% of US electricity production, compared with a current global average of about 36%. Total US coal consumption has grown 17% since 1990, in stark contrast to the rest of the world, where coal use has dropped 16% (EIA, 2000). Over this same period, China removed its long-standing coal subsidies and many OECD countries such as the UK and Germany shifted away from coal to cleaner burning and less expensive gas. Ironically, the past decade witnessed the US surpassing China in its use of coal.

- **Still the culprit.** Coal plants are the electricity industry's principal source of pollution. They account for 92% of that sector's sulfur oxide emissions, 85% of its nitrogen oxide emissions, 76% of its carbon dioxide emissions, and 99% of its mercury emissions. Nitrogen and sulfur oxide emissions lead to a host of damages to crops, ecosystems, and human health. As precursors to acid rain, they are responsible for rendering 25% of Adirondack lakes devoid of fish and vegetation, and damaging forest systems from the Shenandoahs to Canada. One study attributes 26,000 premature deaths annually through heart and lung disease to power plant emissions (overwhelmingly coal), and finds that a 75% reduction in NO_x and SO_x emissions (below 1997 levels) could eliminate 18,000 of

them. Furthermore, as a result of power plants and other pollution sources, average visibility in national parks and wilderness areas today is less than a third what it would be under natural conditions.

- **The mercury is rising.** Coal plants are the single leading source of all mercury pollution in the US, accounting for a third of all airborne mercury releases. Mercury has already contaminated over 50,000 lakes and streams in the US. Coal plant mercury emissions are expected to increase 33% by 2010, and yet they are the only major mercury sources that are unregulated. Ironically, a proposed "clean coal" plant (fluidized bed) proposed in Kentucky could actually emit up to 1.8 tons of mercury per year, twice as much as any other coal plant currently in operation.

- **It's not just the air.** Coal is increasingly extracted from surface mines, and in Appalachia this has meant more and more mountaintop mining. One mountaintop removal mine can strip up to 10 square miles and dump hundreds of millions of tons of waste into as many as 12 valley fills that can be 1,000 feet wide and 1 mile long. Coal mining also results in 95% of acidic mine drainage in the US, harms aquatic life in 12,000 miles of American rivers.

- **The dirty twenty dozen.** Of the 500-plus coal plants in operation in the US today, most were built before the advent of modern pollution control regulation. These, older "grandfathered" coal plants, largely exempt from clean air regulations, have continued to operate at emission levels 10 times that of plants meeting current standards. Ironically, the electric industry originally justified this exemption on the grounds that these older plants would soon be retired and replaced by new technology. In fact, the opposite has occurred – generation from these plants has *increased*. Without purposeful efforts by the Bush Administration to mandate the necessary controls, pollution from these aging coal plants will continue to grow.

- **"Clean coal" is *not* the wave of the future.** Plant owners, given an encouraging regulatory and market environment, could well bring another 5 GW of old mothballed plants out of retirement, and increase the output of currently operating coal plants by 20%. Based on EIA's projections for new coal-fired capacity, 70% of the increase in coal-based power over the next *twenty* years would come from *today's* (and yesterday's) power plants, not from *tomorrow's* so-called "clean coal" power plants. (See figure 1.) Annual carbon dioxide emissions from power plants would increase by about 40% relative to today's levels by 2020, at a time when the US should be dramatically reducing emissions.

- **Making a bad situation worse.** Until recently, almost all new power plants were expected to be relatively clean and efficient natural gas-fired power plants, as was reflected in EIA's analyses. However, recent increases in gas prices appear to have dimmed this promising trend. If the Administration succeeds in promoting and further subsidizing coal, this shift back towards coal would only be further intensified. Assuming that coal will dominate the expansion in generation instead of natural gas, emissions from power plants would increase by about 60% relative to today's levels by 2020.

- **Putting the climate at risk.** Perhaps the greatest challenge to making coal truly clean is to reduce or eliminate its high carbon dioxide emissions, which lead to global warming. Compared with natural gas, coal contains 70% more carbon, plus coal power plants are much less efficient. Together, these two factors make coal-based electricity more than twice as polluting, in greenhouse gas terms, as natural gas-based electricity. Compared with natural gas-fired *co-generated* electricity, coal electricity fares still worse. Ultimately, protecting the climate will require that homes, offices and factories shift to highly efficient energy using equipment, and that electricity comes largely from carbon-free energy resources, such as wind, solar, geothermal and biomass.

If one factors in the environmental costs of a typical coal plant's pollutant emissions, plus the costs of capturing and storing CO_2 to make coal electricity carbon-free, coal no longer appears the cheap electricity source it seems today. The cost of coal power jumps to over $80/MWh, whereas power from new plants costs about $40/MWh, and about $20/MWh from existing plants. Even power from a so-called "clean coal" plant with lower pollutant emissions and higher efficiency rises to around $70/MWh if it includes the environmental costs and the cost of capturing and storing CO_2. However, effective long-term and environmentally safe storage of CO_2 in deep depositories on land or at sea remains unresolved. Already, energy-efficient technologies and wind energy can provide carbon-free and pollution-free electricity at much lower costs.

If the objective is truly clean electricity, the least-cost and environmentally safest path, involves turning instead towards a combination of energy efficiency, natural gas, wind, cogeneration and other clean resources. Recent studies have demonstrated that an "innovation path" reliant on renewables, efficiency, and natural gas could achieve major reductions in CO_2 and other pollutant emissions, with no harm – or even considerable savings – to the US economy[1]. The economic benefits could be partly used to compensate coal-mining communities, since under these scenarios coal use would drop significantly. These communities are already suffering due to major changes in the coal industry, including dramatic decreases in employment (from increased mechanization and other pressures to reduce labor costs), and the environmental impacts of mountaintop removal and other destructive mining techniques.[2] An innovation and compensation strategy could help these communities in a just transition to a post-coal energy economy.

