

Todd letters

'97 OCT 17 AM 9:27

October 10, 1997

Subject: Take Action on Climate Change

Dear Todd Stern,

I was encouraged by the October 6 conference on climate change. It seems the administration is genuinely concerned about this issue and understand what must be done. However, I am concerned that pressures from the fuel industry will weaken your resolve. I ask you to be strong and make decisions which are right for the citizens of this country, the rest of the world and most importantly - future generations.

The United States must take a leadership role in taking actions to protect our planet from the devastating effects of climate change. And we must work cooperatively with developing nations. Over time the U.S. and other developed nations have emitted most of the greenhouse gas emissions - we must take responsibility for this. We go first and help the developing nations to meet their energy needs in the most environmentally sound ways, using the most advanced, clean technology.

We must move aggressively to reduce greenhouse gas emissions. **A cost cap will prevent us from meeting targets.** Investments in energy efficiency, renewables now will have significant benefits in the future - they really are not "costs". Same goes for investments in more efficient cars and public transportation. These investments make sense for reasons other than climate change.

Our children and grandchildren are depending on us to take action. Please make them your first priority. I want my little niece (Lisa - 4 years old) and nephew (Jeffrey - 5.5 years old) to have a livable planet when they grow up.

Sincerely,



Chandra Shah
800 - 2nd Ave. N. #42
Seattle, WA 98109
206-285-1921

Todd
Letters

October 14, 1997

'97 OCT 17 PM 1:06

Todd Stern
Staff Secretary's Office
The White House
Washington, DC 20502

Dear Mr. Stern:

On behalf of the more than 430,000 members of the 20 undersigned environmental organizations, we are writing to you today to urge the Administration to actively support an early and strong, legally-binding commitment to reduce greenhouse gas emissions in order to combat global climate change.

We are very concerned about climate change and the impacts it will have on our environment, public health, economy and way of life. As you know, the Intergovernmental Panel on Climate Change concluded two years ago that the balance of evidence indicates our modern civilization is altering the Earth's fragile climate. This year, more than 2,700 of the nation's top scientists and 2,500 of our top economists called for the United States to take global leadership in reducing emissions of greenhouse gases. With that in mind, we encourage you to negotiate the strongest possible treaty at the Third Conference of Parties to the United Nations Framework Convention on Climate Change to be held in Kyoto, Japan in December 1997.

There is no sector of the globe, the economy, the environment or human culture that will escape climate change impact. Some impacts are awesome in their proportion and threaten entire regions and the lives of millions. For example, the World Health Organization has warned that we may experience 50 - 80 million new incidences of malaria each year. Other potential impacts include the loss of rare and unique species. The ramifications of such impacts are enormous and will touch all of us.

While we appreciate this administration's past commitment to reducing the CO₂ emissions that cause global warming, we are concerned that the United States has not announced a plan of action to illustrate its support of an international agreement with binding targets for reductions in greenhouse gas emissions. In addition, we are very concerned that the United States does not appear to be living up to its commitment made by President George Bush, in the 1992 Framework Convention on Climate Change and President Clinton's 1993 Earth Day pledge to reach 1990 emission levels by the year 2000. We cannot delay any longer -- reductions must

Conservation Law Foundation

Todd Stern
October 14, 1997
page 2

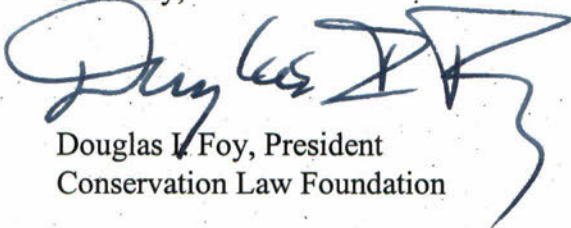
start now and must be substantial in order to be effective in dealing with the threat of global warming.

The President recently remarked that "we could reduce [greenhouse-gas emissions] 20% tomorrow with technology that is already available at no cost if we just changed the way we do things." Throughout our economy, the U.S. uses energy inefficiently compared to our major trading partners. On a per capita basis, the U.S. uses twice as much energy to produce a unit of Gross Domestic Product as does Germany or Japan. This inefficiency is more than environmentally damaging, it is lost economic opportunity, as well as increased dependency on foreign oil. Reducing this inefficiency and capturing this now lost economic opportunity will help the U.S. economy. One economic study found that energy innovations could create as many as 800,000 new jobs in the next 15 years. We urge immediate action to advance policies designed to increase efficiency in the use and production of energy, and to accelerate the development and transfer of energy-saving and renewable energy technology worldwide.

Early and significant action to reduce greenhouse gas emissions would put the nations of the world on an emissions trajectory that could curb the predicted impacts on the environment and public health. On the other hand, delaying action to curb greenhouse gases would only allow more time for the IPCC's predicted impacts to become a reality. Delayed action would also force much steeper annual emission declines in future years to make up for the excess emissions, and would therefore inflict greater economic penalties on those who must cope with the demands of more stringent emissions reductions.

At this critical stage in the international negotiations, we respectfully request the Administration to adopt an early and substantial emissions reduction commitment for the upcoming Kyoto negotiations.

Sincerely,



Douglas L. Foy, President
Conservation Law Foundation

Kevin Knobloch, Director of Conservation Programs
Appalachian Mountain Club

Conservation Law Foundation

Todd Stern
October 14, 1997
page 3

Thomas Kiernan, President
Audubon Society of New Hampshire

Donald P. Gagnon, Chairman
Citizens League for Environmental Action & Recovery (CLEAR)

Cindy Luppi, Organizing Director
Clean Water Action New England

Pamela W. Person, Vice Chairperson
Coalition for Sensible Energy

Stuart Greenberg, Executive Director
Environmental Health Watch

Nam Kapur, Legislative Director
Environmental League of Massachusetts

Bryan Hager, Chapter Chair
Georgia Sierra Club

Sanford Lewis, Director
Good Neighbor Project

Thomas Urquhart, Executive Director
Maine Audubon Society

Jack Clark, Advocacy Director
Massachusetts Audubon Society

Laura Scott, Clean Air Associate
MassPIRG

Pete Didisheim, Advocacy Director
Natural Resources Council of Maine

Conservation Law Foundation

Todd Stern
October 14, 1997
page 4

Leslie Lowe, Executive Director
New York City Environmental Justice Alliance

Judi Friedman, Chairperson
People's Action for Clean Energy (PACE)

Curt Spaulding, Executive Director
Save The Bay

Cara Lee, Environmental Director
Scenic Hudson

Elizabeth Courtney, Executive Director
Vermont Natural Resources Council

Sam Gieryn, Associate Director
Wisconsin Environmental Decade

Todd Letters

'97 OCT 10 PM4:33

To: Vice President Al Gore (202)456-2326, (202)456-2461 FAX
cc: President Bill Clinton (202)456-2326, (202)456-2461 FAX
Katie McGinty, Chair CEQ (202)456-2710 FAX
Todd Stern, Asst. to President (202)456-2215 FAX
From: Dr. Paul J. Bartels
Environmental Leadership Center
Warren Wilson College
Re: Climate Change
Date: 10-Oct-97

I understand that meetings are underway to decide the U.S. position for Global Climate Change treaty negotiations. Your action on global climate change could be the single greatest legacy you leave for the health of this planet.

Please do not agree to something that is too little and too late.

- We need more stringent standards, not weaker ones.
- We need to move quickly, rather than slowly.
- We need to remove loopholes like the "Clinton Cost Gap".

In your book, "Earth in the Balance", you said, "The time has long since come to take more political risks...by proposing tougher more effective solutions and fighting hard for their enactment." That time is surely now!

299 4139

Instructor's Name Paul Bartles Address _____ Phone (11) _____
 Assistant Coach _____ Address _____ Phone (11) _____
 _____ Address _____ Phone (11) _____

Player's Name	DOB	Age	Address	Phone
Daniel Wiederhouse				738-3974
Paul Simone				738-3988
Danella Simone				738-3988
Bryan Bartles				659-1614
Matthew Watts				652-1146
Cardis Robinson				652-3540
Matthew Leazer				652-1189
Richard Case				659-3607
Julia Bingham				668-7939
LAUREN BARNES				659-0029

Christian Environmental Council

C/O the Evangelical Environmental Network '97 OCT 20 PM 4:43

(610) 649-8090 - (610) 645-8090 fax

een@esa.mhs.compuServe.com

*Todd
Lester*

To: *Todd Stern*

Date: *10-20-97*

Fax Number: *(202) 456-2215*

Number of pages, including cover:

4

CHRISTIAN ENVIRONMENTAL COUNCIL

MEMO

October 20, 1997

To: President Clinton; Vice-President Gore; Ron Klain; Todd Stern; David Gardiner, Timothy Wirth; Stu Eisenstadt; Katie McGinty; Gene Sperling; Samuel Berger.

From: Christian Environmental Council

Re: The Clinton Administration's position at Kyoto

Accompanying this is a Resolution from the Christian Environmental Council to President Clinton and Vice-President Gore urging that the President at Kyoto "advocate a legally-binding reduction of at least ten percent in emission of greenhouse gases for all of the industrialized countries of God's Earth by 2010." A press release is also included which gives information about the Council and who to contact for more information.

CHRISTIAN ENVIRONMENTAL COUNCIL

PRESS RELEASE

For Immediate Release:

October 20, 1997

Contacts:

Dr. Calvin DeWitt - via

Dr. Peter Bakken, (608) 255-0950

Dr. Richard Wright (978) 927-2300

Stan LeQuire (610) 649-8090

CHRISTIANS URGE CLINTON TO TAKE LEAD AT CLIMATE CHANGE CONFERENCE

October 20, 1997 - The Christian Environmental Council today urged President Clinton to take a strong leadership role at the upcoming international conference on climate change, to be held in Kyoto, Japan, December 1-12.

A resolution sent to the White House expressed the Council's desire that the "Clinton administration advocate a legally-binding reduction of at least 10 percent in the emission of greenhouse gases for all of the industrialized countries of God's earth by 2010."

"The climate of earth is God's gift to life—it's not ours to defile or destroy," said Dr. Calvin DeWitt, president of the Christian Environmental Council. "Do we have the courage to tell this to the world? Do we have the courage to lead?"

The resolution resulted from the Council's annual meeting this weekend in Portland, Oregon. Attending were representatives of 41 Christian groups, including The Christian Society of the Green Cross, the Christian Environmental Association, and the Evangelical Environmental Network. The Christian Environmental Council is a gathering of evangelical leaders concerned with creation care. The Council was instrumental in the successful defense of the Endangered Species Act in 1996.

The Council's deliberations on global climate change were guided by six environmental scientists from a wide array of colleges and universities. Dr. Richard Wright, author of the textbook *Environmental Science: The Way the World Works*, and professor of biology at Gordon College in Massachusetts, expressed the Council's concerns: "Twelve of the last 17 years are the hottest on record for global temperature. Sea level is rising at a rate of 3 millimeters a year. Violent storms and climatic fluctuations like the El Nino have been increasing in recent years. It seems obvious that the burning of fossil fuels increases the atmospheric concentration of carbon dioxide resulting in major changes in the climate."

Concern for "the less powerful of the Earth" and "the rest of Creation" motivated the resolution. "These changes in the climate will have their greatest impact on people in the developing world where environmental degradation is already seriously impacting their way of life," said Wright.

The Council emphasized that all of the global climate change scenarios predict major shifts in rainfall and temperature over mere decades. "These shifts will impact ecosystems in serious and

unpredictable ways. In a world struggling to feed an expanding population, global climate change represents the greatest threat to our agricultural capacity," said Wright.

The mission of the Christian Environmental Council is to serve the church and society in all matters concerning the care of creation. The Council provides a forum for discussion of mutual concerns, a structure to facilitate joint action, and a platform for expression of common views.

The names and Affiliations of the CEC's consulting scientists:

Dr. Jeff Greenberg, Wheaton College, Wheaton, IL

Dr. Jeff Schloss, Westmont College, Santa Barbara, CA

Dr. John Wood, Kings University College, Edmonton, Alberta

Dr. Calvin DeWitt, University of Wisconsin, Madison, WI

Dr. Ken Peterson, Dort College, Sioux Center, IA

Dr. Richard Wright Gordon College, Wenham, MA

CHRISTIAN ENVIRONMENTAL COUNCIL RESOLUTION ON THE POSITION OF THE UNITED STATES AT THE CLIMATE CHANGE SUMMIT IN KYOTO

Whereas Scripture persistently affirms that Christians are to seek justice for the less powerful of the Earth and to care for the rest of Creation, and

Whereas the potential consequences arising from Global Warming seriously threaten both, and

Whereas the upcoming third meeting of the Conference of the Parties (COP-III) to the Framework Convention on Climate Change (FCCC), to be held in Kyoto, Japan, December 1-12, 1997, promises to be the most important meeting to date of the Nations of God's Earth who are concerned about Global Warming, and

Whereas decision made at this meeting could determine for years to come the human response to the threat of climate change, and

Whereas reports indicate that the policy options being considered by the Administration on the position of the United States at Kyoto are substantially less than what is required to seek justice for the less powerful and care for the rest of Creation,

Be it therefore resolved, that we, the Christian Environmental Council, assembled in Portland, Oregon, October 18, 1997, call upon you, President Clinton and Vice-President Gore, to exercise strong, just, and decisive leadership in addressing the challenge of Global Warming. Specifically, we urge that the Clinton Administration advocate a legally-binding reduction of at least ten percent in emission of greenhouse gases for all of the industrialized countries of God's Earth by 2010.

Green Group

- American Oceans Campaign • Defenders of Wildlife • Environmental Defense Fund •
- Environmental Information Center • Friends of the Earth • Izaak Walton League •
- League of Conservation Voters • National Parks and Conservation Association •
- National Wildlife Federation • Natural Resources Defense Council • Physicians for Social Responsibility • Population Action International • Rails to Trails Conservancy •
- Sierra Club • Union of Concerned Scientists • United States Public Interest Research Group • The Wilderness Society •

October 8, 1997

The President
The White House
Washington, DC 20500

Dear Mr. President:

We want to thank you for your continuing efforts to focus the attention of the American people on the most serious environmental threat facing the planet, global warming. We especially want to commend you for convening Monday's White House Conference on Climate Change. We are encouraged by your opening statement that the United States "must show leadership" on the global warming issue and that we need "to do the responsible thing...to avoid leaving our children and grandchildren with a catastrophe."

We are, however, increasingly concerned by reports that the policy options being assembled for your consideration will, at best, do no more than stabilize US emissions of greenhouse gases at 1990 levels, and may even include a target-busting escape clause. Such policies would be totally inconsistent with the gravity and urgency of the global warming threat, as was so forcefully presented by the science panel at Monday's conference. In addition, a stabilization-only approach would deny the United States the global leadership role that you committed to at Monday's conference.

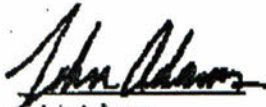
We are gravely concerned by indications the administration is even considering ill-conceived proposals for a "relief mechanism" that would allow nations to abandon the emissions reduction commitments made in Kyoto if costs exceeded some pre-set level. This escape-clause scheme would be a direct repudiation of your principled statement on Monday that the US "must be prepared to commit to realistic and binding goals on our emissions of greenhouse gases." Such a mechanism would undermine the credibility of the entire treaty process, and would frustrate our shared goal of engaging the meaningful participation of developing countries in a global emissions reduction regime. Finally, this proposal would weaken, if not eliminate, any incentive for private sector innovation and investment in clean technologies that, as you acknowledged on Monday, is the key to successfully addressing the global warming problem.

As you know, it is our strong view that the United States must support a treaty that ensures substantial industrialized country emissions reductions below 1990 levels starting no later than the year 2005, in order to make meaningful progress towards addressing the global warming problem. Numerous studies indicate that such reductions are achievable with current and near-term technologies at very reasonable costs. Moreover, recent polling by the World Wildlife Fund demonstrates that such measures would enjoy the overwhelming support of the American people.

We want to assure you that the environmental community will mobilize a massive grassroots campaign in support of an agreement committing industrialized countries to achieve substantial emissions reductions below 1990 levels before 2010. However, we also want to make it very clear that none of our groups will be able to mobilize grassroots support for, and indeed will be compelled to oppose, a position that simply seeks to freeze emissions at 1990 levels by 2010 or later, or that includes a treaty-busting escape clause.

We respectfully urge, in the strongest possible terms, that you assume international leadership by supporting an agreement in Kyoto that commits industrialized countries to reduce greenhouse gas emissions well below 1990 levels, starting no later than 2005, with no escape clauses. If we do less, future generations will wonder why, having acknowledged that this is the most significant environmental threat of the next century, we failed to take more meaningful action.

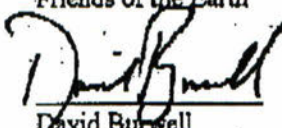
Sincerely,


John Adams

Executive Director
Natural Resources
Defense Council



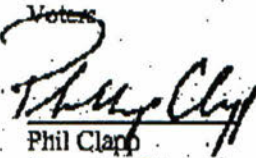
Brent Blackwelder
President
Friends of the Earth



David Burwell
President
Rails to Trails Conservancy



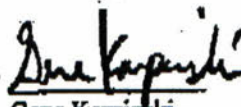
Deb Callahan
President
League of Conservation
Voters



Phil Clapp
Executive Director
Environmental Information
Center



Paul Hansen
Executive Director
Isaak Walton League



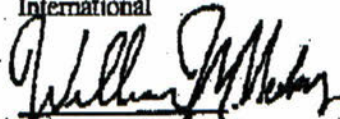
Gene Karpinski
Executive Director
U.S. Public Interest
Research Group



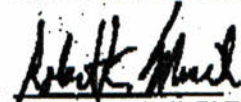
Fred D. Krupp
Executive Director
Environmental Defense
Fund



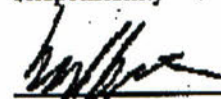
Victoria Markell
Vice President
Population Action
International



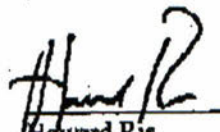
William H. Meadows
President
The Wilderness Society



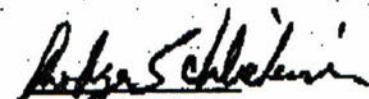
Robert K. Musil, PhD
Executive Director
Physicians for Social
Responsibility



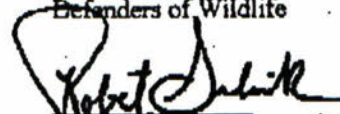
Carl Pope
Executive Director
Sierra Club



Howard Ris
Executive Director
Union of Concerned
Scientists



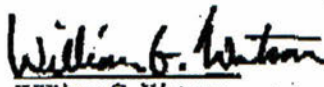
Rodger Schickeisen
President
Defenders of Wildlife



Robert Sulnick
President
American Oceans
Campaign



Mark Van Putten
President & CEO
National Wildlife
Federation



William G. Watson
Interim Executive Officer
National Parks and
Conservation Association



**The
Business Council
for
Sustainable
Energy**

1200 18th Street, NW
Ninth Floor
Washington, DC 20036

*Phone 202-785-0507
Fax 202-785-0514*

'97 OCT 17 PM 1:11

October 16, 1997

Mr. Todd Stern
Staff Secretary
The White House
Washington, DC 20500

Dear Todd:

Thanks again for stopping by the dinner hosted by the Business Council for Sustainable Energy last week. Sorry you weren't able to stay longer but I certainly understand your desire to get back to your family.

