PROGRESSIVE POLICY INSTITUTE

**Policy Report**
October 2001

# Getting More for Four

*Principles for Comprehensive Emissions Trading*

*Byron Swift and Jan Mazurek*

## Introduction

Clean energy or dirty energy? The choices made today will affect the health, welfare, and economic well being of Americans today and tomorrow. A clean energy policy would deliver not only environmental benefits but economic ones as well. Such a policy also could help to stem the potentially staggering costs of climate change. While the terrorist attack of September 11 has naturally deferred debate in Washington over energy and environmental policy, the issue is likely to re-emerge before long, especially if the war on terrorism increases concerns about U.S. energy independence.

To address the issue, this paper shows how we can achieve a cleaner energy future, outlining a set of principles for environmental legislation in the power sector. As a foundation for discussion, it examines first why market-based methods are needed to reduce emissions from the power sector and why we support programs that cap emissions and promote allowance trading.

*Emissions from the Electricity-Generating Sector*

The electricity-generating sector produces a disproportionately high percentage of our nation's air pollution—about one-third of the total U.S. emissions of nitrogen oxide (NOx) and mercury, and it is responsible for an even higher share of sulfur dioxide ($SO_2$) and carbon dioxide ($CO_2$) emissions. Emissions of these substances are linked to some of our most pressing environmental problems—acid rain, exposure to fine particles, smog, and regional haze, as well as global climate change.

In response, momentum has grown recently in Congress to create comprehensive market-trading programs for $SO_2$, NOx, and $CO_2$ and to regulate mercury. Legislators have introduced at least four comprehensive emissions bills, and power industry groups have proposed several others.[1]

The Progressive Policy Institute (PPI) has long championed the idea of using market-based regulation instead of prescriptive standards to achieve public goals. In that regard, PPI has endorsed the concept of emissions trading and has advanced a proposal to cap and trade greenhouse gas from utilities and industry (Naimon and Knopman, 1999). PPI also supports the development of energy policies that promote clean growth. Those policies are summarized in a companion paper (Fox-Penner, 2001).

To illustrate the effectiveness of a cap-and-trade system, the paper draws from the successes of the Environmental Protection Agency's (EPA) $SO_2$ emissions trading program, as well as from ideas contained in the various four-pollutant trading bills and proposals. Although it draws from these bills and proposals, this paper does not endorse any one specific emissions cap-and allowance-trading plan.

*The Acid Rain Example*

During the late 1970s, the problem of acid rain loomed large on the nation's agenda. This problem is largely caused by the $SO_2$ emissions from the utility industry, which, citing cost concerns, resisted congressional efforts to place a limit or "cap" on its emissions. The former Bush administration broke the deadlock in 1989 by proposing an emissions reduction system that has since proven that a cleaner environment need not be inordinately expensive. The Acid Rain Program sets a single tonnage limit or "cap" on the emissions of $SO_2$ from all utilities. Those who can control $SO_2$ cheaply can sell emissions trading allowances to those who find reducing emissions more costly. This combined approach is far less expensive than "first generation" laws that regulate emissions from each source separately. By combining an emissions cap with allowance trading, a stringent environmental result was achieved at relatively low cost. The expected costs of the Acid Rain Program have decreased since it was debated in Congress from early estimates, ranging from $400 to $1,500 per ton of $SO_2$ removed, to a current price of only $200 a ton—far less than estimated benefits (Carlson, 2000).

*The "Four-E" Approach*

The cap-and-trade system that has been so successful in controlling $SO_2$ emissions holds the promise of reducing pollutant emissions further and of addressing a problem that looms even larger: climate change. Many scientists believe that the accumulation of carbon dioxide in the earth's upper atmosphere will change the earth's climate (IPCC, 2001). Initiatives to cap carbon here at home and for the United States to participate in efforts to curb greenhouse gas emissions internationally stalled this past year. Those opposed to regulating $CO_2$ have employed the same argument used by those who resisted attempts to reduce acid rain: the cost of controlling greenhouse gas emissions is too high. Ironically, many electric utilities and a growing number of members in Congress now view the price of *not* developing a comprehensive strategy to reduce power plant emissions as too high.

Two key aspects of the comprehensive emissions trading approach are worth mentioning at the outset.

The first is the need to include carbon dioxide. It appears likely that the White House will support a program to cap-and-trade the three pollutants, minus carbon. Yet excluding carbon from emissions reduction efforts now simply means that utilities will later need to make costly modifications. Moreover, it means that the United States will miss the opportunity to harness market forces to stimulate the development of technologies to reduce $CO_2$ emissions, forces which have proven so successful in the case of $SO_2$.

The second is that a comprehensive emissions reduction package must integrate existing provisions for new sources under the Clean Air Act's New Source Review (NSR) with a cap and trade program. Congress created those provisions to ensure that air quality would not deteriorate when industry built new facilities or "sources." The NSR provisions require new plants to undergo a lengthy permitting process before being built. They also require older plants to secure approval for major modifications that can affect air quality.

NSR's provisions require sources to install "Best Available Control Technology" (BACT) and, in some instances, state of the art emissions controls to attain "Lowest Achievable Emissions Rates" (LAER). Such requirements can reduce incentives to bring new power online and to upgrade older generating facilities. To correct these deficiencies, Congress should integrate the two standards by eliminating these NSR standards for those sources that are covered under the emissions cap. Once these caps are imposed, NSR no longer provides any significant emissions reductions, and eliminating these NSR provisions for new sources has the potential to actually boost cleaner energy technologies by equalizing the economic burden for pollution control placed on old and new sources.

## Principles for a Four-Pollutant Approach

The following principles can guide decision-makers as the various three- and four-pollutant proposals move forward:

- **Make the strategy comprehensive.** A multi-emissions strategy makes the best economic sense over time and delivers significant environmental benefits that can be expected to far exceed the costs of control.

- **Cap carbon now.** An emissions reduction strategy must include carbon to ensure a clean energy future. Capping carbon now gives generators more certainty about how to address regulatory requirements and stimulates investment in a diverse mix of clean energy technologies and mitigation techniques that will form the basis of our modern energy supply.

- **Use emissions caps, not end-of-pipe rate standards.** Effective market-based strategies such as emissions caps outperform "first generation" approaches such as end-of-pipe rate standards that end up dictating technologies to sources and control emissions after they are created.