As this report shows, a coal-focused national energy strategy would be fundamentally misguided. Wearing foggy and myopic lenses, one might perceive the California power crunch, high natural gas prices, and talk of "clean coal" as ample economic and technical justification for more coal. But closer and clearer examination reveals that there is a long way to go before coal will be truly clean, if ever, and an even longer way before such coal would be competitive.

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[1] ORNL, LBNL, 2000. *Scenarios for a Clean Energy Future: Interlaboratory Working Group on Energy-Efficient and Clean-Energy Technologies*. Oak Ridge, TN: Oak Ridge National Laboratory; Berkeley, CA: Lawrence Berkeley National Laboratory; Bernow, S. et al., 1999. *America's Global Warming Solutions*, Tellus Institute, www.tellus.org.; Geller, H. et al., 1999, *Meeting America's Kyoto Protocol Target*, American Council for an Energy-Efficient Economy, www.aceee.org.

[2] Between 1980 and 1996, mining employment per ton of coal in the US plummeted three-fold, and overall jobs fell by almost 60 percent, while coal production increased by about 40 percent, according to statistics from the Department of Energy and the Monthly Labor Review. Continued steady decline in mining employment coinciding with increasing production are projected, with an overall seven-fold drop in employment per ton and a 75 percent job loss by 2006 from 1980 levels.

Coal use today remains the major culprit for a host of local and international concerns, from polluted American streams and respiratory illnesses to a changing global climate. Despite talk of "clean coal", policy efforts to promote coal threaten to seriously exacerbate these problems. Much of the US's recent growth in coal consumption was due to increased use of existing and dirtier, rather than new and cleaner, coal plants. The next 20 years could see more of the same, given the considerable potential for additional electricity production at existing and currently mothballed facilities. And if legions of new coal plants are in fact built, that may only further commit us to future, unsustainable levels of carbon dioxide emissions. This in turn would render the chances of international accord in tackling global climate change more remote.

If we accept as President Bush has, that global warming is real and we need to something about it, then we need to come to grips with the implications: the age of coal may soon be over.

Coal at the Crossroads

"It is up to all of us to remind folks that we can safely mine coal and we can cleanly burn it with the right technology," President Bush told an audience at the West Virginia National Guard headquarters in Charleston. This means not only using clean coal technologies at home, he said, "but also being able to have clean coal technology as part of an export policy, so that nations that have not developed as we have will be able to utilize the technologies."

Introduction

Coal fueled the Industrial Revolution of the 19th century and the US electricity industry in the 20th century. The question is … What role will coal play in the 21st? Of all fossil fuels, it remains the most abundant; US coal reserves are about 4 times those of oil and gas combined, and sufficient to last 220 years at current rates of consumption[3]. Coal is by far the cheapest fuel in today's energy markets, and will likely remain so until we more fully account for the many environmental, health, economic and social damages that it causes. We lop off mountain tops to get it, impair lungs to extract it, pollute the air to burn it, and contaminate land and water to shed its wastes. More profoundly, if we continue to depend upon it, coal and the vast quantities of carbon dioxide it can produce, threatens to dangerously alter the Earth's climate, and the ecosystems and social systems that require its stability.

We are at a crossroads with coal. On one side of the national debate, we hear that greater reliance on coal is essential to addressing a so-called energy crisis. It is argued that with more federal funding and private investment, we can make coal far cleaner, and cleaner coal more affordable. On the other side, we hear that so-called "clean coal" merely continues reliance on the most polluting source of fossil energy. Continued coal use is a principal reason we breathe dirty air, acidify streams, lakes and forests, contaminate them with mercury and other toxic pollutants, and risk potentially devastating global climate disruption.

"Twenty years ago, no one dreamed a coal mine would destroy so much land and water and sacrifice entire communities to get at a seam of coal. One mountaintop removal mine can strip up to 10 square miles and dump hundreds of millions of waste into as many as 12 valley fills that can be 1,000 feet wide and 1 mile long." www.citizenscoalcouncil.org

The term "clean coal" has been attached to coal technologies under development that would cost more but could sharply reduce emissions of certain pollutants. But coal technologies that could produce similarly steep reductions in mercury emissions and carbon dioxide, the main global warming gas, remain elusive and potentially far more costly. If we factor in the costs needed to make coal-based electricity even approach the low emissions and impact levels of other resources and technologies – such as natural gas, wind, or energy efficiency -- coal would

[3] Energy Information Agency, 2001. *International Energy Outlook.* http://www.eia.doe.gov/oiaf/ieo/; U.S. Geological Survey, *World Petroleum Assessment 2000*, web site http://greenwood.cr.usgs.gov/energy/ DDS/60.

likely price itself out of most energy markets. Even then it is unclear whether some of these coal "clean-ups" – such as carbon capture and storage -- are fully feasible, reliable and without serious environmental concerns of their own.

Competing outlooks for coal have led to conflicting goals, embodied in existing and proposed legislation and initiatives.

- Title IV of the 1992 Clean Air Act Amendments is now in its second phase, which will create tighter sulfur dioxide (SO_2) emissions standards for power plants. However, with evidence of continued acid damage, heightened concern over the health costs of toxic metals and particulate pollution, and banked allowances from Phase I that will enable increased emissions in coming years, there are calls to substantially tighten these standards.

- Assuming EPA's propose NO_x rules[4] hold up in court, many existing coal plants in Texas, the East and Midwest, will be required to install technologies that reduce emissions of nitrogen oxides (NO_x) or to shut down, in order to overcome worsening summertime smog conditions. These rules are still under debate, and the outcome is unclear.

- Several bills pending in Congress aim for a consistent "multi-pollutant" strategy to simultaneously reduce emissions of CO_2, SO_x, NO_x, and mercury – an approach that President Bush pledged to support during his campaign. It was in the context of this legislation, that Bush made his announcement in March to renege on his support for "regulating CO_2." Statements of the Bush Administration flatly rejecting the Kyoto Protocol followed, notwithstanding the decade-long work on this agreement and the widespread international backing for it. Yet, a multi-pollutant approach remains alive in Congress. The basic idea is to cap emissions of these pollutants and to create a more level playing field for all generation fuels and technologies. The net effect of such bills would likely be to reduce the production of coal-based electricity, particularly from older, dirtier plants.