The dinner was a great way to top off a day of activities that exceeded the expectations of virtually everyone in my organization. Given the timeframe, the logistics and the political dynamics of such a meeting, the odds were stacked against you. Congratulations on a truly superb job all the way around.

Kyoto notwithstanding, we are nowhere near the finish line on climate change. The members of the Council and its staff look forward to continuing to work with this Administration in its search for aggressive and achievable options to climate change mitigation.

With best wishes,

Michael L. Marvin
Executive Director

cc: Mr. Robert B. Catell, Chairman and President, BCSE
Mr. James Wolf, Chairman, Climate Change Task Force
Mr. Terence Thorn, Chairman, International Finance Task Force



AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

Executive Office

Todd Letters
1200 New York Avenue, NW
Washington, DC 20005
Tel: 202 326 6640
Fax: 202 371 9526

30 September 1997

Mr. Todd Stern
Staff Secretary
West Wing, Ground Floor
The White House
Washington, DC 20500

'97 OCT 21 04:10:37

Dear Todd,

I thought you might like to have a copy of the enclosed recently published special feature from SCIENCE magazine. This focus on Human Dominated Ecosystems is part of SCIENCE's ongoing effort to highlight the latest scientific findings on critical issues of our times.

The articles document and quantify numerous human impacts and suggest policy implications. As Vitousek and his co-authors point out in the overview article, "Until recently, the term 'human-dominated ecosystems' would have elicited images of agricultural fields, pastures, or urban landscapes; it now applies with greater or lesser force to all of Earth."

I trust this special feature will be useful to you.

Sincerely,

Jane Lubchenco
Chair, Board of Directors

JL:md

SCIENCE

SCIENCE INTERNATIONAL, Thomas House, 14 George IV Street, CAMBRIDGE, UK, CB2 1HH
Tel +44 (0) 1223 302067 Fax +44 (0) 1223 302068

A handwritten signature in blue ink, appearing to read "Richard S. Cooper".

with compliments

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AMERICAN
ASSOCIATION FOR THE
ADVANCEMENT OF
SCIENCE

SCIENCE

25 JULY 1997

\$7.00

VOL. 277 • PAGES 445-608

**Human-
Dominated
Ecosystems**

Todd Letter

Bethlehem Steel Corporation

'97 OCT 17 AM 11:16

1170 EIGHTH AVENUE
BETHLEHEM, PA 18016-7699

CURTIS H. BARNETTE
CHAIRMAN
AND
CHIEF EXECUTIVE OFFICER



October 16, 1997

Mr. Todd Stern
Assistant to the President
and Staff Secretary
The White House
1600 Pennsylvania Avenue
Washington, DC 20500

Dear Todd:

This will confirm our recent conversation. Enclosed is a very preliminary draft of points regarding a possible Hybrid Permit System for reducing greenhouse gases.

Dr. Gus Moffitt of Bethlehem is also very familiar with this subject. Please telephone us if we can be of assistance.

Best personal regards.

Sincerely,


Curtis H. Barnette
(610) 694-6137

Enclosure

cc: Dr. A. E. Moffitt, Jr.
(610) 694-7640

**PRELIMINARY EVALUATION OF RESOURCES FOR THE FUTURE'S
HYBRID PERMIT SYSTEM FOR REDUCING GREENHOUSE GASES**

The Concept: As described by Resources for the Future (Morgenstern, Kopp, and Pizer), this system would couple binding emission targets with a relief mechanism for unexpectedly high costs. A fixed number of tradable permits (rights to emit), based on an emission target, would be established. The system would then provide for additional permits at a pre-specified trigger price. Theoretically, as long as the cost of controlling a ton of greenhouse gas emissions (GHG) remains below the trigger level, the emission target would be attained.

Economic Theory: The hybrid system encompasses both tax and permit mechanisms. For example, it would work like a permit system by fixing emission limits as long as the marginal cost (i.e., the price of the permit) lies below the trigger price and would behave like a tax system by fixing the marginal cost of abatement when the marginal cost hits the trigger price. When the trigger price is set high, the hybrid system functions like a pure permit system (since additional permits are never sold). When the number of permits is set low, it functions like a pure tax mechanism (since additional permits are always sold).

Issues and Concerns:

- While the concept seems simple and appealing on its face, the administration and monitoring of such a system would be difficult, if not impossible, based on our experience with trade policy.
 - How will permits be allocated? Worst first basis as was done in Clean Air Act sulfur permit trading system (i.e., utilities first tier)?
 - Who would set trigger prices and how would it be done?
 - What government agency would take the lead on administration and enforcement? Commerce would be viewed by business community as more balanced and experienced than EPA.
- The starting point of the system appears to be legally binding emission targets. We continue to believe that voluntary programs should be tried first since they would provide maximum flexibility for industry and avoid negative consequences for the U.S. economy.
- The hybrid model is too new to allow for a realistic assessment and inclusion as a key element of U.S. policy for Kyoto. It should be developed further by an appropriate body with representation from key stakeholders and be considered for future

application as part of a set of flexible compliance mechanisms, which would include joint implementation, cooperative arrangements, R&D incentives, and technology transfers that would lead to reductions in developing nations.

- There is a concern that the system may result in a "backdoor approach" to governmental mandatory fuel selection. Supply/Demand economics will drive prices up with more use of natural gas, renewable energy and nuclear vs. coal in the power generating sector. Therefore, will the threshold emission cap proposal take these associated economic impacts into consideration?
- The U.S. must insist on a global solution to this problem and resist current attempts to exempt developing nations from emission reduction efforts. (In our industry, 4 of top 10 steel producing countries are "developing nations.")
- The acid rain/sulfur permit trading system under CAA was never fully utilized. Large utilities installed expensive scrubbers and passed costs on to consumers.
- How does this system reward energy efficient industries that have reduced GHG emissions since 1990, like steel??
- How does this system address U.S. consumer habits, which are the major contributor to U.S. emissions? The burdens may fall unfairly on the industrial sector and utilities.

Conclusions: A GHG hybrid system of this scale has never been tested and imposing it on the world's economies, without further analysis and debate, would be risky and premature. It could distort energy supply and demand, and rather than being "market-oriented" is in the truest sense "command and control". A permit system picks energy winners and losers based on the number of carbon atoms in a fossil fuel molecule. Sound policy should instead encourage voluntary actions, technology development, energy market liberalization, energy price transparency, diversity of energy supply, competition among and between fuel sources, and sustainable use of natural resources.

Miss Katie Jennings
P.O. Box 13
Stephensport, KY 40170

Mr. Todd Stern,

I am a gifted student in Breckinridge Co., taught by Marcella Mercer. I've been asked to request your help on some subjects such as global warming.

I was pleased with the world's leaders in their recent approval of a global warming pact at Kyoto, Japan. This pact would reduce greenhouse emissions to below 1990 levels. It's very important that the U.S. Congress keep this pact. Please do all you can to influence them.

The idea of destroying all the trees is ridiculous. It is dismantling the earth. Trees that are harvested for useful purposes must be replaced. Penalties should be applied to any logging company that does not responsibly resupply the trees they cut down. Newspapers should publish the companies that don't replant trees.

Thank You for taking time
out to listen to my opinions.
I appreciate your attention
to my request.

Sincerely,

Katie L. Jennings !!

Age 10

NIAGARA MOHAWK POWER CORPORATION

NIAGARA MOHAWK

300 ERIE BOULEVARD WEST
SYRACUSE, N.Y. 13202
(315) 428-6572

Thomas R. Fair
Vice President
Environmental Affairs & Ethics

October 21, 1997

'97 OCT 22 PM 1:57

Mr. Todd Stern
Special Assistant to the President
The White House
1600 Pennsylvania Ave.
Washington, D.C. 20500

Dear Mr. Stern:

Subject: Global Climate Change Trading System

As the Third Conference of the Parties ("COP") in Kyoto, Japan approaches, the United States appropriately has begun to consider how to develop and implement measures to reduce the Nation's greenhouse gas emissions. At the September 26, 1997, meeting in Washington, D.C., which I attended, you indicated that the Administration plans to promote a cap and trade system, both domestic and international, to implement any binding reduction agreement that comes out of the Kyoto COP. Niagara Mohawk Power Corporation ("NMPC") strongly supports the Administration's plan to achieve its climate change goals through a market based system that involves trading of greenhouse gas emission credits.

It was apparent from the September 26 meeting that one very important issue related to implementing such a trading system is being seriously debated within the Administration; that is, whether the initial allocation of greenhouse gas ("GHG") emission credits will be issued to affected industrial sources based on an ex ante, historical basis, or whether the allocation will be distributed through an auction system to any person desiring to acquire the emission credits. You invited us to provide you with our thoughts and comments on this issue.

NMPC believes that an ex ante allocation based on historical activities is far superior to an auction-based allocation. Below are the reasons that we strongly recommend the ex ante allocation.

First, unlike economic theory, we are not faced with a blank slate, but rather with a history of economic development and industrial activity that cannot be ignored. Absent the huge investments already made, if all parties bidding on auctioned emission credits did so as part of an initial decision to engage in GHG emitting activities (that is, to become an automobile manufacturer, electric utility or steel foundry) an auction system would be preferable. However, the core industries that are responsible for the greenhouse gas emissions have invested multiple billions of dollars in capital stock that cannot be sold, written off or abandoned without devastating economic impact. Those investment decisions were made based on circumstances that should not be ignored. An auction system would ignore that history.

For example, although much has been made of the success of the "spectrum" auctions in the communications industry, this is a poor analogy to a carbon auction. The spectrum auctions were of new band widths and spectra. By contrast, the proposal for a GHG auction effectively would confiscate existing rights, prohibit companies from continuing their productive activities and force them to bid for that right. The spectrum auctions likely would not have been considered so popular or successful if all of the existing licenses (e.g., those owned by ABC, CBS, TimeWarner, etc.) had been revoked and thrown into an auction.

Second, as a result of changing policies, we will be calling on major industry sectors to make large capital investments in new technology and efficiency improvements to achieve our GHG reduction goals. Under an auction system, these same companies would be required to spend scarce capital on emission credits just to continue operating, even at an improved level of efficiency. This would impose a double financial burden on the affected industries: they would be forced to make investments to reduce GHG emissions and, simultaneously, forced to spend millions more for emissions credits to even operate at the more efficient level.

By contrast, if allocated emission credits are based on some historical benchmark, companies can make efficient decisions about how to meet their prospective production goals in light of their allocation and current market demand. Although they would have a variety of ways to comply with new GHG limits, they would have the positive incentive to invest in new technology knowing that if they can reduce GHG emissions below the allocation level, they can sell the emission credits and help pay for the investment in efficiency improvement.

Our objective in meeting GHG reduction goals must be to do so with the least possible disruption to our economy. An auction system cannot meet this objective. Our economy is so pervasively dependent on processes that result in carbon emissions that requiring electric utilities, oil companies, major manufacturing industries to make huge financial outlays to acquire emission credits just to continue their operations would severely disrupt our economy; it would effectively be an auction for the right to do business and to participate in the American economy. Indeed, simply committing to an auction-based allocation system would be disruptive to financial and investment markets because of the wide-spread uncertainty it would create. If "uncertainty is the enemy of action," the announcement of an auction-based allocation would create inertia in the affected industries because of the unknown impact that a program of such magnitude would have on American industry's costs and competitive position at home and abroad.

Third, because of the scarcity that would be created by the cap and trade program, we know that the industries and companies that have historically had significant GHG emissions would have to acquire the overwhelming portion of available emission credits.¹ An auction would inevitably cause the price of the emission credits, and costs of goods produced by these companies, to be higher than with an ex ante allocation. In an auction, participants other than these industries would bid on emission credits, including speculators and arbitrageurs. Since only those industries that have GHG producing activities value the emission credits for their underlying rights (rather than the potential commodity value), these industries ultimately must acquire the credits. If the speculators and arbitrageurs make any profit, the costs to these industries must be higher than would result in an ex ante allocation. Indeed, even if the speculators and arbitrageurs lose money, the transactional friction created by their participation (delay, contracts, attorney fees, etc.) would force up the costs. The impact of an initial auction of limited GHG emission credits would be to impose unnecessary costs on U.S. industries and consumers and make U.S.-produced goods less competitive in international markets.

Fourth, an auction system will create undesirable market distortions that likely will hinder efficient movement toward technology improvement. Under an auction, the government will receive billions or tens of billions of dollars as a result of the auction. To avoid the significant drain that would impose on the economy, the government will have to

¹Indeed, if we assume that the initial allocation is 5% to 15% below 1990 levels, these companies likely will have to acquire all of the emission credits in the early years or substantially reduce production.

Mr. Todd Stern
Page 4
October 21, 1997

reinject that money back into the economy. Presumably, most of the money would go back to the industries that will be hardest hit by the cap and trade system; e.g., energy sector and energy intensive industries such as aluminum manufacturing, electricity generation, automobile manufacturing, etc. However, the money will be returned to these industries (and, no doubt, to other segments of the economy) in the form of tax credits, rebates or other incentives. The effect is that appropriate price signals and market incentives will be replaced with governmental fiat and political preferences. No matter how well intended and designed these tax incentives may be, they will distort the normal market reaction to the price of emission reduction credits and change the efficient allocation of resources to deal with the problems.

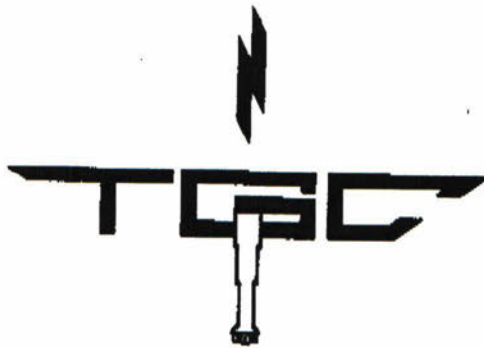
Finally, political reality cannot be ignored. For the Administration to have any realistic hope of passing legislation that will so dramatically change exiting business structure, there must be a significant level of consensus. If the core sectors of the U.S. economy are to be persuaded that they should support a GHG cap and trade program, they must be provided positive incentives rather than multiple penalties. If the coal, petroleum, utility, ferrous and non-ferrous metals, cement and large manufacturing industries uniformly oppose the legislation, there is virtually no hope that such a program can be enacted. We are confident that a cap and trade system that is implemented through an auction will be vehemently opposed by all of the energy-intensive industry segments of the economy.

As a company that has made a commitment to reduce its emissions below 1990 levels and one of the few companies that has openly supported the U.S. efforts to lead the world toward reasonable GHG objectives, NMPC strongly encourages you to give serious consideration to these comments.

Sincerely,



pc: D. Forrister (Council on Env. Quality)
D. Gardiner (U.S. EPA)
H. K. Gruenspecht (DOE)
E. A. Helme (Center for Clean Air Policy)
H. Lee (Harvard University)
W. M. Bumpers, Esq. (Baker & Botts)
W. J. Holzhauser, Esq. (NMPC)



TGC
Todd Letter
TRANS-PACIFIC
GEOTHERMAL
CORPORATION
1901 Harrison
Suite 1590
Oakland, Calif.
94612-3501
(510) 763-7812
FAX 763-2504

September 19, 1997

Mr. Todd Stern
White House Task Force on Climate Change
88 Jackson Place, NW
Washington, DC 20503

By Fax 202-456-2215

Dear Mr. Stern,

I wish to share with you a letter that I have recently sent to Vice-President Gore. In that letter I discuss possible financial mechanisms that would greatly amplify the role of clean energy resources such as wind, geothermal, solar and others in displacing fossil fuel sources. The underlying concept in that letter is that various stimuli are available to the U.S. government. In particular, the proposed approach would achieve the administration's goal of increasing the role of clean energy, and could be directly implemented by this administration through a joint effort with the financial community.

I would be pleased to provide you with additional inputs if requested.

Sincerely yours,
TRANS-PACIFIC GEOTHERMAL CORPORATION

By Tsvi Meidav, President

Attachment



TRANS-PACIFIC
GEOTHERMAL
CORPORATION

1901 Harrison
Suite 1590
Oakland, Calif.
94612-3501
(510) 763-7812
FAX 763-2504

September 5, 1997

Vice-President Al Gore
The White House
Washington, DC 20500

By Fax 202-456-2461

In re: Financial mechanisms for reduction of the rate of global warming from power generation.

Dear Mr. Gore:

As the CEO of a company engaged in renewable power development, I am fully aware of the dilemmas faced by the U.S. government in its efforts to reduce global warming. Numerous regulatory and financial mechanisms could be suggested to abate the problem of rising CO₂ emissions worldwide. In this letter I wish to address only the financial mechanisms that can slow the rate of growth of CO₂ emissions while having a significant positive impact on the U.S. economy.

Mechanisms which would encourage U.S. energy companies to increase their involvement in clean energy projects operating internationally are all related to financial incentives. Any incentive that increases the rate of return of an investment and reduces the comparative price of clean energy projects is likely to interest many potential U.S. investors in environmentally friendly international projects.

Tens of billions of dollars will be invested in renewable energy power generation within the next two decades, even without special incentives. A much larger investment in renewables may take place due to new international agreements on global warming abatement. The share that U.S. industry carves out will depend on the fiscal mechanisms that are put in place.