- **Establish phased reduction targets.** We should adopt emissions caps with integrity, but give sources reasonable time to meet them. Doing so will help the

United States maintain a diverse fuel portfolio, including advanced coal technologies, yet spur development of alternative fuel sources and technologies.

- **Replace redundant requirements.** Eliminate new source review provisions only for those sources whose emissions are placed under mandatory, four-emissions caps.

- **Distribute trading allowances equitably.** Select allowance distribution methods that cover sources equally—old and new, large and small—and use methods that promote efficient energy production.

The following discussion of these principles suggests the advantages of a comprehensive regulatory system that emphasizes cap-and-trade approaches, explaining why a growing number of electricity-generating companies support it.

## Principle 1—Make the Strategy Comprehensive

To understand the advantages of a comprehensive cap-and-trade strategy, consider what will happen without one. If the four emissions generated by electric utilities are not addressed in one strategy, EPA must regulate the emissions individually, under different provisions of the Clean Air Act, and with differing standards applied to different classes and ages of energy-producing technologies.

Currently, $SO_2$ is the only pollutant subject to a national cap-and-trade program. The Acid Rain Program limits $SO_2$ emissions to nine million metric tons per year, and applies year-round to all major utilities that emit $SO_2$. In contrast, a bewildering array of regulatory programs control NOx emissions from power plants, including state standards, Title IV of the Clean Air Act, new source standards, and a summertime cap-and-trade program for sources in the Northeastern states. EPA has indicated that it probably will seek to reduce the sulfur dioxide cap to four and one-half million metric tons per year by 2008, and it is also pursuing further reductions in NOx. Further NOx reductions are essential for controlling urban smog, and there are considerable benefits to capping NOx year-round and nationwide (Palmer et al., 2001a).

Mercury and $CO_2$ emissions from power generators are currently unregulated. Pursuant to the Clean Air Act, EPA has proposed to control mercury from these sources by 2008, although it has not yet stipulated a reduction level. As for carbon, no emissions limit exists in the United States, but 178 nations will likely move forward with the Kyoto Protocol. As a reference point, under the Protocol the United States would be required to reduce its $CO_2$ emissions to a level 7 percent below 1990 emissions levels.

Targeting these emissions one by one makes it harder for generators to develop up-front a coherent investment strategy; moreover, the strategy does nothing to promote the development of new, clean, and efficient multi-pollutant emissions reduction technologies. Controlling these four emissions individually will also impose high costs in terms of regulatory overhead and could result principally in installation of expensive abatement technology, which may later become a "stranded cost." A comprehensive strategy is needed.

## Principle 2—Cap Carbon Now

The decision this summer of 178 countries to stick to the terms of the Kyoto Protocol to reduce $CO_2$ and other greenhouse gases clearly indicates that carbon eventually will be capped and traded worldwide. But the absence of the United States from the bargaining table means that U.S. companies will be left in the cold, as a global market develops to control greenhouse gas emissions. Here at home, uncertainty about when and how $CO_2$ will be regulated and how EPA will decide to reduce $SO_2$, NOx, and mercury creates additional uncertainties for utilities and higher energy prices, if not shortfalls in energy supply, for their customers.

Although carbon dioxide emissions do not harm humans on the Earth's surface, many scientists agree that it is among the set of gases that act as a "greenhouse," allowing heat from the sun to penetrate to the earth's surface but preventing that heat from radiating back into space. Without greenhouse gases, most of the earth's surface today would be frozen, not the moderate 60 degrees we are accustomed to. Rising emissions of greenhouse gases are expected to raise the Earth's temperature and cause other severe climate changes. Unlike pollutants such as NOx and $SO_2$, technologies to capture and control carbon dioxide remain under development and are not readily available.

The adoption by other countries of greenhouse gas caps virtually guarantees that the country (or company) first to market with carbon-abatement technologies will reap unprecedented dividends. Although we can't foresee exactly what carbon mitigation technologies will form the ultimate response to global warming, we should be creating incentives to develop them now. We know from experience that new technology, an entrepreneurial spirit, and sound public policies can simultaneously produce environmental improvements, growth, and affordable energy. U.S. companies should have incentives to develop carbon mitigation technologies that will have world markets. It is also up to countries like the United States that have the capital and expertise to develop these technologies in order for lesser-developed countries to be able to commit to reductions by applying those technologies.

It is critical to include carbon in an emissions reduction bill now, because utilities face two fundamentally different choices in deciding how to reduce NOx, $SO_2$, and mercury emissions. The first is simply to install end-of-pipe controls on existing coal-fired power plants, most of which are many decades old; the other is to invest in clean power technologies, including clean coal technologies, which generate fewer emissions to begin with. Whereas the former strategy will do nothing to reduce carbon, the latter strategy will reduce carbon emissions by 50 percent or more for equivalent power output and will set the stage for a clean energy future.

Studies have shown that the economic difference between the first strategy—which adds emissions controls onto existing power plants—and the second—which provides incentives to use cleaner and more efficient power-generating units—is likely to be only a fraction of a cent per kilowatt-hour. This relatively small "cost" of a cleaner energy policy is far outweighed by its social and economic benefits.

A legal mandate to cap and trade carbon now can spur the development of clean power technologies and greatly reduce the potential for utilities to misallocate resources. In contrast, a three-E strategy will likely reward (older) methods to control emissions at the "end of the pipe"—that is, after they are created. The reason is because in the competitive power sector, a fraction of a cent represents an enormous cost differential to individual private firms. Therefore, if the government pursues a three-E strategy, such a differential is likely to persuade firms to invest mostly in end-of-pipe controls to stem NOx, $SO_2$, and mercury emissions from their existing generators. Once that investment is made, modifications to reduce carbon dioxide emissions at those facilities will become far more difficult and expensive.

Another advantage of the four-E strategy is that by promoting cleaner energy technologies it avoids the parasitic power losses and massive waste streams generated by end-of-pipe control efforts. Technologies to "scrub" $SO_2$ from the air consume between 0.5 and 1.5 percent of a power plant's energy. Such technologies also create enough solid waste to cover 1,000 acres during the life of a large power plant. Similarly, technologies used to control NOx emissions can consume up to 2 percent of a plant's power, and some also use toxic metals as catalysts and emit ammonia, a hazardous air pollutant. These ancillary environmental consequences are another reason to favor a prevention or clean energy approach.