- Senator Byrd of West Virginia recently introduced S.60, the National Electricity and Environmental Technology Act, a bill that would exempt coal power plants that adopt "clean coal" technologies from the New Source Review requirements of the Clean Air Act, and provide them with tax credits as well. This bill could pave the way for new coal plants, including a proposed coal waste burning facility in Kentucky, with among the highest mercury emissions. It would also provide incentives for bringing old coal plants out of retirement. The net effect could be a large increase in coal-based electricity production.

- President Bush has proposed $2 billion in new coal subsidies on top of the existing $6 billion Clean Coal Technologies effort. This proposal comes at a time when funding for

[4] On September 24, 1998, the EPA set out rules to limit NOx emissions in 22 states. The rules, commonly referred as the "NO x SIP Call," called for capping summer season power plant NO x emissions beginning in 2004. These rules thus far held up in court to several industry challenges.

cleaner, renewable and energy efficiency technologies are slated for cuts by the Bush Administration.

At stake in these and other local and national debates, is not only whether older coal plants continue to operate and new coal plants are built, or the extent to which low emissions coal burning technologies are possible or made the standard. More fundamentally, it is whether to invest in coal as the fuel of the 21st century, or in cleaner resources and new advanced technologies for energy production and use.

Coal Today

The US produces and consumes roughly a quarter of the world's coal supply. Our consumption of roughly 4 tons of coal per person a year is far above the per capita average for the industrialized world. While US coal consumption has grown 17% since 1990, this is in stark contrast to the rest of the world, where coal use has dropped 16% (EIA, 2000). Over this same period, China removed its long-standing coal subsidies and many OECD countries such as the UK and Germany shifted away from coal to cleaner burning and less expensive gas resources. Environmental concerns over coal use were one reason that coal consumption dropped 40% in Western Europe during the 1990s[5], a trend that should continue as these countries make further efforts to address global warming and other concerns. In contrast to much of the rest of the world, where coal subsidies have been curtailed, the Bush Administration is now attempting to introduce new coal subsidies in the US. Over the past 25 years, the coal industry has already benefited from billions of dollars to increase coal use by financing promotion of new coal products such as synthetic fuels and coal-based chemical feedstocks. Yet these efforts have not borne fruit, and some have been financial and technological failures.

More than 90% of US coal use is for electricity production, a fraction that has been increasing for decades. Fifty years ago, buildings, industry, and railroads consumed over 80% of US coal. But local air quality concerns and substitution by electricity and cleaner, higher quality fuels in these sectors have left the demand for US coal almost exclusively with electricity generators and specific industries such as steel making. Coal accounts for 55% of US electricity production, up from around 45% in the mid-1970s. This compares with a current global average of about 36%[6].

Until recently, it appeared that coal use might also be facing a decline in electricity supply markets, given the emergence of high-efficiency natural gas technologies as the electricity option of choice, and the rapid growth in deployment wind and other renewable energy technologies. Wind is still the fastest growing electricity source worldwide, increasing at 25% annually; with a 50% jump in US wind capacity expected this year[7]. However, recent increases in gas prices have raised the prospect of even heavier reliance on coal for power production in the future.

Of the 500-plus coal plants in operation in the US today, most were built before the advent of modern pollution control regulation. These, older "grandfathered" coal plants, largely exempt

[5] Energy Information Agency, 2001. op cit.
[6] World Coal Institute, 1999. www.wci-coal.com/speech19.htm
[7] American Wind Energy Association, 2001. Global Wind Energy Market Report. http://www.awea.org/faq/Global02-2001.PDF

from clean air regulations, have continued to operate at emission levels 10 times that of plants meeting current standards. Ironically, the electric industry originally justified this exemption on the grounds that these older plants would soon be retired and replaced by new technology. In fact, the opposite has occurred. These older coal plants are flourishing, profiting from deregulation and tightening electricity markets. These outdated but fully depreciated plants run at a cost of only 1-2 cents per kWh produced, and are producing more electricity than ever.

The average rate of utilization (capacity factor) of US coal plants rose from 60% to 67% between 1992 and 1997. Existing coal plant usage could conceivably rise to their full availability of about 85%. The resulting additional 400 TWh would be the equivalent to the production from 50 new, large (1000 MW) coal plants – but without the improved emissions performance of newer technologies.

These coal plants are the electricity industry's principal source of pollution. They account for 92% of that sector's sulfur oxide emissions, 85% of its nitrogen oxide emissions, 76% of its carbon dioxide emissions, and 99% of its mercury emissions.[8] Coal plants are the single leading source of all mercury pollution in the US, accounting for a third of all airborne mercury releases.[9] Mercury is a powerful nervous system toxin, and has already contaminated over 50,000 lakes and streams in the US.[10] Coal-fired power plants emitted 46 tons of mercury in 1990, an amount that is expected to increase 33% by 2010 as coal use increases,[11] and yet they are the only major mercury sources that are unregulated. Coal power plants released roughly 4000 tons of toxic metal compounds to the air in 1998, many of which are known carcinogens and neurotoxins, yet whose emissions are largely uncontrolled.

In many parts of the US, especially the Midwest, coal-fired power plants are the principal sources of these pollutants. Nitrogen and sulfur oxide emissions lead to a host of damages to crops, ecosystems, and human health. As precursors to acid rain, they are responsible for rendering 25% of Adirondack lakes devoid of fish and vegetation, and damaging forest systems from the Shenandoahs to Canada.[12] NO_x and SO_x emissions also contribute to the formation of fine particulate matter in the atmosphere, which can be inhaled deeply and lead to asthma and respiratory illness. One study attributes 26,000 premature deaths annually through heart and lung disease to power plant emissions (overwhelmingly coal), and finds that a 75% reduction in NO_x and SO_x emissions (below 1997 levels) could eliminate 18,000 of them[13].