A key issue in the increasingly privatized international electric power markets is the cost of clean energy sources, which, though abundant in certain parts of the world, are considered expensive in comparison to conventional fossil fuel resources. The rapidly industrializing

countries of southeast Asia and the Pacific Rim will continue to develop the least cost energy sources first, if the clean energy sources are more expensive. Most U.S. companies will continue to avoid aggressive development of clean renewable energy resources internationally if the financial rewards are similar to, or lower than the conventional energy options, because of the greater perceived risks involved in clean energy development.

Key players in the financing of energy projects - the World Bank (WB) and the Inter-American Development Bank (IDB) - have not been helpful in promoting clean energy sources, notwithstanding their pro-environment manifestos. The U.S. government, as a major contributor to both, can affect their lending policies in a manner that could produce a dramatic shift toward financing clean energy projects.

Both the WB and the IDB claim to favor clean energy, but neither one has established practical policies that would stimulate the accelerated development of environmentally friendly lending policies. On the other hand, the U.S. Public Utility Regulatory Policies Act (PURPA) caused a significant increase in the development of renewable resources in this country. PURPA required electric utilities to give preference to clean, renewable energy resources, and freed the developers of those projects from onerous regulations. Additionally, favorable tax treatment, such as the energy tax credit and accelerated depreciation, made investments in renewable energy an attractive business opportunity.

The WB and the IDB, on the other hand, leave it entirely to the governments applying for financial support as to which energy projects those governments wish to sponsor. The only requirement is that each plant meet the WB/IDB pollution standards. However, neither the World Bank nor the Inter-American Bank has developed a carbon dioxide standard. The societal costs and effects on the global environment are not a factor in the evaluation of the financing of such projects.

Governments of developing countries are exempt from the agreements of the Rio compact on global warming, and continue to ignore the societal costs of power generation. The price of power almost always remains the only consideration. Several clean energy technologies have been successful in bringing down the cost of power generation in recent years, but their prices are not yet quite low enough to meet or beat the prices obtained from conventional power technologies, unless societal costs are considered. Modifications of fiscal policies of the WB, the IDB, and other multilateral financing institutions can change that.

The amount of clean energy produced in future years would be substantially increased if (a) potential buyers of electricity in the developing countries - the distribution companies - find the price of renewable energy projects attractive, and (b) the financial rate of return to private developers meets or exceeds those of projects of equivalent risk level.

Recommended general policy changes

These goals could be met by two broad requirements in the way that energy projects should be carried out:

1. Urge the WB and the IDB to modify their policies so that financing for fossil fuel projects will be supported only when available clean energy sources are demonstrably more expensive, even after all incentives to the latter are taken into account, and;
2. Require financial lending policies to be modified so as to reduce the risk and increase the rate of return for clean energy projects.

Recommended specific changes in financial policies.

The following menu of lending policies will achieve the objectives of cost reduction of clean energy projects:

1. Increase the debt to total cost ratios required when lending to clean energy projects. Banks traditionally lend only 60-70% of total project cost. Increasing that to 80-85% would significantly increase the rate of return to equity investors.
2. Extend the term of loans from 10-12 years to 15-20 years, when appropriate.
3. Offer the lowest interest rate for the loan fraction that comes from the multilateral banks.
4. Reduce political risk insurance charges by MIGA and OPIC.
5. Extend the grace period of no-loan-payment, in conjunction with a longer loan term.
6. Change the allocation of funding in the multilateral institutions to favor the "private project windows", as opposed to the "government project windows". After all, privatization of electric power is the accepted new credo of governments worldwide.
7. Evaluate the practicality of renewable energy loan guarantees. Such guarantees will substantially facilitate loans and improve loan terms.

All of the items in the above menu have been done before on a sporadic basis by the multilateral institutions or by the U.S. government.

Implementation of all or part of the above recommendations will result in a substantial increase in clean energy projects, thereby slowing down the rate of carbon dioxide buildup in the atmosphere. At the same time, such policy change will be spared from the potential criticism of traditional source energy developers. It will give them the incentive to branch out into those newer sources of energy because it would make economic sense to do so. The magnitude of the economic benefit to U.S. energy companies will be substantial. The U.S. is still the world leader in renewable energy technologies such as geothermal and solar. Increasing the size of renewable energy market opportunities for U.S. companies will have a significant impact on the U.S. economy.

A major shift in policies, primarily of the World Bank and the Inter-American Development Bank, is necessary to cause a major movement towards the implementation of the Rio Earth Summit goal of combating global warming. A bold declaration by the U.S. government that this is the thrust of its policy is likely to win the applause of other industrialized countries. Those countries are puzzled and disappointed by the absence of decisive actions by the U.S. government that promote a cleaner environment.

Such a declaration and appropriate actions to implement its concepts could be one of the significant steps towards increasing the momentum towards the reduction of global warming.

Respectfully yours,

TRANS-PACIFIC GEOTHERMAL CORPORATION

A handwritten signature in black ink, appearing to read "Tsvi Meidav". The signature is fluid and cursive, with a long horizontal stroke at the beginning.

By Tsvi Meidav, President

Todd
letters

'97 OCT 27 AM 9:55

Christine Krajewski

933 Jenifer St #2

Madison, Wisconsin 53703

October 20, 1997

Dear Mr. Stern,

I am writing to urge you to stand by the resolutions made at the Rio Conference on the environment to reduce greenhouse gases. The U.S. along with many other nations, pledged to reduce greenhouse gas levels to the 1990 level by the year 2000. I expect you to represent the interest of *all* citizens' health and well-being, rather than serve the interests of the car and fuel industries of this country by ensuring that at *least* those restrictions decided upon in Rio are met. Thank you, in anticipation, for taking a courageous stand for the environment.

Sincerely,



Christine Krajewski

Todd Carter
'97 OCT 27 AM 9:58

**Strategic
Alliances
Group**

44 East Mifflin Street
Suite 303
Madison, WI 53703

tel: 608. 251. 8156
fax: 608. 251. 4136

Washington DC ■ Madison ■ Miami ■ Sacramento ■ Seattle

October 22, 1997

Mr. Todd Stern
Assistant to the President and Staff Secretary
1600 Pennsylvania Avenue NW
Washington, DC 20500-0003

Dear Mr. Stern:

Thank you for inviting me to attend the White House Climate Change Briefing last month at the White House. I think you share my assessment that it is vital that small businesses and their representatives have a seat at the table during these important discussions.

The National Small Business Union is celebrating its 60th Anniversary this year, making it the oldest organization advocating for these concerns in America. The twenty-two million small businesses of this nation are an integral component of our economy and our growth rate continues to add millions of jobs to the American workforce.

Small businesses are good citizens of our communities. We want a safe environment for our families, friends and neighbors. However, we also recognize that environmental decisions can not be made in a vacuum without regards to other factors. Therefore, we hope small businesses and their representatives will be present at the Kyoto Summit in December.

Again, thank you for your time, expertise and inclusiveness on this very challenging issue of climate change. I look forward to working with you and other environmental and economic experts on this most pressing concern.

Sincerely,



Camille Haney
President
Board Member National Small Business United

Todd Letters

B. D. Norman

914 62nd St. Oakland, CA 94608

510-654-7438

'97 OCT 27 AM 9:57

White House Advisor on Global Warming - Todd Stern
The White House
Washington, DC 20500

21/Oct/97

Re: 14/Oct/97

Unsolicited Research Proposal

Dear Mr. Stern:

For Fear that your response may not come in time for this project to be finished in 1997, I am sending the proposal right now, since I do not know whether or not YOU are looking for IMMEDIATE ANSWERS.

This 30 Days Research Report comes from 10 Years of Research, and it is as IMMEDIATE as you can get to dispel the Greenhouse Theory with SUPERIOR DATA.

Sincerely,

B. D. Norman

X P

Chi Rho

Who's Who Among Black Americans --- Library of Congress

UN-SOLICITED PROPOSAL
under
Federal Acquisition Regulations
6.3 and 15.5

PROPOSAL COVER SHEET

- 1 - Project Title: GLOBAL WARMING: The Basic Fundamental CAUSE
versus Theoretical Mis-information
- 2 - Submitted by: Bobby Don Norman, Tectonic Analyst/Principal Investigator
914 62nd St.
Oakland, CA 94608
- 3 - Topic: Correcting the Greenhouse Theory
- 4 - Organizational Unit: Individual - Sole Authority on Biblical Geology
- 5 - Research Element: CAUSE of Global Warming
- 6 - Duration of this project: 30 Days
- 7 - Project Cost: \$300,000
- 8 - Proposed Project is not a Continuation Award
- 9 - Proposed Project is being submitted to: White House Global Warming
Advisor - Todd Stern
- 10 - Principal Investigator:
Name: Bobby Don Norman
Title: Tectonic Analyst
Signature: B.D. Norman Date _____
- 11 - Closing Date: 31/Dec/97 for this offer to be negotiated.

PROJECT SUMMARY

Name and Address of Proposer: Bobby Don Norman

914 62nd St.

Oakland, CA 94608

(510) 654-7438

Name and Title of Principal Investigator: B. D. Norman, Tectonic Analyst

Title of Project: GLOBAL WARMING: The Basic Fundamental CAUSE versus
Theoretical Mis-information

Technical Abstract:

The erroneous scientific speculations and mis-information on Global Warming and the Greenhouse Effect are concoctions of theories that have misled the Decision Making Process of Federal Authorities and other governing bodies, as the mis-information had NEVER IDENTIFIED the CAUSE through WORKABLE DATA.

There is a COMPLETE VOID of Basic Fundamentals that are essential to the understanding of the events of rising temperatures throughout all of the industrial nations of the world, as well as the volatile events of climates.

Biblical Geology is Earth Science under God that is extracted from Scripture and the Words of God cannot be declared Junk Science by those scientists who have established all of the mis-information while they disavowed God's Words with all of the FACTS.

It is from the DISCOVERIES made through Biblical Geology that the CORRECT DATA will show the Scenario of FACTS. TEN YEARS of Research has gone into writing these Basic Fundamentals through which this research proposal will establish and accomplish the ANSWERS to Global Warming.

There are NO PEERS to evaluate this NEW DISCOVERY DATA of Biblical Geology, since I have not taught anybody and it is beyond a doctorate degree in either Geology, Climatology, Meteorology or Theology, bar none. All of the consortiums of scientific minds, do not have a single clue to the CAUSE of Global Warming and this is the ONLY CONCLUSIVE EFFORT to provide the ANSWERS.

HOW this work is done, is the expertise of having established the Basic Fundamentals through years of experience in writing and preparing diagrammatic analyses within the daily tasks.



COST

- 1 - FEE for preparing this Research Report \$300,000
(50% to Start and 50% upon Finish)
- 2 - The Fee for proprietary data used to establish the FACTS that are most necessary in the identification of the CAUSE of Global Warming, is being extracted from UN-PUBLISHED Manuscripts of TEN YEARS of prior research.
- 3 - The Fee is authorized under Federal Acquisition Regulations 6.3 and 15.5 for the Federal Government to obtain research data without competition and without annual submission date, nor dates of solicitations.
- 4 - Fee is extremely small in comparison to the billions of Federal Research Dollars that have been squandered on all of the previous research projects that have produced all of the WRONG DATA.
- 5 - Cost Comparison to Similar Proposals: NONE, since no other research project has established the Basic Fundamentals of Earth Science to dispel the data of the present-day theory that will cost the Industrial Nations billions of dollars.
- 6 - The Dollar Value of the data from the ONLY SOURCE is un-known, and this research effort is the ONLY ONE OF ITS KIND that will produce the Scenario of FACTS, and the Cost is un-precedented for New Discovery Data.
- 7 - Closing Date: 31/December/97, as it will allow this project to close 1997.
- 8 - FAIR MARKET VALUE of this project is well below 1% of any Billion Dollars that have already been spent to produce the WRONG DATA.

Significance of the Project

The specific problem being addressed is the VOID of Basic Research of the Geothermal Activity towards the CAUSE of Global Warming, and there is no recorded discoveries of FACT that will allow WORKABLE DATA to aid in the understanding of Temperature Changes throughout the world.

Scientist disavow God and Religion in their sciences which is HOW they dug pitfalls for their own erroneous theories and un-workable tenets based on outspoken personages within their own ranks. This research data is SUPERIOR DATA extracted from Scripture that is being offered for the education of students, professionals and all governing bodies dealing with the environment.

None of the professionals within the ranks of Geology, Climatology, Meteorology nor any of the environmental sciences, have ever had a clue to the FACTS of DISCOVERY that will be used to dispel the Greenhouse Theory that is advocated by the consortiums of scientific minds who have established the WRONG THEORY.

This project will establish the ONLY FORMAT that is WORKABLE towards the CAUSE of Global Warming.

Biblical Geology is an exact science, as it is extracted from the Word of God that is recorded in Scripture. It is because academic scientists have not had a valid understanding of Earth Science under God that they have ignored those axioms that God used in the Creation of the Earth. This very science that was hidden in Scripture by God, requires God's Gift of KNOWLEDGE and Wisdom that is the CREDENTIAL of 1 Corinthians 12:8, and it is beyond a doctorate degree in any academic science; thereby, the data of Scripture will dispel the WRONG THEORY of Global Warming.

Since academic scientists consider God's Word in Biblical Geology to be a form of "Junk Science", the finished Report of this research proposal will show, in comparison, the numerous asinine conclusions drawn by the consortium of well educated scientific minds.

To overturn TENETS of Scientific Theory, a Scenario of Facts must be developed to prove beyond any doubt that the established tenet and/or rule is WRONG; yet, such scientific journals as National Geographic refuses to accept the Tectonic Analysis Diagram of the Great Lakes that proves that they are Tectonic Cleavages and did not exist as residual waters of a Great Ice Age. While so-called science journals are suppose to be interested in SUPERIOR DATA, they are only journalist that are equally ignorant and they are an AFFRONT TO GOD.

The Federal Government will be the authority examining the validity of this data towards establishing a whole new format of HOW the Globe is warming.

PROJECT PLAN

To prepare this Research Report requires the ability to write the text and draw the diagrammatic analyses through the principles of Biblical Geology; whereas, any reader of the report will see and understand the activity and events of Global Warming.

HOW this work is accomplished, in specific detail, is not the purpose of this proposal, as it is an educational process that started in 1987 towards making the Basic Fundamentals available for this project.

This report will be ORIGINAL DATA prepared by the Principal Investigator that has NEVER BEEN SEEN BEFORE by any other scientist, agency or institution. It is proprietary data of discovery that is being used for the sole purpose of providing the Federal Government with SUPERIOR DATA.

Simple Outline of the Report

- 1 - Narratives of the Technology
- 2 - Diagrams of the Analyses
- 3 - Compiling the Research Data
- 4 - Final Report

All data will be produced on 8 $\frac{1}{2}$ inches by 11 inches typing paper.

Common language will be used for the narratives of the technology for easy reading.

Specificity of the Project Plan is not provided, as this project is about providing ANSWERS to the CAUSE of Global Warming, and NO ANSWERS will be given for Federal Evaluators to PIRATE my research projects again.

RELATED EFFORTS

NONE. This is NEW DISCOVERY DATA that has NEVER BEEN RECOGNIZED by the various agencies, institutions, nor departments on Environment, as they have entrenched themselves in backwards theories and UN-WORKABLE TENETS. The Scientific Think Tanks have mis-educated themselves and have established the WRONG DATA; thus, the issue of the Greenhouse Theory has brought on the center of attention out of erroneous speculations without the FACTS, and widespread interests and their comments without a valid clue.

Without an established FORMAT, the Greenhouse Theory is an issue without the Basic Fundamental Truths that can be examined for authenticity.

Project Personnel and Bibliography of Directly Related Work

B. D. Norman, Principal Investigator Male Born: 5/June/33 Dallas, TX

Sole Authority: Biblical Geology and Tectonics. Author and Researcher of Earth Science under God, as extracted from Scripture.

- 1 - Discovered the ancient Gihon River of the Garden of Eden that has NEVER BEEN FOUND by academic teachings of Geology, nor any of the professional geologists, as they disavow God in Earth Science.
- 2 - Discovered that Florida came from Mauritania which dispels the mis-information on Tectonics published by U.S.G.S.
- 3 - Discovered that the San Francisco Bay was a Tectonic Cleavage/Tear of the mouth of the Sacramento River.
- 4 - Discovered that Oakland, CA is moving away from San Francisco, CA through the Bay Area Tectonics that went UN-RECOGNIZED by any other geologist, geophysicist, nor seismologist in California, or anywhere else.
- 5 - Discovered the Tectonic Axiom of Earthquakes that dispelled the ERRONEOUS THEORY that Faults created Earthquakes, as the axiom is that Tectonics create Earthquakes that create Faults and Fissures.
- 6 - Discovered the Great Lakes to be Tectonic Cleavages created by the Tectonic Swing of the Quebec Peninsula, and they were NEVER the residual waters of an Ice Age that geologists had established in all of our atlases, encyclopedias and geology books.
- 7 - The only Tectonic Analyst to FOREWARN of the 25/Nov/88 Earthquake that shook from Quebec down to Washington, DC, as of my letter to State University of New York, National Center for Earthquake Engineering Research (member of National Earthquake Hazards Reduction Program), dated 5/Oct/88. The Quebec Peninsula-New England Peninsula diagram is called Exhibit-A, and it was the ONLY such diagram of ACTIVE TECTONICS that had ever been done in all of geological map making history.
- 8 - Wrote the Norman Report to FEMA (Federal Emergency Management Agency) that was a CRITIQUE of Emergency Response MIS-MANAGEMENT of the Loma Prieta Earthquake of 17/Oct/89, dated 21/Feb/90, and it was the only such document of its kind that included Exhibit-B which is the only diagrammatic analysis of ACTIVE TECTONICS of the Bay Area that had ever been done in all of geological history.

This data has been circulated throughout the White House Administrations, The House of Representatives, The Senate, U.S. Geological Survey, Secretaries of the Interior, National Science Foundation, F.E.M.A. and a host of so-called science journals and science editors of numerous newspapers, since 1987.