## Principle 3—Use Emissions Caps, Not End-of-Pipe Rate Standards

Regulating four emissions sources simultaneously makes good economic and environmental sense, but the method used to reduce emissions also matters. Our environmental laws use primarily two methods to control emissions: rate-based standards and emissions cap and allowance-trading systems. Historically, the Clean Air Act has imposed "rate-based" formulas to meet air quality standards.[2] Applied to generators, such formulas typically state how many pounds of emissions a source can emit per unit of fuel burned to generate electricity.

In contrast, emissions cap and allowance trade programs place a permanent limit on all emissions from all sources covered under the program. The Acid Rain Program illustrates how such cap-and-trade systems work. The program sets a permanent cap on all utility $SO_2$ emissions at 8.95 million tons per year, and EPA annually issues 8.95 million tons of $SO_2$ allowances to covered sources. Sources may trade allowances, but at year's end, each source must hold an allowance for each ton of $SO_2$ it emits. To ensure compliance, EPA requires utilities to use sophisticated monitors that measure emissions continuously, in real time. If annual $SO_2$ emissions exceed the number of allowances held at the end of the year, firms automatically pay penalties of $2,000 for each ton exceeded.

Emissions caps outperform rate-based approaches in several notable ways (see *Table 1*). They have been shown to promote innovation and dramatically reduce compliance costs, as well as to reduce conflict and uncertainty about the way EPA traditionally administers environmental regulations (Swift, 2001; Ellerman, 2000).

*Caps Promote Innovation*

Cap-and-trade programs promote innovation, both in the *breadth* and the *extent* of new technologies available. Market-based systems replace rate levels on individual sources with flexible approaches that impose a single industry-wide limit. Rather than install a specific technology, sources are free to use the most cost-effective strategy to reduce emissions. Sources that reduce emissions below their allocated levels can sell their allowances to firms that find emissions control more costly, creating continuous incentives for firms to find cheaper, cleaner technologies. A cap thus promotes innovation while maintaining strict environmental integrity.

Experience shows that rate-based standards can distort firms' investment decisions and prevent them from lowering costs and achieving greater environmental quality (Palmer et al., 2001b; Ellerman, 2000; Swift, 2000). To implement rate-based standards, EPA and state regulators tend to pick technologies that control exactly the amount of emissions necessary to hit the rate standard at a given cost. Such practices discourage firms from experimenting with riskier methods that have the potential to control even more pollution than the standards require. They also provide few incentives for firms to upgrade abatement methods when better technologies come along. Experience also shows that superior pollution abatement technologies tend to come along within several years of the date that a standard takes effect—after most companies already have made the costly investment in less optimal emissions control equipment. Thus, standards defined in terms of rates carry few incentives for continuous improvement, eliminating one of the principal drivers toward greater environmental quality.

To understand how rate-based standards reduce incentives for firms to experiment, consider how firms responded to the acid rain cap-and-trade program. Because that program mandates major reductions while not dictating end-of-pipe limits or requiring government review and approval of compliance technologies, it allowed firms to achieve emissions reductions in any manner. This led to experimentation and unexpected cost savings in methods of blending cleaner Western coals with Eastern coal to reduce sulfur dioxide emissions—a strategy that would not have been tried under the older rate-based approach. As a consequence, utilities have steadily re-engineered their plants to increase the percentage of Western coal used to generate electricity.[3] Also, competition with low-sulfur coal and the more flexible standard also resulted in significant innovation in scrubber technologies throughout Phase I (Swift, 2001). These innovations were due to the flexibility of the cap-and-trade approach and also led to significant reductions in compliance cost.

*Caps Reduce Compliance Costs*

Because rate-based methods tend to dictate specific technologies that firms must use to control emissions, they usually are more expensive than cap-and-trade approaches. In contrast, cap-and-trade approaches allow firms to select the most cost-effective abatement option, such as using cleaner fuels or better scrubbers, or buying, banking, or selling allowances. This allows reductions to be achieved in the most cost effective way, rather than requiring reductions at high-cost sources when lower-cost reductions are available. In the case of acid rain, rate-based approaches were estimated to cost companies about $4.5 billion to control sulfur dioxide. By contrast, the total cost to firms under a cap-and-trade approach is a little more than $1 billion (Ellerman, 2000; U.S. General Accounting Office, 1994; Portney, 1990).

**Table 1. Cap-and-Trade Approaches Versus Rate-Based Approaches**

| | **Cap & Trade** | **Rate-based** |
|---|---|---|
| Lowers compliance costs | + | - |
| Creates continuous drivers for improvement and innovation | + | - |
| Lowers administration costs | + | - |

Source: Swift, B. 2001.
Note: + is positive and - is negative.

*Caps Reduce Conflicts and Are Less Costly to Administer*

In addition to spurring innovation and lowering costs, cap-and-trade programs can transform how industry and government interact. Rate-based standards require government regulators to review and issue to every firm a permit to control pollution from every source. This process imposes high transaction costs as well as creates conflicts between government regulators and firms regarding what abatement technology firms must use.

Under cap-and-trade programs, EPA simply ensures that firms have high-quality emissions monitors and determines whether, at the end of any given year, each firm's emissions match its allowances. By replacing permits with a real-time emissions monitoring system, a cap-and-trade program like the Acid Rain Program vastly reduces transaction costs to firms and to EPA. Such a program also has the potential to make relationships between EPA and industry less adversarial—one of the most troublesome features of "first generation" regulation.

## Principle 4—Adopt Stringent Levels with a Phased Approach

There are good reasons to adopt stringent standards for NOx, $SO_2$, mercury, and $CO_2$. One is that a tight cap ensures that regulated sources are making real reductions and improving environmental quality. But making steep emissions reductions quickly is potentially much more costly and disruptive than letting the market reward the gradual development of clean reduction methods. If Congress establishes tight caps, regulated sources must have a reasonable time period to comply.

The experience of the Acid Rain Program shows that sources need at least five to eight years to hit emissions reduction targets if disruption to the power grid is to be avoided and developers are to have sufficient time and incentives to build abatement technologies. A reasonable four-E approach would allow industry at least five years to cut emissions by 50 percent and eight years to reduce emissions by 75 percent. However, the proposed limits for carbon emissions in *Table 2* are based on existing comprehensive emissions trading proposals.