Fine particles emitted directly from coal combustion, or created as the result of SO_x and NO_x emissions, contribute to reduced visibility in urban as well as distant rural areas, as sulfate particles typically travel 300-750 miles downwind of power plants. As a result of power plants and other pollution sources, average visibility in national parks and wilderness areas today is less than a third what it would be under natural conditions.[14]

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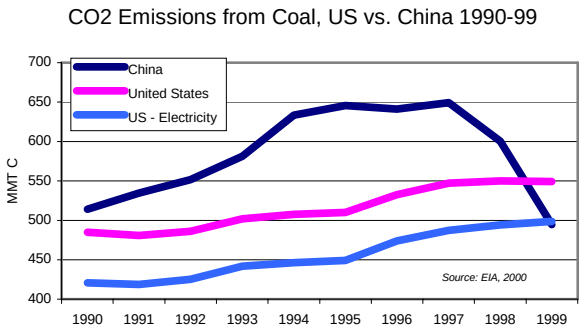
[8] EIA, 2000. Annual Energy Outlook, 2001.
[9] US EPA, Office of Water, *Air Pollution and Water Quality: Atmospheric Deposition Initiative: Where is the air pollution coming from?* www.epa.gov/owowwtr1/oceans/airdep/air5.html
[10] USPIRG, 1999. *Up In Smoke: Congress' failure to control emissions from coal power plants.*
[11] Clear the Air Campaign, 2000. *Mercury, Health, and Your Environment*, http://www.cleartheair.org/relatives/17951.pdf
[12] National Acid Precipitation Assessment Program, August 1998, as cited in USPIRG, 1999, op cit.
[13] Abt Associates, the Particulate-Related Health Benefits of Reducing Power Plant Emissions, October 2000. www.cleartheair.org
[14] Out of Sight: Haze in our National Parks *How Power Plants Cost Billions in Visitor Enjoyment,* Clean Air Task Force, 2000.

Implementation of EPA's State Implementation Plan (SIP) requirements would mean important reductions in NO_x emissions at existing coal-fired power plants, with most of the facilities in the Eastern US slated for retrofits to install NO_x control technologies in coming years. The 1992 Clean Air Act Amendments have already led to reductions in sulfur dioxide emissions. But without further cuts, the remaining particulate and acid precursor emissions (NO_x, SO_x) will continue to burden us with major ongoing health, ecosystem and economic costs.

Our continued dependence on coal-based electricity is an important reason that the US leads the world in greenhouse gas (GHG) emissions, and has difficulty working with other nations in reaching a meaningful climate accord, for which the Kyoto Protocol has established the basis. Coal-fired power plants account for over a quarter of all US GHG emissions. In fact, increased generation of coal-based electricity has accounted for 44% of the US growth in GHG emissions since 1990.[15] This increase directly inhibited the US' ability to live up to the UN Framework on Climate Change, which was signed by President Bush's father and ratified by the Senate in 1992, and which calls on us to stabilize GHG emissions at 1990 levels by the year 2000. Ironically, the past decade witnessed the US surpassing China in total coal combustion.



Coal Tomorrow

Despite recent concerns over natural gas prices and availability, recent government projections still indicate that almost 90% of new power plant capacity in the next 20 years will come from natural gas, and less than 10% from coal[16]. Current gas supply bottlenecks are viewed as short-term (1-2 years until pipeline capacity and drilling respond to high prices), while long-term constraints are expected in 20-30 years as reserves begin to dwindle. Over the next 20 years natural gas supplies are expected to be cheap and abundant enough to power most new generation. These projections were made assuming that natural gas prices would rise 1.6% per year from 1999-2010, while coal prices would decline 1.0% per year, due to increasing productivity in mining, a shift to lower-cost western production, and competitive pressures on labor costs. EIA projected coal-based electricity production to rise by 20% over the next 20 years, while its share of electricity production would drop to 47%.

Since EIA made these projections, however, electricity prices have started hitting record levels in several parts of the country, and natural gas prices have spiked and perhaps stepped up to new levels. At the same time, the Bush Administration and some in Congress began rallying behind coal, putting forward pro-coal incentives and legislation such as S.60. If efforts succeed to roll back environmental protections and siting reviews, coal use could easily rise faster than the

[15] According to EIA (*Emissions of Greenhouse Gases in the United States 1999,* Report#:EIA/DOE-0573) total carbon dioxide equivalent emissions for 1999 was 1833 MMT Ceq, an increase of 178 MMTCeq over 1990 levels. During that period, emissions from coal-based electricity grew by 78 MMTCeq.

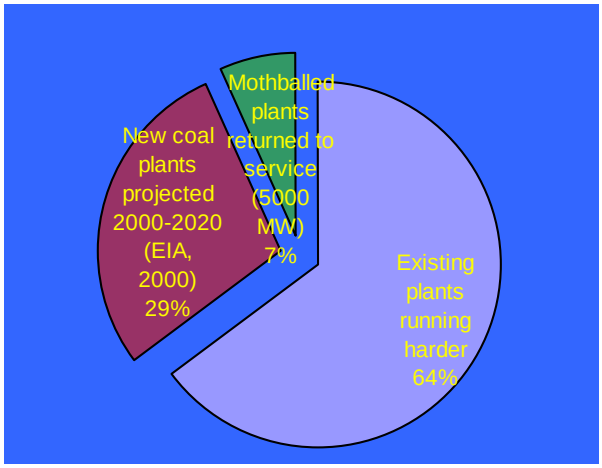
[16] EIA, 2000. *Annual Energy Outlook* (2001, published in October 2000)

1%/year EIA projection. Recent months have witnessed a string of new proposed coal generating facilities. Included are: a 1200 MW coal plant that would be Colorado's first new coal plant in twenty years; a 350 MW coal plant in Western Washington; a 600 MW coal waste burning plant in Kentucky, with among the highest mercury emissions in the country, to name a few.

But, does more coal use necessarily imply "clean coal" use?