Project Personnel and Bibliography

Bobby Don Norman: Principal Investigator/Tectonic Analyst/Artist/Author

Pioneer of Biblical Geology and Tectonics (Earth Science under God)

CREDENTIAL - 1 Corinthians 12:8 1987-1997

This credential is the Gift of God and it is a Spiritual Achievement proclaimed in Scripture that has NEVER BEEN attained by any academic degree, not even a doctorate degree in any of the sciences.

Graduate - Ground Radio Electronics Technician
U.S.A.F. (Korean War) 1951-1955

Graduate - Business Administration
Southwest School of Business Administration
Dallas, TX 1956-1959

Studied Art, Social Science and Humanities
San Francisco, City College, San Francisco, CA 1950-1951

Artist and Writer 42 Years 1955-1997

Current Work Experience: Researcher/Tectonic Analyst of Biblical Geology

Unpublished Work Copyright - Biblical Geology, Prophecy & Tectonics
1991

Unpublished Manuscripts: 1987-1997 FIVE
Biblical Geology and Tectonics

Creative Religious Artist, Illustrator and Writer of Biblical
Geology and Tectonics

Past Work Experience is NON-Germane:

Manager of Club Restaurant, Motel
U.S. Postal Clerk
Office Manager & Founder - Southern Christian
Leadership Conference of Dallas, TX
Community Liaison Developer - PPNET, Inc. of Dallas, TX
Executive Vice President - Davis, Norman & Zanders, Inc.
National Opinion Researcher - Univ. of Chi., IL, Dallas
Director of Cultural Gallery Workshop - AAAW, Ind.

Published References: Who's Who Among Black Americans
- Library of Congress



White House Advisor on Global Warming - Todd Stern
The White House
Washington, DC 20500

Todd Stearn

I urge President Clinton to sign
on at the World Climate Change Conference
in Kyoto for a reduction in green-
house gasses to 20070 below the 1990
levels by the year 2005. We need
an agreement that contains legally
binding targets.

Barbara Center
19 Ravine Rd.
Amherst, N.H. 03031



97 OCT 24 AM 10:34

Todd Stearn, Assistant to the President
White House
Washington, D.C. 20500



USPS 1995

PHOTOCOPY
PRESERVATION

Todd Stern
Todd Letters

AMERICAN OCEANS CAMPAIGN * CAPE ARAGO AUDUBON
CENTER FOR MARINE CONSERVATION * ENVIRONMENTAL DEFENSE
FUND * FSDWAC FOR ENVIRONMENTAL CONCERNS, INC. * FISH
FOREVER * GULF RESTORATION NETWORK * JERSEY COAST ANGLERS
ASSOCIATION * MASSACHUSETTS WILDLIFE FEDERATION, INC.
NATURAL RESOURCES DEFENSE COUNCIL * OREGON SHORES
CONSERVATION COALITION * PACIFIC COAST FEDERATION OF
FISHERMEN'S ASSOCIATIONS * PACIFIC MARINE CONSERVATION
COUNCIL * REID INTERNATIONAL * SAFER WATERS IN
MASSACHUSETTS (SWIM) * SIERRA CLUB * SIERRA CLUB NEW JERSEY
CHAPTER * WORLD WILDLIFE FUND

October 6, 1997

Todd Stern
Staff Secretary's Office
The White House
Washington, DC 20502

Via Facsimile and Mail

97 OCT 7 PM 1:13

Dear Mr. Stern:

On behalf of the undersigned organizations and their members, I am writing to you today to urge the Administration, as it develops its position for the Third Conference of the Parties to the United Nations Framework Convention on Climate Change to be held in Kyoto, Japan, in December 1997, to actively support an early and strong legally binding commitment to reduce greenhouse gas emissions in order to combat global climate change.

Those concerned with the health and vitality of America's marine resources are concerned about curbing the greenhouse gas emissions that are contributing to global warming, because global climate change will significantly affect our nation's marine environment. Climate change will have a significant impact on fish and shellfish living in the oceans. Much of the nation's marine resources are already threatened by overfishing and pollution. Although warmer temperatures may lengthen the growing season for many fish and could increase the amount of thermal habitat available in deeper areas, the negative effects of coastal wetland losses and increased pollution inflow as a result of climate change are expected to outweigh those potential benefits. Most at risk are marine species living in shallow waters and those fish that spend part of their lives in estuarine habitats. Since roughly 70 percent of global fish resources depend on near-shore or

estuarine habitats at some point in their life cycle, the potential impact of climate change on fisheries is large.

Moreover, as temperatures increase and global sea level rises, many coastal wetlands will become inundated and the water table in low-lying coastal areas will be lifted, allowing pollutants to flow off the land and into the ocean in many coastal regions of our nation. With a 1.5 foot sea level rise by 2100, more than 2.5 million acres of wetlands could be lost in the contiguous United States. The brown shrimp catch in the US Gulf Coast could decline 25 percent with a 10 inch rise in sea level. Contamination of coastal waters by pollutant runoff from agriculture, waste sites and sewer systems not only poses a hazard to the fish that live in those waters, but also to the humans that consume them. The government already closes many fishing areas because of toxic contaminants; increased inflow of pollution as a result of climate-induced sea level rise would serve to increase the frequency and extent of those closures.

Climate change could also affect ocean currents and alter the location and abundance of fish populations. Since these processes are less well understood, it is impossible to predict exactly how the patterns of fish distributions will change. But if the patterns are different from what we find today, commercial fisheries that rely on the current distributions will likely be affected.

Early and significant action to reduce greenhouse gas emissions would put the nations of the world on an emissions trajectory that could limit these adverse effects on America's marine resources. On the other hand, delaying action to curb greenhouse gases would subject marine ecosystems to more rapid warming, with more severe consequences for marine resources that are particularly sensitive to rates of warming. For example, coral reefs will feel the effects of climate change, as increases in sea surface temperatures can cause bleaching of coral reefs. Severe bleaching can lead to the death of corals and all the species that the reef environments support. Postponing action on climate change will expose coral reefs to more rapid changes in sea surface temperature, potentially increasing the risk of bleaching.

Delaying action would also force much steeper annual emissions declines to make up for the excess emissions, forcing those whose responsibility it will be to reduce emissions to bear the heavier economic burden of more rapid reductions in greenhouse gas emissions. Those whose livelihoods and well-being depend on a healthy and stable marine environment - fishers, promoters of marine ecotourism, and other stewards of our nation's marine ecosystems - must necessarily think about the long-term environmental consequences of delayed action, and similarly, we seek to avoid the long-term adverse economic effects that delayed action would entail.

Therefore, we respectfully request the Administration to adopt an early and substantial emissions reduction commitment for the upcoming Kyoto negotiations, one that will move aggressively to protect our vital marine resources from the adverse consequences of global warming.

Thank you for your consideration of this matter.

Yours Sincerely,

David Allison ²¹⁰

David Allison
Fish Forever

Lisa Speer ²¹⁰

Lisa Speer
Natural Resources Defense Council

Dennis Schvejda ²¹⁰

Dennis Schvejda
Sierra Club New Jersey Chapter

Polly Bradley ²¹⁰

Polly Bradley
Safer Waters in Massachusetts
(SWIM)

Wm. Robert Irvin ²¹⁰

Wm. Robert Irvin
Center for Marine Conservation

Barbara Jeanne Polo ²¹⁰

Barbara Jeanne Polo
American Oceans Campaign

Fran Recht ²¹⁰

Fran Recht
Oregon Shores Conservation Coalition

Cynthia Sarthou ²¹⁰

Cynthia Sarthou
Gulf Restoration Network

Kemp Maples ²¹⁰

Kemp Maples
Massachusetts Wildlife Federation, Inc.

Sandra J. Weston ²¹⁰

Sandra J. Weston
FSDWAC for Environmental
Concerns, Inc.

Scott Burns ²¹⁰

Scott Burns
World Wildlife Fund

Ray Nolan ²¹⁰

Ray Nolan
Cape Arago Audubon

Zeke Grader 

Zeke Grader
Pacific Coast Federation of Fishermen's
Associations

Tom Fote 

Tom Fote
Jersey Coast Anglers Association

Doug Hopkins 

Doug Hopkins
Environmental Defense Fund

Vivian Newman 

Vivian Newman
Sierra Club

Bob Eaton 

Bob Eaton
Pacific Marine Conservation Council

Dennis Reid 

Dennis Reid
Reid International

cc: Senator Patty Murray
Senator Slade Gorton
Senator John McCain
Senator Olympia Snowe
Senator Ernest Hollings
Senator John Kerry
Senator Ted Stevens
Senator Kay Bailey Hutchison
Senator Daniel K. Inouye
Senator John Breaux
Senator Mary Landrieu
Senator Phil Gramm
Senator Bob Graham
Senator Connie Mack
Senator Richard Shelby
Senator Jeff Sessions
Senator Trent Lott
Senator Thad Cochran

+

Todd Stern
'97 OCT 8 PM 2:31

**AMERICAN OCEANS CAMPAIGN * CAPE ARAGO AUDUBON
CENTER FOR MARINE CONSERVATION * ENVIRONMENTAL DEFENSE
FUND * FSDWAC FOR ENVIRONMENTAL CONCERNS, INC. * FISH
FOREVER * GULF RESTORATION NETWORK * JERSEY COAST ANGLERS
ASSOCIATION * MASSACHUSETTS WILDLIFE FEDERATION, INC.
NATURAL RESOURCES DEFENSE COUNCIL * OREGON SHORES
CONSERVATION COALITION * PACIFIC COAST FEDERATION OF
FISHERMEN'S ASSOCIATIONS * PACIFIC MARINE CONSERVATION
COUNCIL * REID INTERNATIONAL * SAFER WATERS IN
MASSACHUSETTS (SWIM) * SIERRA CLUB * SIERRA CLUB NEW JERSEY
CHAPTER * WORLD WILDLIFE FUND**

October 6, 1997

Todd Stern
Staff Secretary's Office
The White House
Washington, DC 20502

Via Facsimile and Mail

Dear Mr. Stern:

On behalf of the undersigned organizations and their members, I am writing to you today to urge the Administration, as it develops its position for the Third Conference of the Parties to the United Nations Framework Convention on Climate Change to be held in Kyoto, Japan, in December 1997, to actively support an early and strong legally binding commitment to reduce greenhouse gas emissions in order to combat global climate change.

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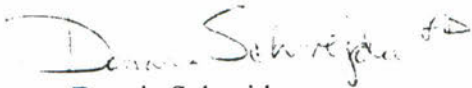
Yours Sincerely,



David Allison
Fish Forever



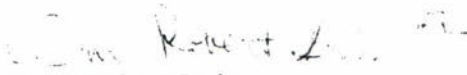
Lisa Speer
Natural Resources Defense Council



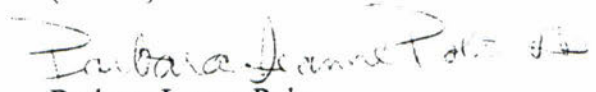
Dennis Schvejda
Sierra Club New Jersey Chapter



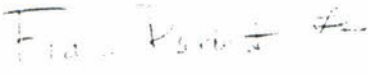
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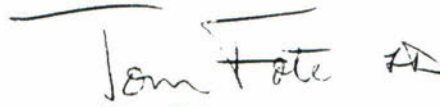
Scott Burns
World Wildlife Fund



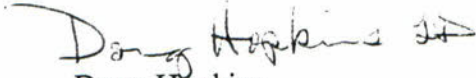
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cc: Senator Patty Murray
Senator Slade Gorton
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Senator Olympia Snowe
Senator Ernest Hollings
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Senator Daniel K. Inouye
Senator John Breaux
Senator Mary Landrieu
Senator Phil Gramm
Senator Bob Graham
Senator Connie Mack
Senator Richard Shelby
Senator Jeff Sessions
Senator Trent Lott
Senator Thad Cochran



World Energy Council

CONSEIL MONDIAL DE L'ENERGIE

97 OCT 1 AM 10:21

Todd Letters

Deputy Secretary General

Our ref K.1/16

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1 October, 1997

Mr. Todd Stern,
Assistant to the President & Staff Secretary,
The White House,
Washington D.C
U.S.A.

FACSIMILE TO: 00 1 202 456 2215

No. of Pages: 5
(including this page)

Dear Mr. Stern,

In the light of the President's meeting on Climate Change, I have pleasure in attaching the World Energy Council's Statement to the forthcoming Kyoto Conference.

The World Energy Council, an industry-based NGO, has Member Committees in some 100 countries - including the USA.

The attached statement is, we believe, balanced, objective and realistic. It may have a somewhat different content and tone than you are familiar with from the energy sector, which prompts us to offer it for your deliberations.

Yours sincerely,

MICHAEL JEFFERSON

enc:
MJ/ddb

The objective of the World Energy Council is to promote the sustainable supply and use of energy for the greatest benefit of all.

Vice-Chairmen WECEA: José Luiz Alquéres (Brazil); Don Jordan (USA); Ye Qing (China); Ali Attiga (Jordan); Ketane Sithole (Botswana);

WEC Secretary General: Ian Lindsay.

Charity Registration No. 259136



World Energy Council
CONSEIL MONDIAL DE L'ENERGIE

STATEMENT

to the Third Conference of the
Parties to the UN Climate Convention

Kyoto, Japan

December 1997

15 September 1997

10 POINT STATEMENT by the WORLD ENERGY COUNCIL

1. The World Energy Council (WEC) exists "to promote the sustainable supply and use of energy for the greatest benefit of all". Established in 1923, the WEC is an officially UN-accredited Non-Governmental Organisation with Member Committees in some 100 countries covering over 90% of global energy demand. The WEC is a non-commercial organisation within which all forms of energy are represented, from fossil fuels to new renewables, and is today the leading global non-governmental energy policy forum.
2. As long ago as 1977, the WEC advocated the need for long-term scenarios and responses to deal with "the CO₂ problem". Today, the WEC's long-term scenario work, first to 2020 and then to the year 2100 (produced jointly with the International Institute for Applied Systems Analysis, Laxenburg, Austria), is widely acclaimed. They indicate that global demand for primary energy will rise by at least 50% in the period 1990-2020, and could well increase by over 70%. By 2100 primary energy consumption could be five times current levels. Related CO₂ emissions could be over three times current levels, and atmospheric concentration of CO₂ could double.
3. The findings are such that the WEC has advocated since 1992 that "Precautionary Action" must be taken to mitigate the impact of such emissions. Notwithstanding the absence of conclusive proof of a link between man-made emissions and global climate change, the WEC has noted the finding of the recent IPCC scientific assessment: "that the balance of the statistical evidence, examined in the context of (its) physical understanding of the climate system, now points towards a discernible human influence on global climate". The WEC awaits further clarification based on scientific research.
4. The WEC supports Article 3 (Principles) of the Climate Convention, notably:
 - the need for "Precautionary Measures", as long as they are operable, cost-effective, and ensure global benefits at the lowest possible cost;
 - such measures should not be postponed on grounds of lack of full scientific certainty on the relationship between fossil fuel burning and possible global climate change.

Precautionary Action should focus:

- above all, on raising energy efficiency. Over 60% of the world's primary energy is now lost in the process of supplying vital energy services, and well over half of this loss occurs at the end-use by the final consumer.
- on pricing energy to cover the full costs of its provision to ensure transparency and to encourage conservation. In some cases this can only be achieved in the longer term.
- on accelerated development and installation of non-fossil energy sources, including new renewables, and nuclear electricity provision where feasible.

5. The WEC, in advocating that Precautionary Measures should be taken now, urges all Annex I Parties to the Climate Convention to show more understanding of recent emissions performance, estimated trajectories, and what is realistically achievable over given future time-periods because:

- global CO₂ fossil emissions rose 6.4% between 1990 and 1996, and by 2.7% during 1996 alone. On their 1996 trajectory the rise will be 9% by Kyoto.
- industrialised countries' Annex I Parties CO₂ emissions are now about 8% above their 1990 level in aggregate. Only in the economies in transition did aggregate emissions fall between 1990 and 1996. This was due to reduced economic activity.
- although the European Union's CO₂ emissions have fallen since 1990, they were less than 1% below their 1990 level in 1996, and the gap is now closing rapidly. On current trajectory they will exceed their 1990 level in the year 2000 by at least 6%.
- most of the proposed current targets and timetables, namely a 20% cut from 1990 to 2005, or even a 15% cut by 2010, are infeasible. It has been suggested by other Parties, for example, that the U.S.A., Canada, Norway, Japan, and Australia, having increased substantially their CO₂ emissions in the 1990's should now reverse this trend and reduce their CO₂ emissions by 20% to 30% (or more) in the period 2000 to 2010.

Of equal importance, the present developing countries account for a rapidly rising share of world emissions (from 29% in 1990 to over 36% today, evolving to about 50% by 2020, and rising further through the next century albeit with low per capita emissions). The WEC recognises that the industrialised countries must take the lead in climate change mitigation policies. However, it is also in the interests of developing country Parties to participate fully at Kyoto, from the start, to ensure effective responses to possible climate change. This is a potential global problem which requires a global solution.

6. The central challenge facing policy makers is that end-consumers use or aspire to use the services provided by commercial energy on which most economic and social development depends, and 76% of these services are now derived from fossil fuels. Reliance on fossil fuels will remain heavy over the next few decades, although other forms of energy could - and hopefully will - become increasingly available which consumers prefer and pay for. Policies aimed at climate change mitigation must gain social and political acceptability, both to the 3.8 billion end-consumers who already use commercial energy services and to the 2 billion people in many developing countries who currently have no access to commercial energy. End consumers will have to pay for all commercial energy services, including those provided by new systems which replace or augment current supplies.
7. In industrialised countries, policy makers should take effective steps to discourage their major greenhouse gas emitting activities from being relocated to other countries, as this makes no contribution to reducing total global emissions. For the same reason proposals for the purchasing-swapping of greenhouse gas emissions permits are unlikely to produce significant benefits, because they will

relieve pressure on richer industrialised countries and companies to engage in emissions-reducing technological innovation and diffusion. A comprehensive greenhouse gas emissions trading system would also be very complex and could not be rapidly introduced. A system should be implemented, however, which makes allowance for the export of goods and services because there is no good reason why the burden of emissions should be shouldered by anyone other than end-consumers in the final reckoning. By the same token, countries' emissions inventories should be debited for the emissions related to imported goods and services.