**Table 2. Four-E Caps and Timelines**

| Emissions Caps (million tons) | Baseline year 2000 | First phase 2007 | Second phase 2010 |
|---|---|---|---|
| **Nitrogen Oxides (NOx)** | 5.4 | 2.7 | 1.35 |
| **Sulfur Dioxide ($SO_2$)** | 8.95 (cap) | 4.5 | 2.25 |
| **Carbon Dioxide ($CO_2$)** | 2,300 | 2,080 | 1,914 (1990 level) |
| **Mercury (emission reduction)** | | 50% | 75% |

Source: Swift 2001.

*Achieving Incremental Reductions*

Several innovative provisions that have been advanced in recent debates offer the potential to link further emissions reductions with future advances in technology that reduce the cost of compliance.

One is the proposal by the Clean Power Group that uses declining caps on NOx, $SO_2$, mercury, and potentially $CO_2$ to reduce these emissions over time. A "circuit breaker" price keyed to the cost of allowances for each pollutant is used, if necessary, to prevent economic disruption and slow the pace of the decline to allow technology and markets to provide efficient, cost-effective control options.

A second option is available if an auction approach is used to allocate allowances, as government could set a price floor for an allowance purchase. Establishing a minimum price for an allowance would lead to future emissions reductions whenever technology advances below that price, without the need to adjust the cap. Raising this minimum price over time would serve as an effective way to further reduce emissions, provided that technology exists to reduce them cost-effectively.

*$SO_2$ and NOx*

The costs and benefits of meeting the NOx and $SO_2$ emissions reductions targets in *Table 2* can already be assessed because EPA's existing market-based programs for these pollutants have helped establish their allowance prices. On the basis of these prices, the current cost of controlling NOx and $SO_2$ through a comprehensive (four-E) emissions trading strategy remains well below estimates of the social benefits, such as lower mortality and fewer illnesses, of additional emissions reductions (see *Table 3*). The cost of $SO_2$ allowances are currently about $200, far below current estimates of the social benefits of the particulate reductions alone of added $SO_2$ reductions, which exceed $5,000 per ton.[4] For NOx, the cost of retrofitting boilers with equipment to reduce emissions averaged $412 per ton in the late 1990s. Current programs in Northeastern states to reduce emissions show that additional reductions could be achieved for about $1,000 per ton. EPA estimates that the benefit of added NOx reductions in Eastern states is between $1,262 and $4,786 per ton.[5] Therefore, for both pollutants, the reduction costs are far lower than the benefits reaped by society in the form of better health, fewer deaths and lost workdays.

**Table 3. Benefits and Costs of $SO_2$ and NOx Emissions Reductions**

| | **Benefit per ton* (EPA estimate)** | **Cost per ton (Current allowance price)** |
|---|---|---|
| **$SO_2$ reductions** | $5,000 | $200 |
| **NOx reductions** | $1,300—4,750 | $1,000 |

Source: Swift, B. 2001.

*Benefits to include factors such as lower mortality and illness rates

*Carbon Dioxide*

Although some companies already have opted to voluntarily trade carbon reductions, estimating reasonable reductions for $CO_2$ is somewhat harder than estimating them for $SO_2$ and NOx, for which allowance prices are established. A reasonable $CO_2$ reduction strategy would reduce emissions by at least 2 percent a year, starting as soon as possible. The point of the strategy is not to achieve quickly huge emissions reductions, but to send out market signals to encourage the development of abatement technologies. A 2 percent per year reduction starting in 2001 would mean that $CO_2$ emissions decreased to 2,080 million tons in 2006 and 1,914 million tons (1990 levels) by 2010. Such reductions should not cause major industry disruptions or substantial hikes in energy bills.

Reducing carbon will provide some disincentives for keeping old coal-fired plants online. But new emissions markets will provide concrete economic incentives to develop clean-burning plants and new emissions control and incentives for sequestration—methods that are wholly lacking today. Given the right incentives, the market is sure to come up with much cheaper ways to keep coal an important part of a clean fuel mix.

As companies develop cleaner coal technologies such as coal gasification, carbon caps in the short run will likely accelerate the switch from coal-fired utilities to natural gas. Promoting greater use of natural gas will require lowering barriers to the use of new gas combined-cycle turbines and co-generation (combined heat and power), as well as ensuring stable natural gas supply.

*Carbon Sequestration*

A cap-and-trade program for carbon emissions will not only stimulate the development of abatement technologies but also create opportunities to remove carbon from the atmosphere in other ways. Carbon can be reduced simply by reforesting or planting trees, or by promoting soil-improving agricultural practices. These methods increase the storage of carbon in vegetation and soils (called sequestration). Other methods are under development as well. Many carbon sequestration efforts carry ancillary benefits—wildlife and biodiversity are promoted through reforestation, and soil erosion reduced with conservation agriculture practices.

A challenge is measuring and verifying how much carbon is really captured in carbon sequestration projects. Assigning too much credit to sequestration projects can create market distortions by providing allowances, which have monetary value, to sequestration projects that may not deserve it. Moreover, it can jeopardize the integrity of the emissions cap. Including sequestration in a comprehensive emissions reduction strategy will require the development of strict measurement protocols. To ensure that credits are not claimed for sequestration projects that are short term, it also may be prudent to require a minimum 40-year life for sequestration projects.

*Mercury*

As with carbon, utilities are waiting for a signal to invest more heavily in the development of new abatement technologies for mercury. Mercury emissions from the power sector come almost entirely from coal-fired power plants, although plants using oil as their fuel also emit some mercury; natural gas plants emit virtually no mercury.

For the entire power sector, achieving first a 50 percent reduction in mercury emissions, followed by a 75 percent reduction, appears reasonable.[6]

How to regulate mercury is an issue because mercury is a toxic substance that causes local health effects as well as global and regional effects. Therefore, pollutant concentrations become a concern, and many environmentalists oppose the trading of mercury emissions reductions for this reason. Therefore, legislators should consider the following options for a mercury reduction standard, weighing the overall reduction achieved with the expected costs and the potential for creating pollutant concentrations.