Not at all. Much of the generation will come from the same old coal plants. Only 5% of these plants are slated for retirement in the next twenty years; and as noted above, another 20% increase in electricity production could be squeezed out of existing plants. Moreover, many utilities are actively seeking to bring old mothballed coal plants back on-line. They have recently begun filing the necessary paperwork to refurbish at least a half-dozen aging facilities. All this new coal-fueled generation will proportionately increase mercury and other emissions, absent new additional regulations. While add-on emission control technologies might take care of some of these emissions – if so required – they tend to reduce plant efficiency and will therefore boost unit CO_2 emissions from these same plants. CO_2 emissions continue to elude control technologies and regulatory control, and would increase by more than 400 million tons.

Figure 1. Where the increase in coal consumed from electricity by 2020 might come from



Assuming that 5 GW of these older plants are brought out of retirement, that existing coal plants increase production by 20%, and that EIA's prediction of 22 GW of new coal-fired capacity through 2020 holds true, then as Figure 1 shows, 70% of coal generation would come from today's (and yesterday's) fleet of relatively inefficient power plants, rather than tomorrow's "clean coal" power plants.

Finally, we are left with the question of how clean will "clean coal" plants truly be.

"Clean Coal": oxymoron or achievable goal?

"At the current time at least 15 separate regulatory actions dealing with SO_2, NO_x, and mercury are now either pending at the Environmental Protection Agency or are in litigation. These actions are based on the faulty premise that an increase in coal means an increase in emissions. This is simply not true."

> Brett Harvey, Chairman and CEO for CONSOL Energy, Inc., testifying on behalf of the National Mining Association, before the House Committee on Energy and Commerce's Subcommittee on Energy and Air Quality, March 14, 2001.

Expectations for "clean coal" often rest on such wishful hyperbole. It may be possible to *eventually* produce electricity from coal with low emissions and limited impacts across its fuel cycle. The technologies to increase combustion efficiency, to remove most pollutants, to mine in a low-impact fashion, and to recycle or reuse the waste products of the coal fuel chain, are either identified or within reach in the coming decade or two. Of course, these could impose quite substantial additional costs on coal use. Carbon dioxide is more difficult to control than other pollutants. To burn coal with near zero carbon emissions will require a combination of high efficiency and carbon capture technologies. Even if the high cost of such technologies were not an issue, doubts remain about the impacts and security of most options for CO_2 storage, to ensure it is permanently kept out of the atmosphere. This raises three big questions. How much will coal-based electricity cost once all these factors are taken into account? How long will it take to get to low impact coal, and how much irreversible damage will occur before we get there (i.e. climate impacts from the billions of tons of carbon dioxide emitted in the meanwhile, tons of mercury and other toxic pollutants released, streams and habitats destroyed, etc.)? How does this path compare to one that invests instead in available zero or low carbon alternatives?

The federal government has thus far invested nearly $2 billion in taxpayer funds in the Clean Coal Technology (CCT) program. It has yielded some important innovations, like lower-cost low-NO_x burners, which has helped 50% of all plant capacity to install NO_x controls. It has also helped to lower the cost of sulfur dioxide controls. However, it is still far short of its ultimate goal of a nearly carbon and pollution-free low-cost coal power plant with efficiency over 60%. It has also been plagued by mismanagement, and has been the target of seven GAO investigations over its 16-year life, largely as the result of project bankruptcies and overruns Advanced coal technologies, like integrated gasification combined cycle (IGCC) and fluidized bed combustion (FBC), have been piloted through the CCT program, and appear to offer potential for very low air emissions of criteria air pollutants like SO_x, NO_x, and particulates, but not CO_2. (See Box) IGCC, which promises the greatest reductions in criteria, CO_2, and toxic pollutants emissions, has yet to be taken up by the private sector without substantial subsidies. It remains to be seen whether developers of the next generation of merchant and utility coal plants will make the necessary additional investments. Even the US DOE recognizes that "despite the performance and emission advantages of these technologies [IGCC and FBC], high capital costs

The ABCs of Clean Coal

FBC: In fluidized bed combustion (FBC) technology, limestone is mixed with the fuel during combustion to binding with sulfur. This reduces SOx emissions, and also enables the use of low quality, high-sulfur, fossil fuels. However, FGD reduces overall conversion efficiencies, and therefore increases CO_2 emissions. Also, both FGD and FBC sulfur abatement uses calcium carbonate, which itself releases CO_2 as it is consumed. The use of high sulfur coals in FBC requires high limestone consumption, which results in increased CO_2 emissions.
IGCC: An integrated gasification combined cycle (IGCC) is a power configuration in which the fuel is gasified so that it can be fed to a high efficiency combined cycle, rather than a steam cycle. Only IGCC reduces both SO_2 as well as CO_2 emissions. A key ongoing area of development is the high-temperature cleaning of coal gas, which is necessary for its combustion in a turbine. An added benefit of coal gasification is that sulfur can be removed before the combustion stage, rendering flue gas desulfurization (FGD) unnecessary. Typically, more than 99 percent of the sulfur pollutants are captured and converted into sulfuric acid or elemental sulfur, both salable by-products. Nitrogen oxide emissions are about one-tenth those of a conventional power plant.