8. The longer action is delayed the higher is likely to become the cost of abatement and adaptation. Given the fact that energy systems cannot be fundamentally changed rapidly, the decision-making process must initiate Precautionary Action now. The next two or three decades represent the key period of opportunity for initiating the development of more sustainable long term energy systems, and if nothing is done alternative ways forward risk being severely curtailed.

9. Policies need to recognise:

- that for most countries and people possible climate change is currently lower down their list of priorities than local environmental issues - including energy related environmental and health problems;
- the varying conditions, needs and realistic ability to change energy systems in given time-frames between different groups of countries (industrialised, transitional and developing economies) and between individual countries;
- the essential global nature of possible climate change which requires a global response from which the whole world can benefit. Piecemeal action will be ineffective and costly.

10. The WEC urges all Parties to the Climate Convention to place greater vigour and resources behind Joint Implementation to ensure that this process moves beyond the pilot stage of Activities Implemented Jointly into the phase where JI schemes can make an effective contribution. Greater technology and financial support for developing countries within a system of quantified global emissions reduction targets is required urgently.

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The responsibility for emissions lies fundamentally with the ultimate consumer, and this means the ultimate consumer across the globe. It is therefore a global responsibility to ensure that all Parties to the Convention are included in any agreement signed in Kyoto, even if action is by phased stages. This is the only way to ensure that possible global climate change can be mitigated efficiently and globally.

E&Co**An Energy Investment Service**

'97 OCT 3 PM5:19

Todd Stern
*Todd Letters***Board of Directors:**José Goldemberg
Chair
BrazilCaroline Williams
Vice Chair
USAAmulya Reddy
IndiaAl Binger
JamaicaMichael Allen
Executive Director**Representation in:**Bolivia
Costa Rica
India
Nepal
South Africa
Zimbabwe
Washington, DC

October 3, 1997

Hon. Todd Stern
Staff Secretary's Office
The White House
Washington, DC 20502

Dear Mr. Stern:

E&Co is one of a growing number of organizations devoted to financing and implementing sustainable energy enterprises throughout the world. These enterprises, using clean, efficient and renewable energy technologies, are crucial to implementing the future contemplated by the 1992 Framework Convention on Climate Change. Intentions, however, will not reduce greenhouse gas emissions. Men and women in New England, Southern India, Southern California and the Dominican Republic will. These men and women have long battled technology barriers and vested interests to produce affordable, reliable energy systems that are greenhouse gas friendly. Investors (like the World Bank Group) are now paying attention to this important sector and the opportunity exists to significantly increase the level of renewable energy and energy efficiency activity -- and thereby create jobs, investment, tax revenues, exports and banking activity while decreasing greenhouse gases -- through firm, focused leadership at the upcoming Kyoto Conference.

What would Kyoto leadership entail? First, setting firm targets. Second, commencing reductions on the basis of known available, affordable technologies -- technologies where the US is competitive.

What would the impact of such leadership be? For the US: new jobs, new investment, increased tax revenues, a stronger more diverse US renewable energy industry and access to enormous international markets.

With leadership by the Clinton-Gore Administration these gains are within reach. Without focused attention now on the key issues to be addressed at Kyoto these potential gains will slip away.

Good luck as you confront this essential issue.

Sincerely,


Dr. Michael AllenUS Secretariat
Energy House
383 Franklin Street
Bloomfield, NJ 07003
Tel: 973-680-9100
Fax: 973-680-8066
E-Mail: eco@energyhouse.com

Talking Points on President's Climate Change Proposal

October 22, 1997

The President has proposed an ambitious climate change plan that is environmentally strong and economically sensible. Based on the President's conviction that global climate change is the premier environmental challenge of the 21st century, the President's plan will proceed pragmatically -- in three stages and with periodic economic and scientific reviews -- to cut greenhouse gas emissions by almost 30% from levels projected for 2010.

In the first stage, the President's plan will provide funding, create incentives, build partnerships and give credit for early emissions reductions. The second phase, beginning around 2004, will review, evaluate and extend the efforts of the first phase while laying the groundwork for phase three. In phase three, an international and domestic emissions trading system would begin.

The President's plan includes the following key elements:

- **A binding, realistic target to reach 1990 emissions levels by 2008-2012.** This target is part of a comprehensive framework for agreement in Kyoto that also includes flexible, market-based mechanisms and the participation of developing countries. The President is also committed to reductions below 1990 levels in the five-year period that follows.
- **A \$5 billion program of tax cuts and R&D for new technologies.** To spur energy efficiency and the development of new technologies, the President proposes a major new package of tax cuts and R&D spending amounting to \$5 billion over five years.
- **Active consultations over the next 9 months on an industry-by-industry basis, with early credit for companies making early reductions.** The President is committed to working with business to get their best ideas on how they can best reduce their own emissions, and to rewarding firms that act early.
- **Developing countries must participate.** Climate change is a global problem, and requires a global solution. That's why the President has committed that the United States will not adopt binding obligations without developing country participation.
- **A domestic and international emissions trading system.** Such a system can harness the power of the market to reduce emissions, as it has with great success in the case of acid rain.
- **Encouraging the use of energy-efficient products.** The President will engage in a broad-based effort to expand the use of existing energy-efficient technologies.
- **Federal procurement and energy use.** The Department of Energy will spearhead a comprehensive effort to reduce greenhouse gas emissions from Federal sources.
- **Electricity Restructuring.** To deliver a significant down payment on emission reductions, while saving consumers billions, we will pursue a bold plan for electricity restructuring.
- **Setting a concentration goal.** With advice from the National Academy of Sciences, the U.S. supports developing a specific, long-term concentration goal for greenhouse gases in the atmosphere.
- **Transition assistance.** The President is committed to working with Congress and labor to ensure a just transition for any workers dislocated by the changes in energy usage inherent in any climate change plan.

RICHARD L. SCHMALENSEE
Deputy Dean
Gordon Y Billard Professor of Management
and Economics

October 16, 1997

'97 OCT 17 PM3:48



Mr. Todd Stern
Special Assistant to the President
Ground Floor, West Wing
The White House
Washington, DC 20502

Dear Mr. Stern:

At last week's White House Conference on Climate Change, a number of speakers referred to the experience under the US acid rain program. Unfortunately, some of what was asserted is actually inconsistent with that experience.

A group of us from the MIT Center for Energy and Environmental Policy Research (CEEPR) have been studying the US acid rain program for several years. The enclosed documents, one of which will appear in the *Journal of Economic Perspectives* and one of which will appear as an NAPAP-sponsored report, summarize the results of our research. While the acid rain program has indeed been much more cost-effective than most previous environment programs, and has performed well by any reasonable standard, it has not produced miraculous reductions in costs. While costs, properly measured, are below expectations, they are not dramatically lower. And much of the difference can be accounted for by greater than expected penetration of low-cost, low-sulfur Powder River Basin coal into eastern markets.

I hope the enclosed documents help to set the record straight. My colleagues and I will be happy to answer any questions about our findings.

Sincerely,

A handwritten signature in dark ink, appearing to be "A.D. Ellerman".

cc: A.D. Ellerman
P.L. Joskow
Enclosures

An Interim Evaluation of Sulfur Dioxide Emissions Trading

**Richard Schmalensee, Paul L. Joskow, A. Denny Ellerman, Juan Pablo Montero,
and Elizabeth M. Bailey**

[Preliminary Draft of June 14, 1997]

Title IV of the 1990 Clean Air Act Amendments established the first large-scale, long-term environmental program to rely on tradable emissions permits (called “allowances” in this program) to control pollution.¹ This program was designed to cut acid rain by reducing sulfur dioxide (SO₂) emissions from electric generating plants to about half their 1980 level. It is of interest both as a response to an important environmental issue and as a landmark experiment in environmental policy. This experiment comes at a particularly important time, since emission trading is under serious consideration (with strong U.S. backing) for use to deal with global climate change by curbing emissions of carbon dioxide (CO₂). The economic stakes in climate change surpass those in acid rain by several orders of magnitude.²

In this article we summarize the results to date of our ongoing empirical analysis of compliance costs and allowance market performance under the US acid rain program. Our work is based primarily on data at the generating unit level for 1995, the first year this program constrained emissions, and earlier years.³ Supporting analysis and additional detail are presented, and other issues are explored, in Ellerman, et al (1997) and our other papers that are cited in what follows.

What is the Acid Rain Program?

Acid rain (or, more properly, acid deposition) occurs when SO_2 and nitrogen oxides (NO_x) react in the atmosphere to form sulfuric and nitric acids, respectively. These acids then fall to earth, sometimes hundreds of miles from their source, in either wet or dry form. The dominant precursor of acid rain in the United States is SO_2 from coal-fired power plants in the Northeast and Midwest. These emissions are the focus of the acid rain program created by Title IV of the Clean Air Act Amendments of 1990.

Title IV creates a cap on utility SO_2 emissions from electric generating units, to be implemented in two phases. During Phase I (1995 through 1999), aggregate annual emissions from the 263 dirtiest large generating units (the so-called "Table A units") must be below a fixed cap. Two provisions, little noted when Title IV was debated, provide that other units can be voluntarily brought under Title IV regulation in Phase I. The idea was to enable owners of Table A units to substitute emission reductions from other units for reductions from Table A units.⁴ In Phase II (2000 and beyond), virtually all fossil-fueled electric generating units in the continental US become subject to a tighter cap on aggregate annual emissions.

In both Phases, owners of affected generating units (i.e., those subject to SO_2 emissions limits under Title IV) are given fixed numbers of tradable permits, called "allowances," each year. Each allowance enables its holder to emit one ton of SO_2 legally. An allowance can be used in the year of issue or "banked" for use in any subsequent year. A small number of additional allowances are auctioned annually by the US Environmental Protection Agency (EPA), with the revenues rebated to utilities in proportion to their allowance allocations. Each generating unit must deliver to EPA valid allowances sufficient to cover each year's emissions

within 30 days of year's end or incur serious penalties. (Emissions are continuously monitored from affected units, at an average annual cost of about \$124,000 per unit.) Allowances can be bought or sold without restriction to cover emissions anywhere in the continental US, and they can be held for use in any future year.⁵ In the early 1990s, analysts predicted allowance prices of \$250-350 in Phase I and \$500-700 in Phase II.⁶

The acid rain program represents a conceptually important departure from the "command and control" tradition that has dominated environmental policy in the US and abroad. This traditional approach involved prescription of either particular abatement methods (so-called engineering standards) or maximum emission *rates* (so-called performance standards) for a particular pollutant for classes (commonly, vintages) of emissions sources. In 1971, for instance, the EPA set maximum SO₂ emission rates (measured as pounds of sulfur emitted per million Btu of fuel burned) for new coal-fired power plants, but it imposed no limits on old plants or on total emissions. The tradable permit approach, in contrast, deals with a quantity more directly linked to damages: total emissions from all regulated sources.

One important reason why Congress adopted this non-traditional approach in Title IV was that there seemed to be no workable "command and control" solution to the acid rain problem.⁷ Because new generating units had historically been subject to stricter environmental controls than old units, utilities had faced strong incentives to extend the lives of their old units. By 1985, 83 percent of power plant SO₂ emissions came from units not meeting the 1971 SO₂ emission rate standard for new units.⁸

The designs and site characteristics of these old units varied enormously, and, as a consequence, so did the costs of reducing their SO₂ emissions. Holding power generation constant, there are two basic ways to reduce SO₂ emissions from electric generating units: burn

fuel with less sulfur (“switching”) or retrofit and operate flue gas desulfurization facilities (“scrubbing”). Switching to coal with a lower sulfur content typically involves little or no capital cost, while scrubbers involve substantial capital costs. (Our data imply capital costs of about \$125 million on average for a 500 MW generating unit.) Because of differences in location and design, generating units differ in the ease with which they can switch to low-sulfur fuel. Similarly, some units are located on sites that can easily accommodate scrubbers, while others are not. Any environmental program that imposed the same standards across this heterogeneous population would likely impose very high and politically unacceptable costs on some utilities or regions.

Allowances were given to utilities rather than sold because there was simply no way a sales-based program could have passed Congress. Indeed, the politically live alternative to a simple grant of allowances was the addition of an electricity tax that would have forced “clean” utilities’ customers to help pay “dirty” utilities’ cleanup costs. The complex statutory provisions that allocate allowances to individual generating units show clear evidence of rent-seeking but do not provide strong support for any simple political-economic model of government decision-making.⁹ On the whole, the interests that had successfully resisted acid rain legislation during the 1980s – states that produced and/or burned high-sulfur coal – did less well in the allowance allocation process than their earlier success on this issue would have suggested.

What Happened to Sulfur Dioxide Emissions?

Figure 1 shows the basic pattern of aggregate emissions from Phase I units through 1995. Aggregate SO₂ emissions declined substantially from 1990 through 1994, even though

the EPA had forecast an increase over this period. Our analysis shows that about 80 percent of this pre-Phase I emission decline reflected the expansion of the market area served by low-sulfur coal from the Powder River Basin (PRB) in northeast Wyoming.¹⁰ This expansion was driven mainly by declining rail rates, reflecting the continuing productivity benefits of rail deregulation and the introduction of competition into the haulage of coal from the PRB.

Figure 1 also shows that emissions dropped sharply in 1995 to about 5.3 million tons, 40 percent below the aggregate limit of 8.7 million tons.¹¹ The 3.4 million allowances not needed to cover 1995 emissions were banked for future use. There are two plausible explanations for this dramatic over-compliance.

The first explanation involves intertemporal trading and optimization. Allowances have generally been expected to be more expensive in Phase II than in Phase I, so that even when the Phase I constraint is not binding it may be rational to reduce emissions on the margin and save the allowances thus freed up for use in Phase II, enabling aggregate emissions to exceed the Phase II cap for a time. This point was widely discussed in the early 1990s, and many analysts argued that some banking of this sort would be efficient throughout Phase I.

It is easy to show that if in a riskless world it is efficient to carry allowances from any period t to period $t+1$, the allowance price must rise at the rate of interest between those periods. In addition, the allowance price must equal operating units' short-run marginal abatement cost, with the obvious inequalities for units reducing emissions by either zero or the maximum possible in the short run. Thus if marginal costs of abatement are non-decreasing, emissions from regulated units must fall along an efficient path with banking from period t to period $t+1$.

At some time T^* in Phase II, the “allowance bank” will be exhausted, and thereafter the allowance price must equal marginal compliance cost. In a riskless world arbitrage would then ensure that the allowance price at any time t before T^* would equal the marginal cost of compliance at T^* , discounted back to t . In the real, risky world, of course, neither T^* nor marginal cost at that time are known for certain, and there is a time-varying “convenience yield” associated with holding allowances, as with holding other commodities.¹² The convenience yield will raise Phase I allowance prices, reduce the rate of allowance price increase during a period of banking, and contribute to price variability.

The second explanation for substantial over-compliance in 1995 is that in aggregate the market under-estimated the penetration of PRB coal driven by declines in rail rates and, as a consequence, over-invested in scrubbers and signed too many long-term contracts for low-sulfur coal. This disequilibrium explanation is consistent with the fact that the actual level of banking in 1995 far exceeded earlier predictions and with other evidence discussed below.

While only the 263 generating units listed in the law, the so-called “Table A units”, were required to be regulated in Phase I, Figure 1 also reflects data from an additional 182 electric generating units that “volunteered” for such regulation. This was almost 30 percent of the units eligible to volunteer, far in excess of expectations.¹³

As noted above, the provisions under which these units opted into Phase I was designed to allow substitution of lower-cost abatement at non-Table A units for higher cost abatement at Table A units. However, while some cost-reducing substitution did occur, and we estimate that the volunteers reduced their emissions in aggregate by between 140,000 and 214,000 tons, our analysis indicates that factors other than abatement cost differences had more impact on the decision to volunteer a unit for Phase I regulation.¹⁴ The process of allocating allowances to

volunteers based on simple rules inevitably involved error (in this case litigation was also involved), and we estimate that these “substitution and compensation” units received in aggregate between 243,000 and 336,000 more allowances (18 to 25 percent of their total allocation) than they would have needed to cover their emissions in the absence of Title IV. In addition, volunteers were exempted from certain NO_x regulations that would have been very costly for some units. In short, utilities’ substantial use of the “substitution and compensation” provisions increased both their profits and their emissions somewhat but did little to reduce compliance costs.

How Were Emissions Reduced?

In order to analyze the emissions reduction in 1995 attributable to Title IV, it is necessary to estimate what SO₂ emissions would have been for Phase I units in that year in the absence of Title IV. Our rough estimate of each Phase I unit’s 1995 counterfactual emissions is the product of its 1993 emissions rate, SO₂ emitted per unit of heat input, times its actual 1995 heat input.¹⁵ Figure 1 shows that total 1995 counterfactual emissions for Phase I units, indicated by the asterisk, were slightly above actual 1993 emissions, reflecting a 8.6 percent increase in aggregate heat input for Phase I affected units between 1993 and 1995. As the increase in heat input was 8.3 percent for all US electric generating units, it is clear that compliance was *not* achieved by reducing utilization of units subject to Phase I regulation. Counterfactual emissions were 0.5 million tons above the Phase I cap and 3.9 million tons above actual 1995 emissions. One-quarter of the total 1995 reduction from the counterfactual occurred in Ohio, and 90 percent occurred in the nine high-emissions states extending from Pennsylvania and West Virginia west to Missouri and south to Tennessee and Georgia.

Comparing actual and counterfactual emissions for each unit, we find that the 26 Table A units that installed scrubbers accounted for 45 percent of the total reduction in emissions. Two thirds of the reduction due to scrubbing was contributed by seven units at three large plants. Fuel switching, almost entirely to lower-sulfur coal (rather than, say, to natural gas), accounted for 55 percent of total reductions. While switching to PRB coal accounted for a large fraction of the reductions in emissions between 1990 and 1993, it only accounted for about 13 percent of the difference between actual and counterfactual 1995 emissions at Phase I units. (This was 24 percent of the difference accounted for by fuel switching.) Switching to lower-sulfur (not necessarily low-sulfur) eastern or midwestern coal was much more important. Finally, even though the “substitution and compensation” provisions were much more heavily used than had been anticipated, Table A units accounted for at least 95 percent of 1995 emission reductions. As noted above, abatement cost differences played a minor role in utilities’ decisions to volunteer generating units for regulation.