A rate-based standard for mercury would be more costly than a cap-and-trade approach, but may be more acceptable to a public concerned about mercury toxicity. If a rate-based standard is chosen, it should be a generation performance standard (pounds per megawatt hour), or second best, a concentration standard, in order to encourage efficiency and induce firms to consider lower-mercury coal and fuels. Coals vary considerably in their mercury content—between 5 pounds and 36 pounds per trillion British Thermal Units (BTU), according to the U.S. Geological Survey—and the Acid Rain Program reveals how important it is to create a regulatory standard that encourages the use of cleaner coals. The worst approach would be a percentage reduction standard, which creates no incentives for the use of cleaner fuels.[7] Consideration should also be given to allowing firms to average emissions among their units under any rate-based approach.

Secondly, a cap-and-trade system could be considered for mercury, especially if it implements a greater overall reduction in mercury than could be achieved through a rate-based approach. Because local pollutant concentrations are principally a function of the size, utilization, and siting of plants, rate-based and emissions cap approaches have actually been shown to result in about the same emissions concentrations.[8]

Finally, we note that EPA must develop provisions for safe mercury disposal. It is difficult to store mercury over the long term because the substance is volatile at room temperature and can change into a form more readily absorbed into the environment and by animals and humans. If we are to spend a lot of money to capture mercury in emissions, provisions must be made to promote safer, permanent mercury storage.

## Principle 5—Replace Redundant Requirements for Sources Under a Four-E Cap

A comprehensive emissions reduction package requires that the new provisions for emissions caps be integrated with the Clean Air Act's NSR provisions. Congress should integrate the two standards by eliminating certain NSR provisions for those sources that are covered under the emissions cap. The key provisions that require modification are the NSR standards for Best Available Control Technology (BACT) and Lowest Achievable Emission Rate (LAER) technology.[9]

Once caps are imposed, these NSR provisions no longer provide significant environmental benefits, and eliminating them for new sources has the potential to actually boost cleaner energy technologies by equalizing the economic burden on pollution control placed on old and new sources. As noted above, Congress created the NSR provisions in the Clean Air Act to ensure that air quality is maintained as new generators are built and old generators are modified. These provisions required installation of modern pollution controls only in new sources—new plants or major modifications of existing plants.[10] This distinction has not been as effective as hoped, as it has prompted the perpetuation of older plants far beyond their expected lifetimes (Kaarsberg, 1999). It could be argued that the grandfathering of old plants combined with NSR for new plants creates precisely the opposite driver needed to promote a clean energy future—one that encourages firms to move to new, less-polluting technologies.

*New Source Review Standards Have Not Effectively Reduced Ambient Pollution Levels*

In practice, NSR provisions have provided few incentives for older sources to become cleaner and more efficient, and they have proven disproportionately costly to new generators. To illustrate, consider that since 1995, over 250 NSR permits were issued to new, cleaner gas turbine facilities, whereas just 10 were issued nationally for coal-fired electric generation (U.S. EPA, 2001).

One problem is that utilities have opted not to overhaul old generators to make them more efficient or capable of running on less polluting fuels, so as to avoid triggering the lengthy transaction and compliance costs of the NSR process. The electric utility industry estimates that, without this NSR disincentive, 40,000 megawatts of additional power would be available today from upgrades at older utility plants. By providing a powerful incentive for utilities to continue operating older, dirtier generators, the NSR provisions also potentially contribute to power supply shortages.

In addition to discouraging upgrades at older, dirtier facilities, the NSR provisions create a disincentive to building new utility plants. New plants tend to be much cleaner than old plants because most use natural gas turbines,[11] which emit none of the sulfur dioxide or air toxics of coal-fired plants and less than 10 percent of their nitrogen oxides and particulates.[12] Nonetheless, NSR provisions for BACT and LAER require new power plants to install pollution controls that account for 5 percent to 30 percent of the total cost of a plant. Although new gas-fired plants without add-on pollution controls are still cleaner than coal plants with controls, NSR provisions typically require them to install expensive equipment to further reduce what little NOx they emit. Research shows that the marginal cost of making these reductions exceeds the marginal air quality benefits (Swift, 2000).

*New Source Review Standards Force Only Limited Kinds of Innovation and Distort Industry Funding for Research*

It was thought that end-of-pipe NSR standards would promote innovation. At older plants, however, new source standards discourage firms from making upgrades or efficiency investments, and they have also retarded innovation in the critical areas of pollution prevention and efficiency improvement. For newer plants, NSR has been shown to promote innovation only in a relatively narrow set of technologies, emphasizing control technologies, although they have also contributed to a collaborative federal-industry effort to develop cleaner gas turbines.[13] However, the standards have stymied efforts to use cleaner and more efficient technologies, such as gas turbines, by not recognizing the gains made through prevention and by continuing to require end-of-pipe controls.

The bias toward keeping old power plants running created by the NSR provisions has profound implications for industry research and development. Virtually all research funds spent by the principal utility research coalition, the Electric Power Research Institute, are used to improve the performance of existing units.[14] By contrast, about half of federal research funds are used to explore new, cleaner technologies.[15] These funding priorities indicate that new source standards have created only limited innovation focused on expensive, end-of-pipe controls, and have failed to prompt innovation in existing plants or in ongoing management and operational practices.

*NSR Standards Create Few or No Net Benefits When Used in Conjunction with an Emissions Cap*

Once Congress establishes an emissions cap, any form of rate standard loses its capability to reduce emissions overall. Lowering the cap becomes the only way in which emissions can be reduced further. Therefore, preserving NSR provisions once an emissions cap is in place would only result in the imposition of additional costs on industry without environmental benefits. Also, because NSR creates additional costs on very clean new power sources, eliminating NSR for sources covered under the comprehensive cap could actually speed a transition to a cleaner energy future.

## Principle 6—Distribute Trading Allowances Equitably

Once Congress sets industry-wide caps, a method must be established to distribute allowances to emissions sources. There are several options, each of which will affect electricity-generating firms and the public differently (Palmer et al., 2001b). The first set of options involves government allocating allowances to sources free of charge; under this approach, allowances can be allocated based on ongoing fuel consumption, on energy generated, or on past performance ("grandfathered"). The second option is to auction allowances to the highest bidders. Although economists prefer the auction approach because it can reduce the overall costs of the program, it increases the economic impact on industry and may therefore be less politically feasible.