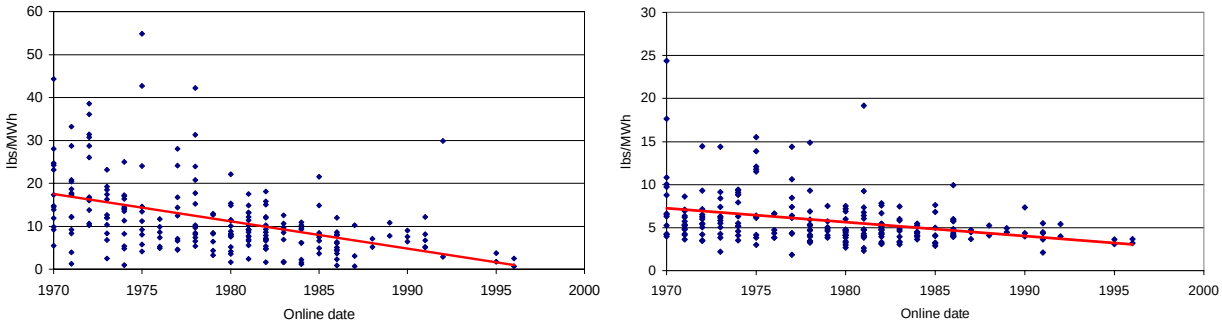
threaten competitiveness in the utility market."[17] FBC does appear to be making some inroads. For example, the 440 MW Red Hills Power Project enters service this year is using FBC technology to burn lignite coal mined near the plant, as part of a so-called Eco-Industrial Park. Coal wastes will be recycled into bricks and wallboard. Because of its inherent fuel flexibility, FBC is also the proposed technology for a Kentucky plant, which would burn coal wastes. Ironically, this "clean coal" plant could actually emit up to 1.8 tons of mercury per year, twice as much as any other coal plant currently in operation.[18]

Reduced emissions from coal combustion: many tough challenges remain

The Clean Air Act and other environmental regulations, along with the control technologies promoted by the Clean Coal Technology program, have yielded important progress in the reduction of criteria pollutants. But success in addressing CO_2, toxic emissions, and local environmental and health impacts has been has been far more limited.

The steady improvement in NO_x and SO_x emissions for newer plants from 1970-1997 is evident in Figure 2. Each data point represents the emission rate for a new coal plant by its on-line date, and the straight lines are the linear trends fit to data from coal plants spanning 28 years. Sulfur dioxide and, to a lesser degree, nitrogen oxide emissions have clearly declined for newer plants. Still, the older dirtier plants dominate overall generation. Moreover, coal-fired power plant efficiencies have not improved. The addition of power-consuming emission control technologies and evaporative cooling towers have more than offset any technical improvements in combustion efficiency, and as a direct result, the rate of carbon dioxide emissions, as shown in Figure 3, has actually increased slightly. Mercury emissions have decreased somewhat across the period. Nonetheless, absent new regulations, it is still possible that even new plants, like the one proposed in Kentucky, could emit at relatively high levels.

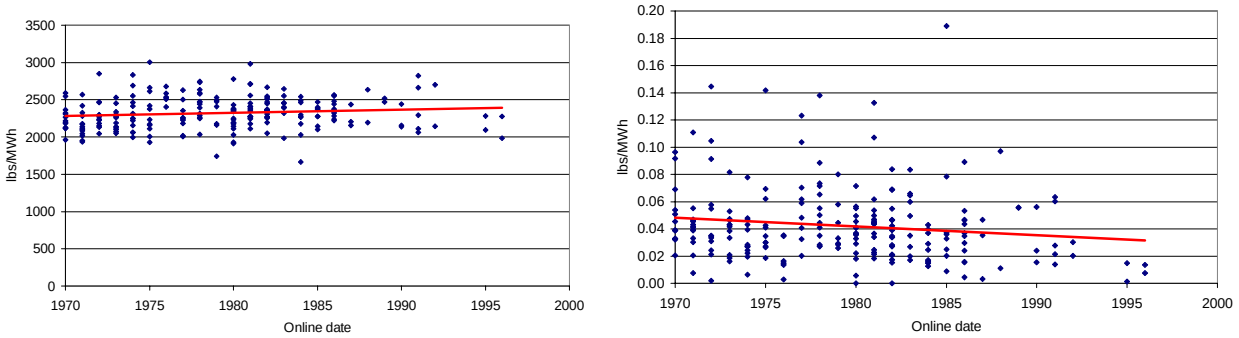
Figure 2. SO_x and NO_x Emission Rates from US Coal Plants by Vintage, 1970-1997



[17] US DOE, *Market-Based Advanced Coal Power Systems, Final Report* - May 1999, p. 1-2 http://www.fe.doe.gov/coal_power/special_rpts/market_systems/market_sys.html

[18] Based on 1998 data found in USEPA's EGRID plant database. Estimates of plant mercury emissions are from http://www.appalachianfocus.org/_mine2/000000a6.htm.

Figure 3. CO_2 and Mercury Emission Rates from US Coal Plants by Vintage, 1970-1997



Coal mining and coal wastes: far from clean

It's easy to focus on the air emissions from coal burning. They are leading contributors to acid rain, air pollution, and global warming – all prominent environmental issues and the target of high-profile regional, national and international control strategies. However, some of coal's most profound impacts occur where it is mined and where its waste products are disposed. Despite many industry and legislative efforts to minimize impacts, coal mining continues to leave a dismal legacy of local environmental damage, from denuded mountains to waste piles and polluted streams and rivers.

The past century has witnessed a strong shift away from Eastern deep-mined coal, with its history of occupational hazards and labor struggles, toward lower sulfur surface-mined coal in Appalachia as well as the West. Although 70% of recoverable US coal reserves are found in deep deposits, most US coal is strip-mined from near-surface deposits.

The future of mountaintop removal mining is currently at issue. In October 1999, a federal judge ruled that the practice had to be limited. State officials and industry lawyers are currently appealing that ruling to the 4th U.S. Circuit Court of Appeals. Whether surface or underground, coal mining produces considerable waste products, especially where coal is "cleaned" to reduce its sulfur and other emissions upon eventual combustion. Coal mining results in 95% of acidic mine drainage in the US, harms aquatic life in 12,000 miles of American rivers.[19]

Many of these mining and processing impacts could be mitigated, for instance, by posting sufficient bonds for mine site reclamation, conducting high quality restoration efforts, neutralizing acid runoff with limestone, and other techniques. There are examples of responsible management by coal companies. However, to successfully address these concerns requires comprehensive, permanent, and enforced solutions. Today, coal mine owners can still declare bankruptcy, abandon mines, and leave waste piles as continuing threats to streams and ecosystems, absent sufficient bonds to cover the cost of reclamation.