One can learn about the extent to which compliance strategies took advantage of the flexibility allowed by Title IV by comparing units’ actual emission rates with what those rates would plausibly have been in the absence of emissions trading. Figure 2 provides such a comparison, using as each unit’s counterfactual emissions rate the smaller of its 1993 rate and the ratio of the 1995 allowances it received to its 1995 heat input. This ratio is the emissions rate the unit would need to have attained in order to be in compliance with neither a shortage nor a surplus of allowances. Emission rate data on Phase I affected units are displayed in Figure 2, with units arrayed in order of increasing counterfactual emission rate. The counterfactual rate is indicated by the ascending curve, and the thin vertical bars show each unit’s actual 1995 emission rate. While there is some tendency for units with higher

counterfactual emission rates to have higher actual emission rates, the correlation is far from perfect. And that is precisely the point.

Some units reduced emissions in 1995 much more than they absolutely had to and either transferred allowances to other units or held them for future use, while others acquired allowances in order to be in compliance. About one-third of vintage 1995 allowances were banked for future use. On the other hand, about 10 percent of 1995 total emissions (534,000 tons) were covered by allowances acquired or transferred from other units. Emissions exceeded allowance allocations at 98 generating units located in 18 of the 24 states with Phase I units. The heterogeneity of unit-specific response strategies depicted in Figure 2 indicates that Title IV was an economically significant departure, as well as a conceptually significant departure, from the traditional “one size fits all” US approach of setting uniform unit-level emission rate standards.

What Happened in Allowance Markets?

Figure 3 displays historical information on the pricing of current vintage allowances.¹⁶ These data come from three sources: trade press reports, price indices from three private market-making organizations, and the EPA’s annual March auctions. As directed by the statute, the EPA has implemented a discriminatory auction scheme, in which winning bidders pay what they bid. The circles in Figure 3 shows the clearing prices (lowest winning bids) for current vintage allowances.

The first allowance transactions were reported in the trade press in mid-1992 at prices of \$300 and \$265 per allowance – roughly in line with expectations. In January 1993, the EPA promulgated the main regulations governing implementation of Title IV, including all the

regulations governing allowance trading. The March 1993 auction results, which included a clearing price of \$131 for vintage 1995 allowances, were dismissed as an aberration or a reflection of defects in the auctions' design. For the remainder of 1993, the few private transactions reported and the Emissions Exchange allowance price index (EX in Figure 3) seemed to support this view, though they pointed to prices in the \$150-200 range rather than the \$250-300 range. EPA's second auction, in March 1994, cleared at \$150 for vintage 1995 allowances, still noticeably below the EX price. Soon thereafter, however, the EX price fell to match the auction price, and the EX series was validated by price series published by Fieldston (EATX) and Cantor Fitzgerald (CF), two other market-makers. The March auction results in 1995, 1996, and 1997 are virtually identical to the contemporaneous private market prices reflected in these three series.

The March 1993 auction was a much better predictor of prices during 1995 than roughly contemporaneous transactions in the emerging (but still thin) private market. Some contemporary critics suggested that prices in that first auction were biased downward, but, with the benefit of hindsight, it appears more likely that prices outside the auction had been inflated by earlier projections of high Phase I allowance prices. The early auctions suggested, correctly as it turned out, that those projections were too high.

Figures on trading volume also suggest the emergence of an efficient allowance market, obeying the law of one price, around the middle of 1994. We estimate that 130,000 allowances had been traded on the private market by the end of March 1993, and an additional 226,000 traded in the April 1993 – March 1994 period.¹⁷ Private market volumes for the next three April – March years were sharply higher: 1.6 million, 4.9 million, and 5.1 million allowances,

respectively. (In contrast, volume in the annual EPA auction has never exceeded 300,000 allowances.)

There is no obvious standard against which to evaluate these volumes, of course. If Congress had allocated allowances perfectly so that setting emissions equal to allocations at each unit would serve to equate marginal costs, Title IV could have produced cost minimization with no trades at all. The point here is simply that the *increase* in trading volume after mid-1994, a factor of almost 20 in two years, was substantial by any standard. It is also worth noting that this increase could not have occurred if the EPA had not implemented Title IV with the intent and effect of keeping transactions costs low – another departure from tradition.

Data from the EPA auctions add a final bit of support to the view that an efficient allowance market emerged as the Phase I compliance date approached. In the two auctions held in March 1993, average winning bids were 11.5 and 20.6 percent above the lowest winning bids, and many bids (offers to sell) were submitted at prices well below (above) this range. In the three auctions held in March 1994, however, the differences between average and marginal winning bids were between 5.7 and 6.4 percent. In the nine subsequent auctions through March 1997, no such difference exceeded 3.4 percent, and all but two were below 2.4 percent. These data are at least consistent with strong constraints on bidding being imposed by a well-developed private market that became established during 1994.¹⁸

When the 1990 CAAA was under consideration, opponents of the tradable allowance approach argued that a private market would not develop for SO₂ emissions from the heavily regulated electric power industry. They contended that publicity-shy utilities would be reluctant to buy “licenses to pollute” and that the state public utility commissions (PUCs) that regulated electric utilities would discourage the interstate trading necessary for the development

of an efficient allowance market.¹⁹ On the surface it is consistent with these fears that as of January 1996 only 15 state PUCs had explicitly addressed the regulatory treatment of allowance transfers by generic order or informal guideline. Interstate trading does not seem to have been deterred, however. By January 1996 allowances had been transferred across the borders of all 24 states with Phase I affected units and of 10 of the 23 states with only Phase II units.²⁰ Interviews with staff of all PUCs that had not addressed this issue indicate that the main reason guidance had not been issued was that no request for it had been received.

How Much Did It Cost?

Even though 445 electric generating units were subject to Phase I aggregate emissions limits in 1995, 132 units actually increased emissions relative to the counterfactual. These generally small increases were approximately balanced by small reductions made at a roughly equal number of other units. All the SO₂ emissions reductions in 1995 can thus be attributed to about 180 units in 70 plants. Because fuel data are available only at the plant level, our detailed analysis of compliance strategies and costs focused on the 206 Phase I units in those plants.

We find the total (annualized) cost of reducing emissions by 3.9 million tons (relative to the counterfactual) in 1995 to have been about \$726 million. This is \$210 per ton of emissions reductions involving positive cost and about \$187 per ton if emissions reduced at no cost (through switches to PRB coal) are included in the total. These per-ton abatement cost figures are at the low end of the range of earlier estimates, which varied from \$180 to \$307 per ton of emissions reduction for reductions between 3.1 and 4.4 million tons. We estimate emissions reduction through switching to have cost \$153 per ton on average, while scrubbing cost \$265 per ton on average. There was considerable variation around both these averages. Thus some

scrubbers may have been economic, while construction of others may have been driven mainly by incentives for scrubbing that were built into Title IV at the urging of legislators from states producing high-sulfur coal, political pressures on utilities in those states to scrub rather than switch away from in-state coal, and pressures from pro-scrubber environmentalists in some other states.

The observed per-ton cost of scrubbing in 1995 is substantially below earlier estimates. Our investigation indicates that this difference reflects unanticipated improvements in instrumentation and controls that reduce personnel requirements, innovative sludge removal techniques, and higher than expected utilization of scrubbed units (which reduces capital cost per ton of sulfur removed).

As Figure 2 suggests, there is no shortage of anecdotal evidence that utilities have made good use of the flexibility provided by Title IV, and it is natural to ask how much money this has saved. However, while there is a large literature comparing ideal market-based policies with actual command-and-control regimes,²¹ it is unclear what sort of command-and-control policy could most instructively be compared with actual performance under Title IV. We have estimated that Title IV saved on the order of 25-34 percent as compared to a regime with the same allocation of allowances to generating units but no ability to transfer allowances from one generating unit to another by trading or intra-company reallocation. This is a substantial dollar saving (on the order of \$225-375 million per year) but lower in percentage terms than most savings estimates in the literature just mentioned. Perhaps this is because, as we next discuss, Title IV did not produce an outcome in which long-run total cost was minimized.

Why Have Allowance Prices Been So Low?

As we noted earlier, much of the story in allowances markets through 1995 was the dawning realization that allowance prices for that year were going to be only around \$100, well under half of what had been expected at the start of the decade. The discussion just above rules out two explanations for this discrepancy.

On the one hand, opponents of the tradable emissions approach commonly attribute low allowance prices to some defect in allowance markets. As a matter of theory it is unclear why unspecified market defects should push prices down, and as a matter of fact our investigation reveals no significant sources of downward bias in prices. On the other hand, some supporters of this approach would be gratified if the difference between actual and expected allowance prices mainly reflected unanticipated innovations that greatly reduced compliance costs. While there was clearly some induced innovation,²² however, and average compliance cost per ton of emission reduction was at the low end of the range of earlier estimates, the difference between actual and expected compliance cost per ton is simply too small to account for the dramatic gap between actual and expected allowance prices.

There are three keys to explaining this gap. The first is that the current vintage allowance price at any point in time must equal short-run marginal abatement costs but can be below long-run marginal and/or average total costs. As noted above, during a period of allowance banking the spot allowance price must also equal the discounted value of expected post-banking long-run marginal compliance cost, plus the convenience yield of holding allowances. The second key point is that market participants seem to have substantially

underestimated the market penetration of low-sulfur PRB coal driven by rail rate declines after 1990 and its effect on premia for low-sulfur coal produced in the East and Midwest.

The third key point is that compliance decisions generally had to be made well before the start of 1995. In particular, decisions to build scrubbers required commitments in 1992-93, when information about allowances prices was highly imperfect. Most of the respondents to the MIT survey who had elected to scrub indicated that expectations of allowance prices in the \$300-400 range were “very important” in the choice of scrubbing. Other respondents identified substantial capacity for which they had reversed an initial decision to scrub; a third of these pointed to “low allowance prices” as a reason for reversal, and two-thirds pointed to a fall in low sulfur coal prices relative to scrubber costs. Though switching does not require as much advance planning as scrubbing, many utilities signed long-term contracts for low sulfur coal in the 1992-94 period at prices reflecting prevailing or expected premia for such coal.

The picture that emerges is one in which market participants underestimated the SO_2 emissions reductions that would be produced at zero or negative cost by switching to PRB coal and thus, until mid-1994 or so (see Figure 3) over-estimated allowance prices during at least the early part of Phase I. As a result, there was over-investment in scrubbers, and too many long-term contracts for low-sulfur coal were signed – some at very high prices. Once a scrubber is built, however, the decision to operate it or not turns on a comparison between the short-run marginal operating cost of using the scrubber to reduce emissions of sulfur by a ton, roughly \$65 per ton on average,²³ and the cost of the allowance that would need to be purchased if the scrubber were not run. Because of over-investment in compliance, the short-run marginal cost of abatement curve, which determines the relation between allowance prices and abatement volumes, was well below the long-run marginal cost curve during 1995. A short-run marginal

cost of abatement curve that is lower than it would be in long-run equilibrium is consistent with both unexpectedly low allowance prices in the short run and unexpectedly high allowance banking.²⁴

Three additional bits of evidence support this disequilibrium explanation. First, it was generally expected that the difference between the spot market prices of low- and high-sulfur coal in regions producing both types, the so-called sulfur premium, would rise because of the onset of Phase I. Nonetheless, the sulfur premium dropped by half in Central Appalachia at the start of 1995, making it consistent with an allowance price of about \$130, near the price range observed at that time. Second, even though total heat input to all electricity fossil-fueled generating units rose by 8.3 percent between 1993 and 1995, heat input rose by only 5.5 percent at Phase I units that had switched fuels. This is consistent with attempts to reduce utilization of units that had signed long-term contracts for low-sulfur coal at above-market prices. Finally, as noted above, along an efficient intertemporal emissions path with banking in Phase I, one would expect allowance prices to rise and, with non-decreasing marginal abatement cost, unit-specific emissions to be non-increasing. Nonetheless, emissions from Table A units appear to have increased by about 7 percent in 1996, consistent with attempts to move toward an efficient time-path of emissions but not with movement along such a time-path.

What Have We Learned?

Economists have argued for decades that, where it can be used, the tradable permit approach is superior in theory to command-and-control environmental regulation.²⁵ The US acid rain program appears to prove this argument correct in practice. Not only did Title IV more than achieve the SO₂ emissions goal established for Phase I, it did so on time, without

extensive litigation, and at costs lower than had been projected. Even though some of the credit for all this must be attributed to increases in the use of low-sulfur PRB coal driven by declines in rail rates, it is important to note that few, if any, command-and-control environmental programs have ever succeeded on all these dimensions.

Viewing the acid rain program as a more general experiment in environmental policy, it is too early to claim that we have learned all the lessons it will eventually teach us. While we have observed the creation of workable allowance markets over a period of several years, we have only completed analysis of one year's data on compliance strategies and costs. Still, we believe several important lessons follow from our experience to date with Title IV.

First, we have learned that large-scale tradable permit programs can work roughly as the textbooks describe. That is, they can both guarantee emissions reductions and allow profit-seeking emitters to reduce total compliance cost. Some environmentalists seem to have learned this lesson too well and have come to regard the tradable permit approach as a magic tool that can solve any environmental problem, including global climate change, at negligible cost. Our analysis does not support such a view, however. It suggests that, like other real markets, tradable permit programs cannot be expected to achieve textbook perfection or guaranteed to produce breakthrough innovations.²⁶

Second, one can expect a tradable permit program both to produce surprises and to adapt reasonably efficiently to surprises produced elsewhere in the economy. The more flexibility an environmental program allows, the more surprises clever behavior will produce.

The ceiling on total emissions in a tradable emissions program eliminates (or at least minimizes) the environmental harm such cleverness can cause. On the other hand, any long-lived policy must adapt to surprise events: the big surprise here was the rapid expansion of the

market area of Powder River Basin coal. The Title IV program did not adapt perfectly to this surprise, since delayed recognition of its extent apparently led to over-investment and excess abatement. But the market did react to the information contained in allowance prices, and orders for scrubbers were canceled. The banking provision then ensured that emissions reductions that were cheap ex post were made, even though they were not required by the statute. It is hard to imagine any command-and-control regime adapting as sensibly to such an important exogenous event, particularly since such programs generally lack any incentives for information production or dissemination.

Third, efficient, competitive markets for tradable allowances can develop, though the speed of development may be sensitive to some elements of program design. In particular, the allowance auctions that the EPA was required to conduct have facilitated both the price discovery process and the development of the allowance market. Larger, better-designed auctions might have done better, or perhaps the allowance market could not have emerged before compliance became a near-term issue no matter how the auctions were structured. Only experience with other new programs will help to resolve this point.

When we discuss among ourselves how to present the lessons of Title IV, we use the metaphor of a glass that is both half full and half empty. The Title IV experience to date has demonstrated that the tradable permit approach is a very valuable policy tool that has proven itself superior to traditional methods for dealing with acid rain. On the other hand, real markets do not perform with the frictionless perfection of those in textbooks, particularly when they must guide long-lived investments made under uncertainty. The tradable permit approach is not a panacea or even necessarily the best approach to most environmental problems.

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Notes

Headnote: ■ Richard Schmalensee is Gordon Y Billard Professor of Economics and Management; Paul L. Joskow is Elizabeth and James Killian Professor of Economics and Management; A. Denny Ellerman is Senior Lecturer in the Sloan School of Management; and Elizabeth M. Bailey is a doctoral candidate in the Department of Economics; all at the Massachusetts Institute of Technology, Cambridge, Massachusetts. Juan-Pablo Montero is Professor of Industrial Engineering at the Catholic University of Chile, Santiago. Schmalensee and Joskow are also Research Associates of the National Bureau of Economic Research, Cambridge, Massachusetts. The authors' email addresses are rschmal@mit.edu, [pj Joskow@mitvma.mit.edu](mailto:pjoskow@mitvma.mit.edu), ellerman@mit.edu, jpmonte@ing.puc.cl, and embailey@mit.edu, respectively. Richard Schmalensee helped design the sulfur dioxide trading program as a Member of the Council of Economic Advisers in the Bush Administration; Paul L. Joskow was a member of the Environmental Protection Agency's Acid Rain Advisory Committee, which helped design the regulations that implemented that program.

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Footnotes:

¹ For discussions of earlier US experience with emissions trading, see Hahn and Hester (1989a, 1989b) and National Economic Research Associates (1994, ch. 2). There is very little experience with this approach outside the US.

² See generally IPCC (1996).

³ As the term is used here, an electric generating *unit* is a combustion device (boiler or turbine) used to power one or more electric generators. A typical generating *plant* houses several generating units, which may be of different vintages, scales, or types. Our work relies heavily on the EPA's National Allowance Data Base (NADB), Supplemental Data File (SDF), Allowance Tracking System (ATS), and Emissions Tracking System (ETS). In addition, we have relied on the trade press, earlier studies of compliance by the Electric Power Research Institute (EPRI), a mail survey of affected utilities (replies covered 37% of affected capacity in Phase I), and many telephone interviews with personnel from government agencies, electric utilities, and participants in allowance markets.

⁴ It was not intended that owners of Table A units be able to meet their emission reduction obligations in Phase I simply by reducing generation from those units. If generation at a Table A unit were reduced significantly, one or more non-Table A units had to be brought under Phase I regulation to compensate, and increased generation at those units had to offset the reduction at the Table A unit. Since generation at Table A units increased substantially in 1995, this provision was not of much importance.

⁵ Permitting allowances to be traded freely anywhere in the US would be a first-best policy if and only if emissions everywhere in the US had the same marginal damages, but they plainly do not. Unrestricted trading would be a reasonable second-best response to worries that the allowance market

would otherwise be too thin, however, if marginal abatement costs are inversely correlated with marginal damages. In this case emissions reductions will tend to be made in the “right” places in equilibrium. It seems likely that this condition is satisfied in this case, though we have seen no formal analysis.

⁶ Most published reports failed to point out that arbitrage conditions rule out a predictable upward jump in allowance prices at the start of Phase II.

⁷ The origins and political economy of this program are discussed in more detail in Joskow and Schmalensee (forthcoming) and in Stavins (this issue).

⁸ Calculated by the authors from EPA’s National Allowance Data Base.

⁹ Joskow and Schmalensee (forthcoming) analyze these rules in detail.

¹⁰ See Ellerman and Montero (1996)

¹¹ In no state did Phase I affected units produce emissions in excess of the allowances they were issued.