*Allocation by Grandfathering*

Traditionally, allowances have been allocated principally by the grandfathering method. Under the Acid Rain Program, allowances are allocated to existing utility units on the basis of formulas that reflect historic fuel use and desired emissions rates, although the government reserves roughly 3 percent of all allowances for an annual auction.[16] The Northeast NOx program allows states to set the allocation formulas. Most states have adopted a grandfathering approach, although some states such as New Hampshire have not, and all states reserve roughly 5 percent of allowances for new entrants.[17] Under grandfathering systems, to maintain the cap, allowances are not allocated to new sources, and new sources must buy them from allowance holders or through government auctions. Finally, if a grandfathering system is used, a decision must be made as to how to allocate the allowances—on past emissions, fuel use or power output.

*Ongoing Output or Generation-Based Allocation*

As EPA and other entities have acquired experience with grandfathering, it has become apparent that an allocation system based on historic fuel use fails to encourage plants to become more efficient. An ongoing "output-based" allocation, whereby allowances are allocated on the basis of recent power generation or "generation-performance standards," would provide an incentive for efficiency. Under these methods, a plant that makes retrofits to improve its efficiency will need to use fewer allowances, since its heat input and emissions will be reduced for the same output or generation. The emissions of that plant decrease because the plant has found a way to use less fuel.

In addition, the output-based allocation should be updated on a frequent basis to bring new sources fully into the program and to stop allowances to plants that have been shut down. In the initial year, differences between the GPS approach and basing the allocation on generation for at least three consecutive years would be minimal. However, over time, the two systems would increasingly diverge, as the GPS system would allocate allowances based on current instead of historic activity.

*Auctions*

Allocating allowances for free is popular with industry for the simple reason that auctions require all market participants to buy allowances at a market price. But economists prefer auctions, as they equalize the burden of compliance between old and new sources and also provide a more accurate price signal. Another reason is that auctions generate revenue, which can potentially be used to offset distortionary taxes for added economic benefits. Ways to limit the economic effect of an auction on industry include recycling auction revenues back to the industry or conducting only partial auctions of allowances.

Some observers prefer auctions to allocations not so much for price reasons but because their overall cost may be less than for an allocation approach. Some analysts predict that the costs of the auction approach may be only half that of an allocation method based on grandfathering or a generation-performance standard (Burtraw, et al., 2001) The lower cost is due, in part, to generation of revenues—which some estimate could be $10 billion to $40 billion per year. Such proceeds can be used in several ways. Proceeds could be recycled back to generators to offset their costs, recycled to households, kept by the federal government, redistributed to a public trust for broad social purposes, or used to offset taxes such as Social Security or other taxes on labor. [18] According to some economists, using auction proceeds to offset the effects of a tax could lower or even eliminate the economic cost of any emissions reduction program on an economy-wide basis.

*Hybrid Approaches Such as a Partial Auction*

Although economists support the potential benefits of an auction approach, the economic impact on industry may limit its political feasibility. In this case, we note that a partial auction of, say, 20 percent to 30 percent of allowances provides some of the advantages of an auction approach while limiting its economic impact, an approach that is consistent with PPI's economy-wide greenhouse gas trading proposal (Naimon and Knopman, 1999). It may also be feasible to start with a partial auction and raise the percentage of allowances auctioned over time.

*Allow Small Sources to Opt In*

Most four-E proposals target generators of more than 10 or 15 megawatts on the assumption that these generators are the largest sources of emissions. Several proposals allow smaller sources to opt into the cap-and-trade system. Allowing small generators—particularly those fired by gas turbines—to participate in a comprehensive emissions trading system makes sense for both economic and environmental reasons. First, modern gas turbines are relatively very clean. Second, smaller, newer sources are among the generators with the greatest potential to reduce $CO_2$ through methods such as distributed generation and co-generation. However, these smaller, newer sources are among the sources most adversely affected by NSR provisions, which can add so much to their cost that building the plant becomes impractical.

Allowing these sources to opt in to the cap-and-trade system would create both environmental and economic benefits by replacing the NSR standards with the cap. The environment benefits because these sources now create a zero net increase in emissions under the cap. Costs are reduced because allowance prices will likely be significantly less than the costs these smaller plants would have to face under NSR.

## Conclusion

When some skeptics feared that the cost of controlling acid rain would be too high, the first Bush administration broke the deadlock with a market-based proposal that has proven to deliver both economic and environmental benefits to Americans. The Acid Rain Program, based on emissions trading rather than on technology-freezing rates, has positively transformed how EPA and participating utilities reduce emissions and how they interact.

Now the threat of global warming looms on the horizon. Fortunately, the Acid Rain Program's record of success demonstrates that the approach can not only further reduce emissions of traditional pollutants, but also address the challenge of climate. Recently, some members of Congress and members of industry developed comprehensive emissions reduction strategies to address global warming as well as health problems associated with emissions that have more local environmental and health effects.

Many power generators view comprehensive emissions cap and allowance trading systems as a better way to reduce emissions than either the individual new regulations promised by EPA or the three-pollutant trading methods proposed by the White House. Three-pollutant strategies will only perpetuate old, end-of-pipe controls and postpone inevitable carbon retrofits, ensuring that those retrofits will cost more money than they otherwise would have.

President Clinton endorsed the Acid Rain Program, made possible by the first President Bush, as a model to follow in the control of carbon emissions. But proposals to cap carbon now have stalled because some perceive them as being too costly. Making gradual cuts in carbon emissions now may be far less costly in economic and environmental terms than making more dramatic cuts further down the road. A four-E approach in which markets are used to promote clean technologies provides a promising foundation for a clean, productive energy future.

***Byron Swift directs the Center for Energy, Economy and Innovation at the Environmental Law Institute in Washington, DC. Jan Mazurek directs the Center for Innovation and the Environment at the Progressive Policy Institute in Washington, DC.***

---

*For further information about PPI publications, please call the publications department at 202-547-0001, write: Progressive Policy Institute, 600 Pennsylvania Ave., S.E., Suite 400, Washington, DC 20003, or visit PPI's site on the World Wide Web at: http://www.ppionline.org/.*

## Endnotes

[1] The bills are the Clean Power Act (S 556—Jeffords), the Clean Smokestacks Act (HR 1256—Waxman), The Acid Rain Control Act (S 588—Schumer; HR 25—Sweeney), the Integrated Air Quality Planning Act (Clean Energy Group), and The Electricity Supply and Emission Reduction Act (Clean Power Group). In addition, Sens. Lieberman and McCain plan to introduce shortly an emissions cap and allowance-trading proposal that targets the $CO_2$ emissions from the whole economy.