The other principal coal wastes are the products of combustion — ash, boiler slag, scrubber sludge where sulfur is removed, and other wastes. The amount of ash produced is equal to about 10% of the coal burned, far more combustion waste than produced by any other fuel (biomass plants produce less than 2% and oil plants about 0.1%)[20]. Coal plants produce about 100 million

[19] Serchuk, 2000, op cit.
[20] Serchuk, 2000, op cit.

tons of these wastes each year. About 25% of these wastes are reused for wallboard, fill, cement or other uses. The rest is largely left at the power plant site in unlined and unmonitored wastewater lagoons, or at landfills and mines, exempt from any federal regulations. Despite the high concentration of toxic metals like arsenic, cadmium, and mercury in coal combustion wastes, local regulations are often less strict than those for municipal garbage. In Texas and North Carolina, coal combustion wastes have been associated with fish consumption warnings. This has led some to call for EPA to investigate whether to classify these by-products as hazardous waste.[21]

Coal and carbon dioxide: the ultimate challenge

Perhaps the greatest challenge to making coal clean is to reduce or eliminate its carbon dioxide emissions. Ultimately, climate stabilization will require that homes, offices and factories shift to highly efficient energy using equipment, and that electricity comes largely from energy resources and generating technologies with no carbon dioxide emissions, such as wind, solar, geothermal and biomass. Two factors largely determine a power plant's CO_2 emissions – its efficiency and the carbon content of the fuel. Compared with natural gas, coal is well behind on both counts. Coal contains 70% more CO_2 per unit of energy input to electricity generation, and new natural gas power plants are 30-50% more efficient[22]. Together these two factors make coal-based electricity more than twice as polluting, in greenhouse gas terms, as natural gas-based electricity. Lowering the carbon emissions from coal to natural gas levels, and below, will require progress on two fronts:

- Making coal plants more efficient. Notwithstanding its gains in NO_x and SO_x control technologies, the Clean Coal Technology program has failed to achieve major improvements in coal plant efficiencies. State-of-the-art pulverized coal plants are approaching their peak efficiency potential, at about 45% for supercritical boiler units[23]. Fluidized bed plants also seem to be inherently limited to at the 45% level.[24] This compares with nearly 60% for state-of-the-art combined cycle natural gas plants, and much higher efficiencies for natural gas co-generation plants. So, if carbon emissions are to be controlled via efficiency improvements, the future of coal ultimately lies in gasification technologies, which, linked with combined cycle units or fuel cells, could potentially exceed 50% efficiency. However, demonstration plants have yet to come close to these levels, and this new technology is still many years from full commercialization in the US. Even then, carbon emissions per kWh of electricity would be far higher from coal plants than advanced natural gas plants and, of course, renewables and efficiency, which are carbon-free.

- Capturing and storing the carbon. If one places faith in coal as a fuel of the future, all roads inevitably lead to this approach. There is simply no way of achieving

[21] Citizens Coal Council, Hoosier Environmental Council, Clean Air Task Force, March, 2000. *Laid to Waste: The Dirty Secret of Combustion Waste from America's Power Plants,* www.cleartheair.org. The Resource Conservation and Recovery Act of 1980 exempts most coal and oil waste from hazardous waste rules, pending a decision by EPA to regulate. (REPP, 2000)

[22] Typical new high efficiency coal plants achieve 40-45% efficiencies (supercritical pulverized coal), while natural gas combined cycle plants can reach 55-60% efficiencies. Both coal and gas efficiencies are continuing to improve.

[23] McMillan, J., Williams, B., McCahey, S. 2001. Strategic Considerations for clean coal R&D, *Energy Policy,* 29 (2001) 441-452.

[24] McMillan et al, 2001, op cit.

meaningful climate stabilization with continued coal use, unless the carbon is somehow kept from entering the atmosphere. Carbon could potentially be "captured" either before burning the coal or afterwards. With conventional solid coal combustion technologies, the carbon must be removed from flue gases, an expensive proposition given that CO_2 is typically a small constituent (9-14%) of a large stream of gases. A more elegant approach is to apply a front-end process like the "steam-shift reaction," which involves mixing coal with steam in the presence of a catalyst to ultimately produce CO_2 and hydrogen gas. After stripping out the CO_2, this hydrogen gas could then be burned cleanly in combined cycle or fuel cells. The IEA estimates that CO_2 capture would increase the cost of coal electricity by 50-70%, depending on whether gasification or post-combustion technologies are used.

The more difficult and unresolved challenge is figuring out a safe and reliable way to store the captured CO_2 on a long-term basis. Possible storage sites include deep saline aquifers, ocean depths, depleted oil and gas reservoirs, or un-mineable coal beds. There is substantial scientific uncertainty about the potential environmental impacts of deep ocean storage, and about the long-term integrity of each of these storage options. For instance, little is known about whether earthquakes could trigger sudden or slow releases of stored CO_2. IEA estimates the overall cost of CO_2 capture and storage today at \$40-60/tCO_2. This alone could more than double the costs of electricity from new coal plants and more than triple the costs of generation from existing plants. Still more costs would be incurred in order to reduce the other human and environmental impacts along the entire coal-to-electricity fuel cycle. Such costly measures are not faced by natural gas, renewables and efficiency.