¹² See, e.g., Williams and Wright (1991).

¹³ In contrast, a much-discussed provision aimed at inducing non-utility sources of SO₂ emissions to “opt-in” to the acid rain program had produced only two volunteers by March 1997. See Atkeson (1997) for a discussion.

¹⁴ This paragraph is based primarily on Montero (1997); alternative estimates are from Ellerman et al (1997). The assertion that opt-ins by electric utility generating units were primarily driven by factors other than abatement cost differences is supported by the fact that over half the units that volunteered for Phase I regulation in 1995 opted out of Phase I for 1996, while other units volunteered for the first time in 1996. [correct??]

¹⁵ The ratio of 1995 heat input to 1993 heat input varied relatively little across Phase I units but did tend to be higher than average for scrubbed units. This pattern casts some doubt on the implicit assumption that 1995 heat inputs were not affected by Title IV. We considered an alternative counterfactual that avoids this problem (using heat inputs proportional to 1993 inputs and scaled up to match the 1995 total) and obtained results qualitatively similar to those reported in the text.

¹⁶ That is allowances that can be used to offset current emissions: vintage 1995 allowances in 1995, vintage 1995 or 1996 allowances in 1996, and so on. This section is based on Joskow, Schmalensee, and Bailey (1997).

¹⁷ EPA's Allowance Tracking System (ATS) was used to identify all transfers of allowances between accounts recorded in the periods indicated. To obtain the trading volume figures in this paragraph, we excluded intra-utility transfers (including intra-holding-company transfers). Our estimates understate private market activity by excluding unrecorded allowance transfers, unexercised options, and trading in allowance futures, all of which seem to have risen over time, particularly during and after 1995.

¹⁸ Joskow, Schmalensee, and Bailey (1997) discuss the criticisms of the design of this auction that have been advanced by Cason (1993, 1995), and Cason and Plott (1996). Two points are particularly important. First, the critics model the EPA auction as involving purely private values, thus completely ignoring the robust private market that has served since around mid-1994 to provide a common value for allowances. Second, the critics' main theoretical argument is that utilities that voluntarily offer to sell allowances on the EPA auctions have incentives to understate their reservation prices. In fact, most offers to sell have involved reservation prices well above market-clearing levels, and only a trivial number of voluntarily-offered allowances have been sold on the EPA auctions.

¹⁹ This paragraph is based on Bailey (1996).

²⁰ Alaska and Hawaii are exempt from this program, and Idaho has no fossil-fuel electricity generation.

²¹ See Oates, Portney and McGartland (1989), and Tietenberg (1985, ch. 3; 1992, p. 403).

²² In addition to the advances in scrubber technology noted above, it should be mentioned that the penetration of PRB coal would not have been as great had ways not been found to adapt midwestern boilers to blends of local (bituminous) and PRB (sub-bituminous) coals. Such adaptation was under way prior to 1990, but it may well have been accelerated by the passage of Title IV.

²³ There is considerable variation around this figure. Short-run marginal abatement costs of unscrubbed units are determined by the relative prices and availabilities of coals with different sulfur content and by contractual terms that may limit flexibility.

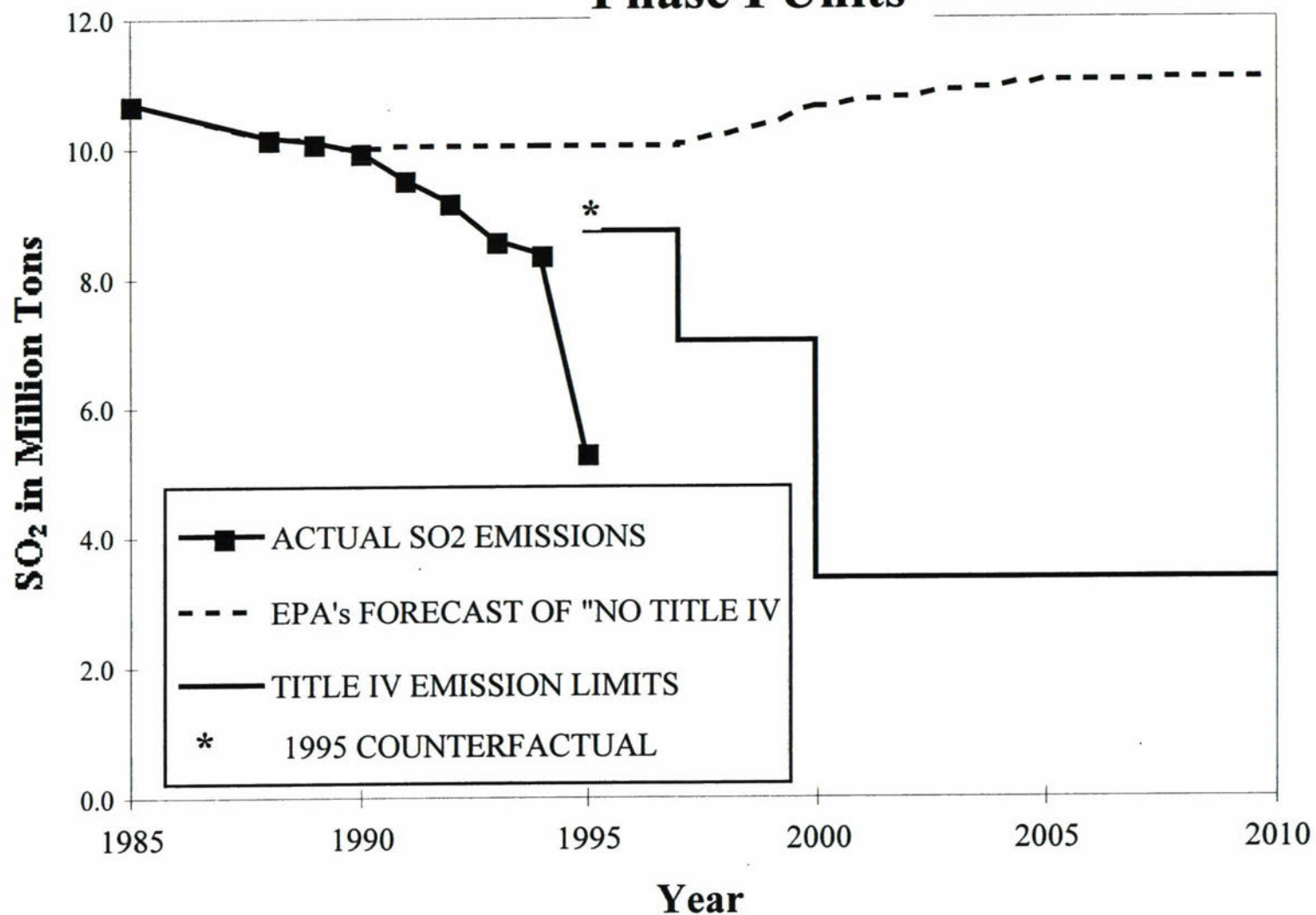
²⁴ This pattern is at least qualitatively consistent with intertemporal equilibrium as well: more banking today postpones the date at which the bank is exhausted (T^* above) and thus reduces the present value of expected marginal abatement cost at that date.

²⁵ See, generally, Tietenberg (1985). One could not use a tradable permit approach of the sort described here, for instance, to deal with an isolated source of toxic emissions with only local effects.

²⁶ There are a variety of reasons why one must be particularly careful about attempting to make inferences from experience with Title IV about the value of the tradable permit approach in the climate change context; these include issues of monitoring and enforcement. See, for instance, Schmalensee (1996).

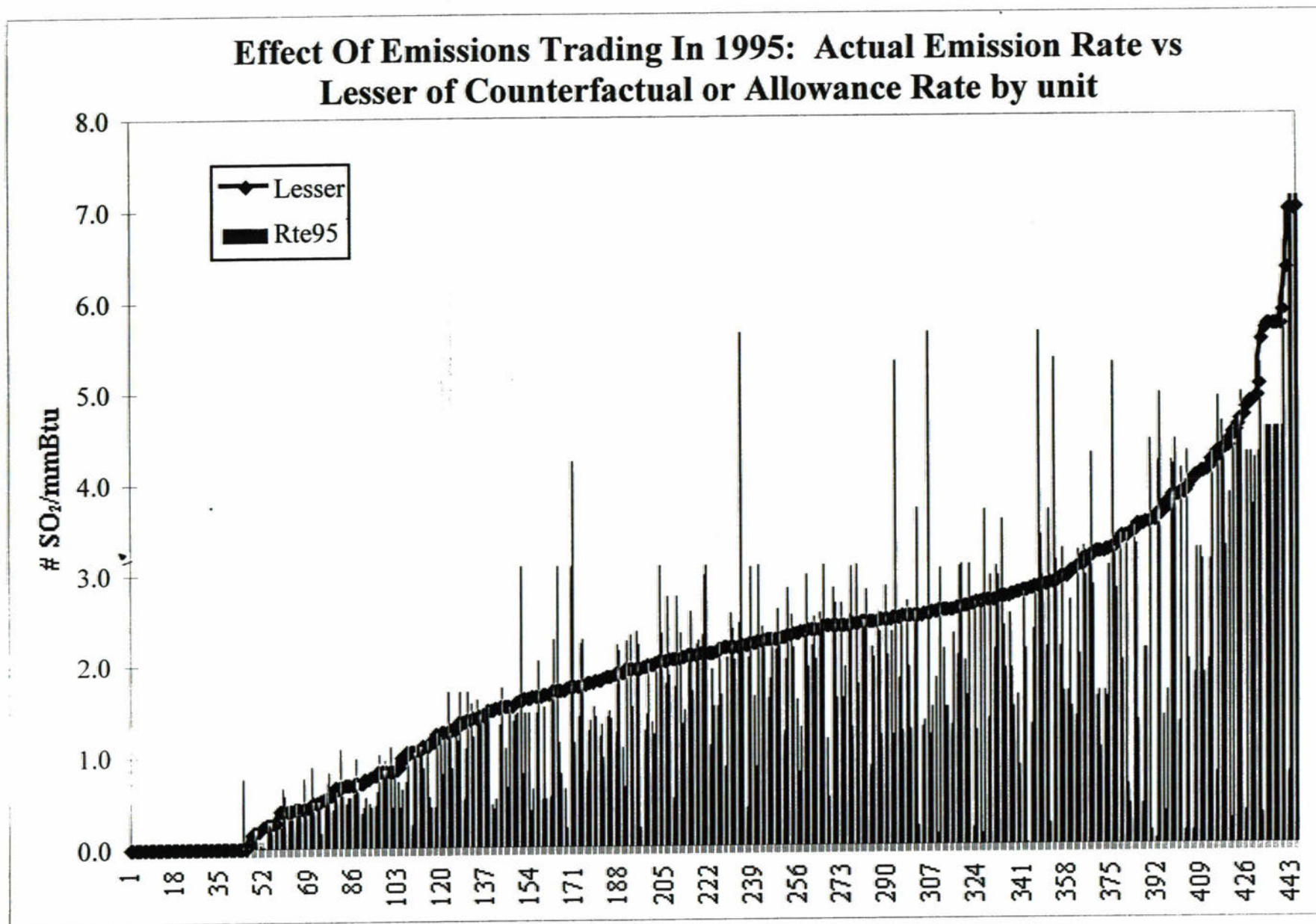
Figure 1

SO₂ Emissions, Caps and Forecast Phase I Units



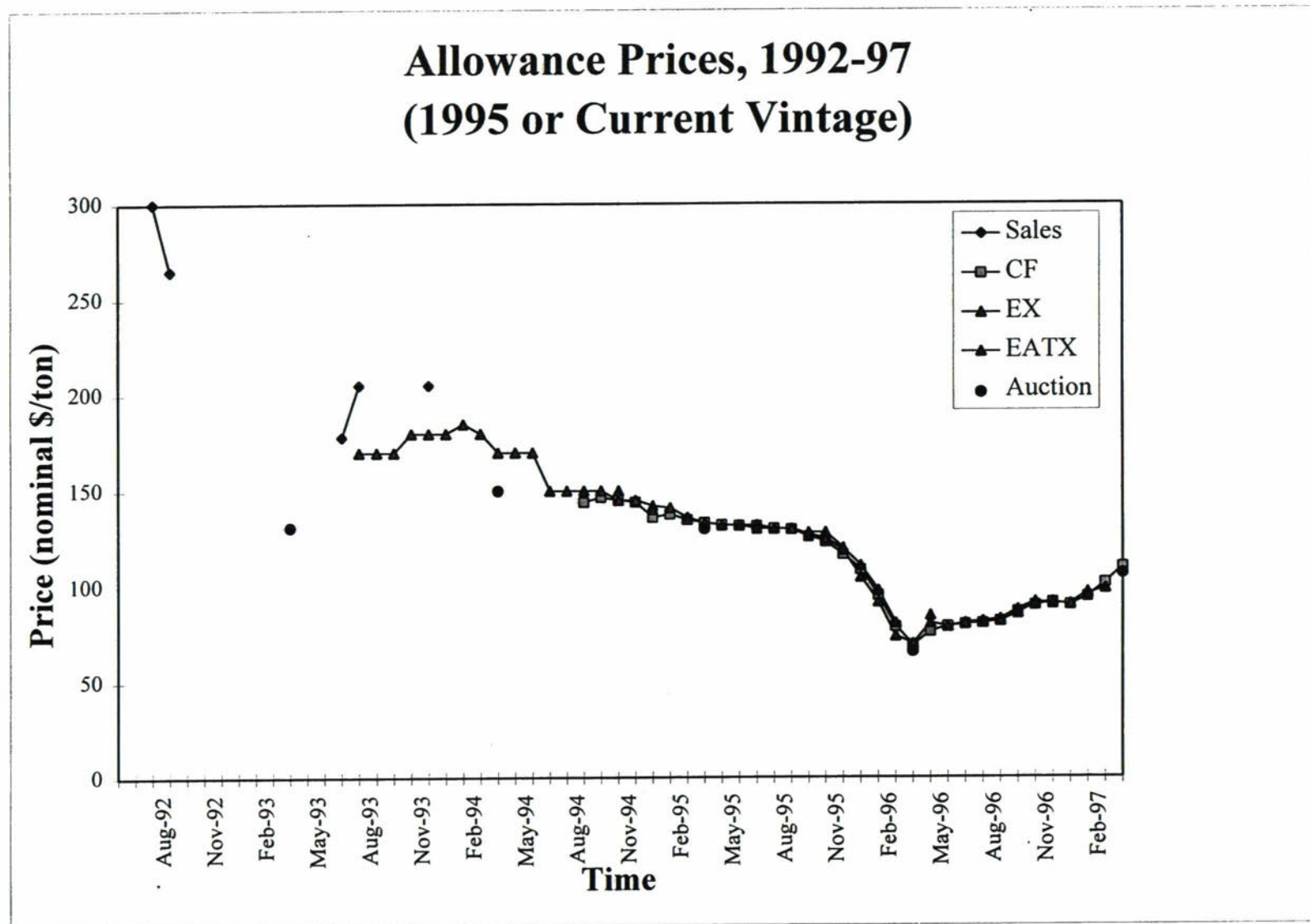
Source: Derived from Pechan (1995), EPA's ETS and ATS, and EPA (1996b).

Figure 2



Source: Derived from Pechan (1995), EPA's ETS, and EPA (1996b).

Figure 3



Source: Allowance Price Indications. 1993-97* Cantor Fitzgerald Environmental Brokerage, NY, NY.
Compliance Strategy Review. 1992-97* Fieldston, Washington, DC.
Exchange Value. 1993-97* Emission Exchange Corp. Escandido, CA.
*Selected Issues

**EMISSIONS TRADING
UNDER THE U.S.
ACID RAIN PROGRAM**

EVALUATION OF
COMPLIANCE COSTS
AND
ALLOWANCE MARKET
PERFORMANCE

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**CENTER FOR ENERGY AND
ENVIRONMENTAL POLICY
RESEARCH**

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
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CONTENTS

I.	Executive Summary	Page 5
II.	Introduction to Title IV	Page 9
	A. Significance of the Program	
	B. Specific Requirements	
III.	Reduction of SO₂ Emissions Through 1995	Page 14
	A. Pre-Phase I Reduction in Emissions	
	B. Counterfactual Emissions	
	C. The 1995 Reduction in Emissions	
IV.	SO₂ Emissions Trading Under Title IV	Page 24
	A. Development of the Allowance Market	
	B. Use of Allowances by Electric Utilities	
V.	Cost of Compliance With Title IV	Page 38
	A. Total and Average Costs of Compliance	
	B. Cost and Performance of Scrubbers	
	C. Other Compliance Costs: CEMS	
VI.	Why Allowance Prices Are So Low	Page 48
VII.	Cost Savings From Emissions Trading	Page 54
VIII.	Concluding Observations	Page 64
	Appendix:	Page 69
	Methodology of Cost Estimation	
	References	Page 74

EXECUTIVE SUMMARY

Title IV of the 1990 Clean Air Act Amendments introduced the world's first large-scale, public policy experiment in the use of tradable permits to achieve an environmental goal. Title IV, sometimes known as the U.S. Acid Rain Program, mandates that electric utility sources achieve a 50% reduction from their 1980 levels of acid-rain precursor emissions—both sulfur dioxide (SO₂) and nitrogen oxides (NO_x). The major part of the reduction, which concerns SO₂, is to be achieved entirely by marketable emission permits. The initial limitation of SO₂ emissions took effect in 1995, when major generating units with relatively high emission levels were issued permits, or "allowances," requiring an intermediate aggregate reduction of emissions during a five-year "Phase I" period. The full reduction will be implemented in Phase II: in the year 2000, all electricity-generating units will be issued allowances limiting SO₂ emissions nationally to about 9 million tons—roughly 50% of their 1980 emissions.

This "cap and trade" approach to emissions control establishes an aggregate emissions limit, distributes to individual sources a number of permits equal to this limit according to certain criteria, and allows individual sources to trade permits with other parties or to bank unused permits for later use. No further emission or technology requirements are imposed; sources are required only to have a valid permit for each ton of SO₂ emitted.