[2] The Clean Air Act established stringent standards for new sources or major modifications of existing sources. The first such standards were "new source performance standards" (NSPS) established in 1971, which limited emissions rates of sulfur dioxide from coal-fired plants according to a rate-based formula (1.2 pounds of $SO_2$ per million BTUs of fuel burned). The NSPS rate was the first in a series of events to create a disparity between new and existing emissions sources, as emissions from existing sources were far higher than those from new sources. To meet the new standard, new sources installed scrubbers to reduce emissions or used coal with a sulfur content equivalent or less than the NSPS rate. Such disparities encouraged electric utilities to focus their research and operational efforts on extending the operating life of older, "grandfathered" facilities. In 1977, Congress created the New Source Review (NSR) process and tightened the new source performance standard. Such efforts required utilities to install scrubbers at all new generating units, thereby removing much of the incentive for firms to use low-sulfur coal. The scrubbers increased the cost of building new coal-fired plants and created additional incentives to extend the life of older, dirtier plants.

[3] Before the Acid Rain Program, many utilities believed that Western coal, which has less sulfur than Eastern varieties, would not perform well in their generating units. Western coal has properties that can wear down generators designed to handle Eastern coal. The utilities therefore thought that the only way to generate cleaner power was to install costly scrubber technologies or to use the cleanest Eastern coals available. See generally, Ellerman, 2000.

[4] Resources for the Future estimates the reduction in sulfate particulate emissions alone to be approximately $5,335 per ton of $SO_2$ reductions. See, Environmental Law Institute, *Cleaner Power: The Benefits and Costs of Moving from Coal Generation to Modern Power Technologies*, at 14 (Washington, DC, November, 2000) (estimating $24.5 billion in benefits from a 4,592,000 ton reduction in $SO_2$ emissions). See also Clean Air Task Force, *Death, Disease and Dirty Power: Mortality and Health Damage Due to Air Pollution from Power Plants*, at 4-5 (Boston, MA, October, 2000) (noting that a 75 percent reduction in $SO_2$ leads to benefits of more than $100 billion from particulate reductions, or more than $10,000 per ton of reductions).

[5] EPA 1998 RIA, at ES-6 (noting that total benefits are between $964 and $3,654 per ton of NOx reductions in 1990, or between $1,262 and $4,786 in 1999 dollars). In comparison, costs were estimated to be $1,468 per ton in 1990. *Id* at ES-3.

[6] We note that further economic research is needed to define the cost of mercury reductions technology, and that there may be a significant cost difference between a 50 percent reduction that could be achieved through conventional technologies and higher levels of reduction that imply added controls for mercury. Another troublesome factor is that mercury is a metal, and any control technology simply transfers the mercury from the air to a solid waste, where it may re-emit over time—the only permanent mercury reduction is that achieved by prevention, using cleaner coals or non-mercury fuels such as natural gas or renewables.

[7] The use of a percentage reduction standard for $SO_2$ in the 1977 new source performance standard has been shown to have strongly anti-competitive effects and reduced potential innovation. This standard

dictated a single technology, scrubbing, hence lowering competition with other compliance techniques, and in retrospect can be seen to have actually reduced innovation in scrubber technologies, as well as in fuel blending and other techniques for the use of low-sulfur coals (Swift, 2001, Ellerman, 2000).

[8] An analysis of the performance of regulations shows that rate-based standards actually may have a greater potential to create emissions concentrations, or hot spots, than cap-and-trade systems. A rate-based regulatory system will therefore continue to allow highly variable concentrations of mercury, as it does not affect parameters such as size, utilization or siting of coal-fired power plants. However, cap-and-trade systems have been shown to result in economic forces that lead the largest emissions sources to reduce the most, thereby slightly cooling hot spots created (Swift, 2001).

[9] Although NSR should be modified, it is important to note that a slightly less stringent set of standards, known as "New Source Performance Standards" should still apply, and provide assurance that new sources would still be clean. The New Source Performance Standards were required in the 1971 Clean Air Act, before the more stringent NSR provisions were created. The most important of these standards is for NOx, where the current NSPS establishes a stringent and fuel-neutral NOx limit of 1.6 lb per Megawatt hour for new plants. 40 CFR 60.44a. This limit would require coal-fired plants to reduce emissions by 80-90 percent, but would allow gas-fired plants to operate without additional controls, as their emissions are already well below this limit. In contrast, the NSR provisions for BACT and LAER can require very clean new gas fired plants to install expensive additional controls for very small added reductions.

[10] The emphasis in our laws on reductions from new sources may derive from an older, static view of technology in which the base technology is not assumed to change much. The modern view is that fundamental technology change may be expected in most industries and that new emissions sources are likely to be more efficient and less polluting than old sources. Indeed, nearly all-new power plants use gas-fired turbine technology and are more efficient and far cleaner than coal-fired units. A strategy focused on new emissions sources will not work well when technology change is rapid or when fundamentally different technologies are used for new sources than for old sources.

[11] Modern gas plants are cheaper to build than coal plants and achieve 55 percent efficiency, compared with coal plants' average 34 percent efficiency. This greater efficiency offsets the relatively more expensive fuel cost for natural gas, and DOE estimates that 90 percent of new generation between 2000 and 2020 will be gas-fired. DOE, Annual Energy Outlook 2000 at 65, 67 (1999).

[12] Even without controls, modern gas combined-cycle plants emit virtually no $SO_2$, particulates, or air toxics, and NOx levels around 0.05 lb/mmBtu, well below the NSPS and 10 to 40 times lower than that of coal units. Because they are more efficient than coal plants, they emit roughly half the $CO_2$. See generally, STAPPA/ALAPCO, *Reducing Greenhouse Gases and Air Pollution: A Menu of Harmonized Options*, 49 (Washington, DC 1999).

[13] Federal funding of the Advanced Turbine Systems program has risen from $5 million in FY 1992 to $33 million in FY 1999. U.S. Energy Information Agency, *Federal Financial Interventions and Subsidies in Energy Markets 1999: Primary Energy*, at 28, 33 (SR/OIAF/1999-03, 2000) [available at www.eia.gov].

[14] EPRI Annual Report (1999) (total EPRI 1999 funding of $364,856,000, of which $102,600,000 is co-funding by industry for specific projects. Almost all projects are applied and oriented toward improving existing plants and technologies).