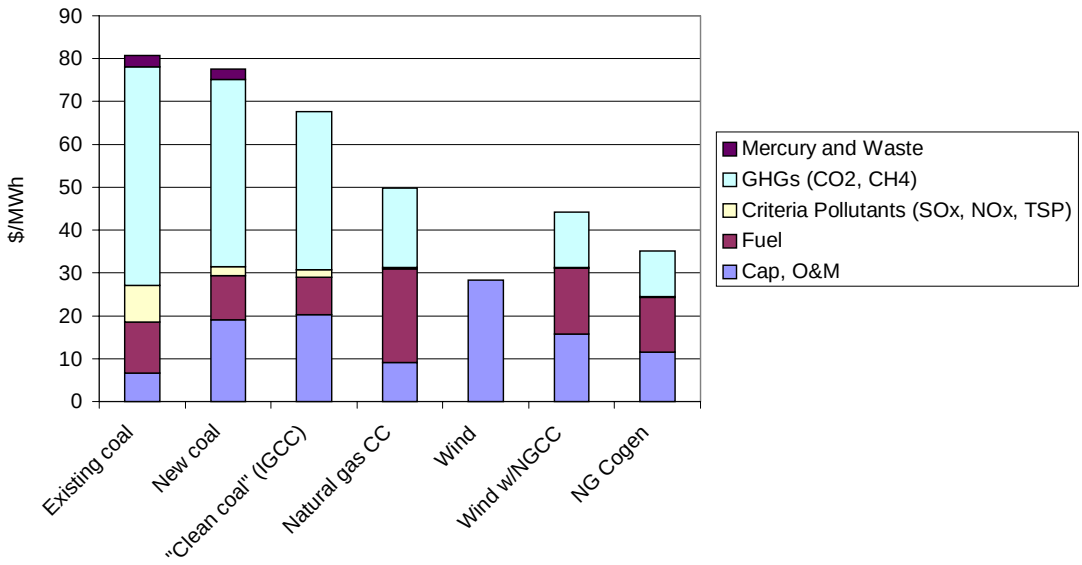
Coal vs. the alternatives: what will it cost?

Figure 4 compares of the costs of electricity from coal, natural gas, and wind plants, including a representation of their environmental costs. Capital and operations and maintenance (O&M) costs are taken from EIA's latest analysis, while the environmental costs reflect conservative assumptions for criteria pollutants, and recent IEA estimates for CO_2 capture and storage[25]. The results are striking.

If one factors in the environmental costs of a typical coal plant's pollutant emissions, plus the costs of capturing and storing CO_2 to make coal electricity carbon-free, coal no longer appears the cheap electricity source it seems today. The cost of coal power jumps to over \$80/MWh, whereas power from existing plants costs about \$40/MWh, and from existing coal plants about \$20/MWh. Even power from a so-called "clean coal" plant with lower pollutant emissions and higher efficiency rises to around \$70/MWh if it includes the environmental costs and the cost of capturing and storing CO_2 in deep ocean or terrestrial depositories. Due their higher efficiency and lower carbon content, natural gas combined cycle plants would be far more cost-effective at delivering low-emission electricity at around \$50/MWh. Wind power and energy efficiency could deliver electricity at still lower costs with no carbon emissions.

[25] EIA, 2000, op cit. There are cheaper sources of CO_2 reductions but these involve offsets, i.e. projects from other sectors and sources that are not linked to coal use. However, CO_2 capture and storage is truer to the notion of "clean coal" than "dirty coal" plus "offsets".

Figure 4. Cost of electricity from coal and alternative sources, accounting for environmental controls and damage



Conclusion

Coal is made mostly of carbon, and burning it inescapably produces carbon dioxide. Our huge fleet of existing coal-burning power plants is pumping carbon dioxide into the atmosphere, and building new coal plants will just intensify the risk that we are dangerously disrupting our climate.

If the objective is truly clean electricity, the least-cost path involves turning away from coal and instead towards a combination of energy efficiency, natural gas, wind, cogeneration, and other lower-emission resources. As shown in Figure 4, natural gas, cogeneration, wind, and wind backed up by natural gas units (for when the wind isn't blowing) are all significantly less expensive than "clean coal". Not shown on this chart, much more electricity is "available" from energy efficiency at less than $30/MWh. Two recent studies have demonstrated that an "innovation path" reliant on renewables, efficiency, and natural gas could achieve major reductions in CO_2 and other pollutant emissions, with no harm – or even considerable savings – to the US economy[26]. The economic benefits could be partly used to compensate coal-mining communities, since under these scenarios coal use would drop significantly. These communities are already suffering due to major changes in the coal industry, including dramatic decreases in employment (from increased mechanization and other pressures to reduce labor costs), the environmental impacts of mountaintop removal and other destructive mining techniques.[27] An

[26] ORNL, LBNL, 2000. Scenarios for a *Clean Energy Future: Interlaboratory Working Group on Energy-Efficient and Clean-Energy Technologies*. Oak Ridge, TN: Oak Ridge National Laboratory; Berkeley, CA: Lawrence Berkeley National Laboratory; Bernow, S. et al., 1999. *America's Global Warming Solution*s, Tellus Institute, www.tellus.org.; Geller, H. et al., 1999, *Meeting America's Kyoto Protocol Target*, American Council for an Energy-Efficient Economy, www.aceee.org.

[27] Between 1980 and 1996, mining employment per ton of coal in the US plummeted three-fold, and overall jobs fell by almost 60 percent, while coal production increased by about 40 percent, according to statistics from the

innovation and compensation strategy could help these communities in a just transition to a post-coal energy economy.

As this report shows, a coal-focused national energy strategy would be fundamentally misguided. Wearing foggy and myopic lenses, one might perceive the California power crunch, high natural gas prices, and talk of "clean coal" as ample economic and technical justification for more coal. But closer and clearer examination reveals that there is a long way to go before coal will be truly clean, if ever, and an even longer way before it would be competitive.

Coal use today remains the major culprit for a host of local and international concerns, from polluted American streams and respiratory illnesses to a changing global climate. Despite talk of "clean coal", policy efforts to promote coal threaten to seriously exacerbate these problems. Much of the US's recent growth in coal consumption was due to increased use of existing and dirtier, rather than new and cleaner, coal plants. The next 20 years could see more of the same, given the considerable potential for additional electricity production at existing and currently mothballed facilities. And if legions of new coal plants are in fact built, that may only further commit us to future, unsustainable levels of carbon dioxide emissions. This in turn would render the chances of international accord in tackling global climate change more remote.

If we accept as President Bush has, that global warming is real and we need to something about it, then we need to come to grips with the implications: the age of coal may soon be over.

Department of Energy and the Monthly Labor Review. Continued steady decline in mining employment coinciding with increasing production are projected, with an overall seven-fold drop in employment per ton and a 75 percent job loss by 2006 from 1980 levels.