[15] Roughly half of the Department of Energy's $2.1 billion FY 2000 appropriation for "Energy Resources" is oriented toward new power technologies and energy conservation. U.S. Department of Energy, *FY 2001*

*Budget Request to Congress* [available at www.doe.gov]. See also U.S. Energy Information Agency, *Federal Financial Interventions and Subsidies in Energy Markets 1999: Primary Energy* at 27. Overall, "nearly two-thirds of Federal energy R&D ($2.8 billion) is allocated to basic research"; an additional $1.6 billion in applied research is divided between research to develop new technologies and research to improve existing technologies, *id*. at 25.

[16] In Phase I of the Acid Rain Program, allowances were issued based on the average annual amount of fossil fuel consumed by a unit from 1985 to 1987, multiplied by 2.5 pounds of SO2 per million metric British thermal units (mmBtu) of heat input. In Phase II, reductions were achieved by lowering the multiplier to 1.2 lb/mmBtu.

[17] Nine states in the Ozone Transport commission have adopted a joint emissions cap and allowance-trading program for NOx, based on a memorandum of understanding signed in September 1994. New Hampshire has adopted an allocation approach that phases in the allowance needs of new entrants over a number of years based on a generation formula. Information on the Ozone Transport Commission NOx trading program is available through the Commission, at www.sso.org/otc.

[18] Work done on the economic implication of these allocation methods: Fischer, Carolyn, "Rebating Environmental Policy Revenues: Output Based Allocations and Tradable Performance Standards," Resources for the Future, Discussion Paper 01-22. (Washington, DC, 2001) (recycling revenues back to the industrial sources); Sky Trust, 2001 (redistribution to public); and Goulder et al., "The Cost-Effectiveness of Alternative Instruments For Environmental Protection in a Second-Best Setting," *Journal of Public Economics*, vol. 72, no. 3 (June, 1999), 329-360.

## References

Burtraw, Dallas, Karen Palmer, Ranjit Bharvirkar, and Anthony Paul. "The Effect of Allowance Allocation on the Cost of Carbon Emission Trading." Discussion Paper 01-30. Washington DC: Resources for the Future, 2001.

Carlson, Curtis, Dallas Burtraw, Maureen Cropper and Karen Palmer. "$SO_2$ Control by Electric Utilities: What are the Gains from Trade?" *Journal of Political Economy*, 108, 6: 1292-1326. See also, Ellerman, 2000. Discussion Paper 98-44-REV, Washington, DC: Resources for the Future, (July), 1998.

Ellerman, A. Denny, P.L. Joskow, R. Schmalensee, J.P. Montero, and E.M. Bailey. *Markets for Clean Air: the U.S. Acid Rain Program,* Cambridge: Cambridge University Press, 2000.

Fischer, Carolyn. "Rebating Environmental Policy Revenues: Output Based Allocations and Tradable Performance Standards." Discussion Paper 01-22. Washington, DC: Resources for the Future, 2001.

Fox-Penner, Peter. *Clean Growth: A Balanced Energy Policy for the 21st Century,* Washington, D.C.: Progressive Policy Institute, 2001.

Goulder et al. "The Cost-Effectiveness of Alternative Instruments For Environmental Protection in a Second-Best Setting." *Journal of Public Economics*, 72, 3 (June 1999): 329-360.

Intergovernmental Panel on Climate Change. *Climate Change 2001*. Contribution of Working Group II. Cambridge: Cambridge University Press, 2001.

Kaarsburg, Tina and Julie F. Gorte. "Promoting Productivity and Clean Air with Innovative Electric Technologies." *Northeast Midwest Economic Review*, Nov./Dec. 1999.

McLean, Brian. "Evolution of Marketable Permits: The U.S. Experience with Sulfur Dioxide Allowance Trading." Proceedings from Controlling Carbon and Sulphur, International Trading Initiatives. Royal Institute of International Affairs, Chatham House, London, Dec. 5-6, 1996.

Naimon, Jon, and Debra S. Knopman. *Reframing the Climate Change Debate,* Washington, DC: Progressive Policy Institute, 1999.

Palmer, Karen, Dallas Burtraw, Ranjit Banvitkar, and Anthony Paul. *Restructuring and the Cost of NOx Emissions in Electricity Generation.* Discussion paper 01-10. Revised. Washington, DC: Resources for the Future, 2001a.

Palmer, Karen, Dallas Burtraw, Ranjit Banvitkar, and Anthony Paul. *The Effect of Allowance Allocation on Carbon Emission Trading,*" Discussion paper 01-30. Washington, DC: Resources for the Future, 2001b.

Portney, Paul R. "Economics and the Clean Air Act." *Journal of Economic Perspectives,* 4, 4 (1990): 173-181.

Swift, Byron, and Environmental Law Institute. "How Environmental Laws Work: An Analysis of the Utility Sector's Response to Regulation of Nitrogen Oxides and Sulfur Dioxide Under the Clean Air Act," *Tulane Environmental Law Journal 14*, 312, (Summer) 2001.

Swift, Byron. "Grandfathering, New Source Review and NOx—Making Sense of a Flawed System," *Environment Reporter* 13 (July 21, 2000): 1538-1546.

State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials (STAPPA/ALAPCO), *Reducing Greenhouse Gases and Air Pollution: A Menu of Harmonized Options at 49*, Washington, DC, 1999.

U.S. Department of Energy, FY 2001 Budget Request to Congress.

U.S. Energy Information Agency, *Federal Financial Interventions and Subsidies in Energy Markets*, 1999.

U.S. Energy Information Agency, *Federal Financial Interventions and Subsidies in Energy Markets 1999: Primary Energy*, SR/OIAF/1999-03, 2000. <http://www.eia.gov>.

U.S. Environmental Protection Agency, *NSR 90-Day Review Background Paper,* Docket A-2001-19, Document II-A-O1, June 22. 2001.

U.S. Environmental Protection Agency, *Regulatory Impact Analysis for the NOx Sip Call, FIP*, and *Section 126 Petitions: Volume 2: Health and Welfare Benefits,* EPA-452/R-98-003B, December 1998.

U.S. EPA, *Human Health Benefits from Sulfate Reductions Under Title IV of the 1990 Clean Air Act Amendments,* EPA 430-R-95-010, November 1995.

U.S. General Accounting Office, *Air Pollution: Allowance Trading Offers an Opportunity to Reduce Emissions at Less Cost,* December 1994.