The year Title IV took effect was marked by significant overcompliance. A total 8.70 million allowances were issued to 72 operating utilities to cover emissions at 445 electricity-generating units having a total capacity of 130 GW^e. These units had emitted 10.68 million tons of SO₂ in 1985; their 1995 emissions, however, were only 5.30 million tons—about 3.9 million less than would have been expected without Title IV, and 3.4 million below the "cap." The 1995 emissions reduction is the more remarkable in that the cap required only a slight reduction beyond that achieved through 1994, because emissions had already declined significantly prior to 1995—largely due to railroad deregulation's effects on the competitiveness of western low-sulfur coal in the Midwest, where local high-sulfur coal had traditionally been used. The 1995 reduction in SO₂ emissions was achieved about equally by retrofitting equipment (*e.g.*, installing "scrubbers") to desulfurize flue gas, and by switching to lower-sulfur coal. Despite fears that "hot

spots" would result from emissions permit trading, significant 1995 emissions reductions occurred in the upper Ohio River Valley, where emissions from high-sulfur coal use have caused particular concern.

A viable market for allowances has developed, despite considerable early doubt, providing current information on the value of additional abatement as well as more opportunities to reduce compliance costs. In the first years after allowances were issued, few allowances were traded outside of a mandated EPA auction; in 1994, however, the volume of private trades increased notably, and various indicators of market price converged to a relatively tight range of values for allowances. Furthermore, derivative instruments—options, swaps, forwards, and futures—have emerged and are being used increasingly.

As this private market for allowances has developed, the mandated EPA auction has receded in importance from its original roles of providing early, transparent indicators of allowances' market value and stimulating the development of a functioning allowance market.

Electric utilities' use of allowances also does not appear to have been restricted significantly by state regulations. Allowances were transferred in all 24 states containing Phase I-affected units, as well as in ten of the 23 states that have only Phase II-affected units.

The total cost of achieving the 3.9-million-ton reduction in SO₂ emissions in 1995 was at the lower bound of earlier predictions. We estimate the appropriately annualized total cost to have been approximately \$725 million, in 1995 dollars—an average total cost of \$187 or \$210 per ton of SO₂ removed, depending on whether 425,000 tons of apparently costless emissions reductions are included. Earlier studies of compliance costs for Title IV predicted an early Phase I emissions reduction of 3.1–4.4 million tons, at an average total cost ranging from \$180 to \$307 per ton of SO₂ removed.

On a total-cost basis, scrubbing (though its cost has been much lower than predicted) has proved to be a more expensive means of compliance than switching fuel. On average, retrofitted scrubbers achieved emissions reductions in 1995 at an average cost of \$265/ton SO₂, compared to \$153/ton for fuel switching—in marked contrast to earlier studies that estimated average total costs for scrubbing to be \$450–500/ton. Most of the difference between predicted and actual scrubbing costs has been due to lower-than-predicted operating costs and to greater-than-expected utilization rates of scrubbers that spread the initial fixed cost over more tons of SO₂ removed.

While the average total cost of achieving Title IV's mandated reduction in SO₂ emissions has been at the low end of early estimates, the price of allowances, at about \$100 (equivalently, \$100 per ton of SO₂ removed), has been well below earlier predictions of Phase I allowance prices, which ranged from \$250 to \$400. The explanation for this disparity is two-fold: first, the price of allowances reflects short-run, marginal cost—not necessarily long-run, average total emission control cost; and, second, mistaken expectations concerning the value of allowances led to overinvestment in compliance during Phase I. Most decisions to invest in scrubbers were made early—before the first EPA auction, when expected allowance prices were well above the values that later materialized—or in response to explicit incentives in Title IV and state regulations to encourage such investment during Phase I. Though the total cost per ton for scrubbing is relatively high, the ongoing operating cost is low. Once an investment in scrubbers is made, the capital cost is sunk, and the only cost affecting operating decisions is the variable cost—which is generally below even the surprisingly low allowance prices. In addition, expectations of a run-up in low-sulfur coal prices led many utilities to contract early for low-sulfur coal, which resulted in an even larger current supply of allowances. The price that emerged in the allowance market reflected a short-run equilibrium of current supply of and demand for allowances (or, equivalently, the current value of additional abatement), given past investment in scrubbers and current contract commitments to low-sulfur coal. The 1995 prices are almost certainly below the long-run marginal cost of emissions control.

The promise of "emissions trading"—the reason it has been advocated as a means for achieving environmental goals—lies in the lower overall cost of compliance possible as participants with lower-cost emissions-reduction possibilities abate more to sell allowances to those who can avoid more costly emissions reductions by acquiring additional allowances. All earlier studies of Title IV compliance costs predicted significant cost savings from emissions trading, though judgments of how much trading would occur differed considerably. In actuality, 45% of allowances issued for 1995 were used in a manner that implied emissions trading either among units or through time. Additionally, cost-saving behavior is indicated by the extremely heterogeneous response of generating units to the new SO₂ emission requirements. Ninety-eight of the 445 affected units acquired a total of 540,000 additional allowances to cover emissions greater than would have been "permitted" by allowances issued to them. Another 200 units reduced emissions in 1995 more than required to meet their allowance issuance, in order to compensate for the 540,000 tons of emissions reductions avoided by the aforementioned 98 units, and to bank an additional 3.4 million allowances, which will defer for several years more expensive emissions reductions required in Phase II.

Cost-saving behavior is also indicated by the 50% decline in the premium paid for low-sulfur coals in the primary coal-producing region of Central Appalachia in early 1995. This premium fell because bundling higher-sulfur coal with allowances was cheaper than purchasing lower-sulfur coal at the premium prevailing prior to the onset of Phase I.

Estimation of 1995 cost savings from emissions trading is fraught with conceptual and empirical difficulties that prevent us from offering a firm figure. For one thing, the hypothetical alternative program from which savings are to be calculated is not obvious. Nevertheless, we believe cost savings have been achieved relative to plausible alternatives, as uniformly predicted by earlier studies, although those savings are probably less than would be implied by simple extrapolation of the earlier predictions. Our rough estimate of the cost savings attributable to emissions trading in 1995 lies between \$225 and \$375 million, in current dollars, which implies that the cost of compliance with Title IV would have been one-third to one-half again as costly had electric utilities simply reduced emissions without taking advantage of the emissions-trading provisions.

Definitive conclusions cannot be drawn from one year's experience, but a few tentative findings do emerge. In particular, Title IV—while holding its share of surprises—has demonstrated that large-scale emissions-trading programs can work more or less as described in textbooks, without offsetting environmental costs. Judging from 1995 results, utilities did take advantage of the cost-saving flexibility provided by emissions trading—to a surprising extent, given the conservative nature of the electric utility industry and uniformly low expectations for emissions trading among analysts. Experience with Title IV has also shown that efficient, competitive private markets for tradable permits can develop. As in any real-life program, some features of program design by public parties and of implementation by private parties could, in retrospect, have been done better, though these defects have proved to be more the exception than the rule. All in all, this market-based alternative to conventional command-and-control approaches to environmental regulation has offered a refreshingly positive experience. That being said, it bears emphasizing that neither textbook perfection in market performance nor major technological breakthroughs in the cost of controlling SO₂ emissions have yet been achieved. Nor should they be expected. While experience with Title IV supports the contention that market-based approaches to environmental regulation cost less than approaches which ignore markets, it does not obviate the necessity of carefully weighing the benefits against the still positive, albeit lower, costs of the environmental goal to be achieved.

INTRODUCTION TO TITLE IV

A. Significance of the Program

Title IV of the 1990 Clean Air Act Amendments (1990 CAAA), also known as the U.S. Acid Rain Program, mandated a 10-million-ton (or 50%) reduction from 1980 levels of acid-rain precursor emissions from electric utilities. Although both sulfur dioxide (SO₂) and nitrogen oxide (NO_x) emissions are affected by Title IV, the major part of the reduction concerns SO₂, abatement of which is being achieved entirely by fully tradable emission permits, or "allowances."¹ As such, the reduction of SO₂ emissions under Title IV is the world's first large-scale application of these market-based instruments in a public policy to achieve an environmental goal.

The basic approach to emissions control in Title IV is simple: an aggregate annual cap on national SO₂ emissions defines the number of emission allowances available for allocation to electricity-generating units each year. To emit SO₂ legally during a given year, an affected unit (*i.e.*, one subject to Title IV's SO₂ constraint) must have enough allowances valid for use that year to cover all its emissions. Title IV also requires each affected generating unit to have a continuous emissions-monitoring system (CEMS) on each exhaust stack, or flue, to measure actual SO₂ emissions, and report those emissions to the Environmental Protection Agency (EPA). At the end of the year, each source must have enough allowances in an account maintained by the EPA to cover all its recorded emissions, or be subject to significant penalties.

Allowances are fully tradable: utilities may acquire additional allowances by purchase or transfer to "cover" emissions in excess of their units' allocations in a given year ("spatial trading"). Alternatively, utilities may reduce emissions to less than the allowance allocation to some units in order to sell the unused allowances, or transfer them to other units for use that year, or it may "bank" the

¹ The NO_x part of Title IV, which does not become effective until the beginning of 1996, permits only limited intra-utility trading among sources.

allowances for future use. Utilities cannot, however, "borrow" from future allocations to cover current emissions.

This emission-reduction and trading program marks a fundamental departure from the regulatory framework that has governed SO₂ emissions since the early 1970s. The first significant federal air-pollution legislation, the 1970 Clean Air Act Amendments, led to source-specific emission *rate* limitations on existing plants and the imposition of a *uniform rate* limitation on emissions from all new sources (*i.e.*, units). The 1977 Amendments altered this uniform new source performance standard (NSPS) by requiring a "percent reduction" that effectively mandated flue gas desulfurization—"scrubbing"—even if a new unit could meet the 1970 NSPS rate limit of 1.2 lb SO₂ per million Btus of heat input (hereafter #/mmBtu) without scrubbing. The regulatory framework governing SO₂ emissions prior to 1990 is generally described as "command-and-control": air pollution regulation focused on *individual* sources, their emission *rates*, and the application of specific *control technologies* to sources with certain attributes. In contrast, Title IV mandates no technology, offering electric utilities instead the flexibility to choose whether and how to reduce emissions at any specific source.² Unlike the earlier regulatory structure, Title IV places an absolute limit on *aggregate* national SO₂ emissions only. Individual sources' flexibility in compliance arises from the tradability of emissions permits: sources for which reduction would be most costly can essentially pay other sources that can reduce emissions less expensively, to do so on their behalf. The result is lower-cost achievement of the environmental objective.³

² The emission rate constraints imposed by earlier legislation and regulation remain in effect, so that sources are free to adjust emission rates only within what is permitted by the applicable State Implementation Plan. In practice, emission rates for many sources have been well below these limits.

³ A simple example illustrates the benefits of a tradable permit program. Imagine a world with two generating plants, and suppose the environmental goal is to reduce SO₂ emissions by two tons from current levels. Plant 1 can reduce SO₂ emissions at a cost of \$25 per ton. Plant 2 can do so at a cost of \$100 per ton. One command-and-control approach to achieving the goal would be to mandate that each plant reduce emissions by one ton—at a cost of \$25 for Plant 1 and \$100 for Plant 2 (total cost \$125). The tradable permits approach is to issue each plant allowances equal to the plant's current emissions minus one ton. If Plant 1 can sell an allowance to Plant 2 for \$30, Plant 1 has incentive to make an additional one-

ton reduction and sell Plant 2 the unused allowance, generating for Plant 1 a \$5 profit (cost to reduce for Plant 1 = \$25; revenue from selling an allowance to Plant 2 = \$30). Plant 2 is happy to purchase an allowance from Plant 1 for \$30 because it would cost Plant 2 \$100 to reduce one ton itself. The cost of this approach is \$20 for Plant 1 (($\25×2) - \$30) and \$30 for Plant 2, for a total cost of \$50. With tradable permits, each plant is better off than under command-and-control (Plant 1: \$20 < \$25; Plant 2: \$30 < \$100) and total costs are lower (\$50 < \$125).

⁴ Several electric utilities responded to our questionnaire, representing 37% of the aggregate affected capacity in Phase I, or 42% of aggregate 1990 SO₂ emissions from affected units. These and a few other utilities provided additional information by phone, enabling us to contrast and complement publicly available data to obtain a more reliable appraisal of actual compliance.

This report evaluates the effectiveness and cost of Title IV in 1995, the year these provisions became binding. The underlying research was funded by the National Acid Precitation Assessment Program in support of its Quadrennial Report to Congress, as required by the 1990 CAAA, and was conducted by the Center for Energy and Environmental Policy Research (CEEPR) at the Massachusetts Institute of Technology. This report serves as a summary only; discussions of the theory and methodology, detailed data, and supporting econometric work can be found as published in CEEPR working papers (referenced herein), more of which are forthcoming.

In contrast to earlier studies of compliance with Title IV, this report has the advantage of hindsight. The focus here is on what actually happened in 1995, using data now available concerning emissions, investments in compliance, and fuel deliveries at affected units. While data on emissions and fuel deliveries are publicly available, information on investment cost is contained mostly in trade-press reports, particularly from earlier compliance studies by the Electric Power Research Institute (EPRI). To supplement such readily available data, CEEPR conducted a survey of affected electric utilities, for which confidentiality of individual responses was promised, concerning compliance actions, costs, and emissions trading in 1995.⁴ We have also benefited significantly from innumerable discussions and comments from those most involved in Title IV compliance, at electric utilities, allowance trading firms, and U.S. government agencies.⁵

B. Specific Requirements

A tradable permits program involves specification of an emissions ceiling, the issuance of permits ("allowances") for emissions that are *de facto* property rights, and the ability to trade these allowances.⁶ In Title IV, the emissions ceiling, or cap, applies to SO₂ emissions from electric generating plants in the 48 contigu-

⁵ The list of those to whom we are indebted is too long to cite in its entirety, but certain institutions deserve special mention. Our report would not have been possible without the data and background unstintingly provided by the Acid Rain Division of the Environmental Protection Agency and the Energy Information Administration of the Department of Energy. Cantor Fitzgerald Environmental Brokerage Services provided a continual stream of information and replies to questions on allowance pricing and transactions.

The electric utilities which responded to our questionnaire greatly assisted our interpretation of publicly available data. Finally, we are indebted to colleagues at Resources for the Future and the Electric Power Research Institute for stimulating and continuing exchanges of views on Title IV.

⁶ See Tietenberg (1985) for a complete analysis of emissions trading programs. For a more rigorous theoretical analysis, see Montgomery (1972).

ous United States, set at about 9 million tons per year, effective from the year 2000. This cap is to be achieved in two phases:

- During Phase I (1995–99), an intermediate aggregate limit on SO₂ emissions is placed on the 263 generating units listed in Table A of the legislation.⁷ These units, totaling 88 GW⁸ of electric-generating capacity, are located in 110 power plants owned by 61 operating utilities. They are targeted by the legislation because their emission rates in 1985 exceeded 2.5 #/mmBtu and their capacities exceeded 100 MW⁹.
- In Phase II, which begins in the year 2000, virtually all fossil-fuel-fired electric-generating units will be included under the final 9-million-ton national cap on aggregate annual utility SO₂ emissions.

The Phase I and Phase II caps are enforced through the annual issuance of tradable emission allowances, each of which permits the holder to emit one ton of SO₂ in the year issued or later.

A total of 8.69 million allowances were issued for emissions in 1995; 5.55 million of these are being allocated to the 263 Table A units every year of Phase I according to a basic formula by which each unit receives an amount equal to an emission rate of 2.5 #/mmBtu multiplied by the unit's average heat input during the baseline period, 1985–87.⁸ The remaining three million allowances issued for 1995 resulted from special legislative provisions for Phase I “extension” units (1.35 million allowances), “substitution” and “compensation” units (1.33 million allowances), an amount auctioned by the EPA annually (150,000), and 314,000 early-reduction credits for certain units.

The Phase I “extension” provisions offer 3.5 million additional allowances, total, throughout Phase I (roughly 1.3 million for each of 1995 and 1996, and 300,000 for each of the next three years) to utilities that propose to reduce emissions via flue gas desulfurization. These provisions, which offer an explicit incentive for scrubbing,⁹ provide extra allowances that effectively delay the onset of Phase I for Table A units retrofitted with a scrubber by January 1, 1997, ostensibly to cover the construction period for retrofitting. Extension allowances have been received by 12 of the 16 utilities (for 18 of the 26 generating units) retrofitted with scrubbers.

⁷ Table A of Title IV (see CAA §404(a)(1)) became Table 1 in the implementing regulations, and is sometimes referred to as such.

⁸ See Kete (1992) and Joskow and Schmalensee (1997) for a full discussion of permit allocation for Phases I and II, and the many departures

from the basic allocation rule, particularly in Phase II.

⁹ SO₂ emissions can alternatively be reduced by switching to a fuel with lower sulfur content—generally coal, but potentially also natural gas or petroleum products.

The "substitution" and "compensation" provisions provide further flexibility for meeting Phase I emission requirements by permitting electric utilities to substitute other units for those designated in Table A, or to reduce generation at Table A units below the baseline level:

- Under the *substitution* provision, an electric utility can nominate one or more non-Table A units to make reductions in lieu of a commonly owned or operated Table A unit. Those non-Table A units then receive allocations of allowances approximately equal to their respective historic emissions and, for all intents and purposes, become Phase I-affected units.
- Under the *compensation* provision, an electric utility can reduce emissions at a Table A unit by reducing electricity generation at that unit below its baseline levels: the source of any compensating generation must be designated, however, and, when that compensating unit is sulfur-emitting, an allocation of allowances is made to it based on its historical usage, so that it essentially becomes a Phase I-affected unit, as well.

The response to these special legislative provisions was substantial: 42 operating electric utilities used the voluntary compliance program to bring 182 Phase II units, representing 41.6 GW¹⁰ of power (47% more capacity), under Phase I requirements, almost all (175) as substitution units.¹⁰ In contrast, similar provisions under which industrial sources could voluntarily opt-in were little used because of the high transaction costs.¹¹

In Phase II, every fossil-fuel-generating unit exceeding 25 MW^e in electric-generating capacity will receive an allocation from 9.4 million allowances available annually from the year 2000 until 2009, and 8.95 million available annually thereafter. Phase II allowances will be issued according to a complex set of provisions based, generally, on multiplying an emission rate of 1.2 #/mmBtu by the unit's baseline (average 1985–87) heat input.

¹⁰ See Montero (1997a) for a thorough description and analysis of the effect of these provisions.

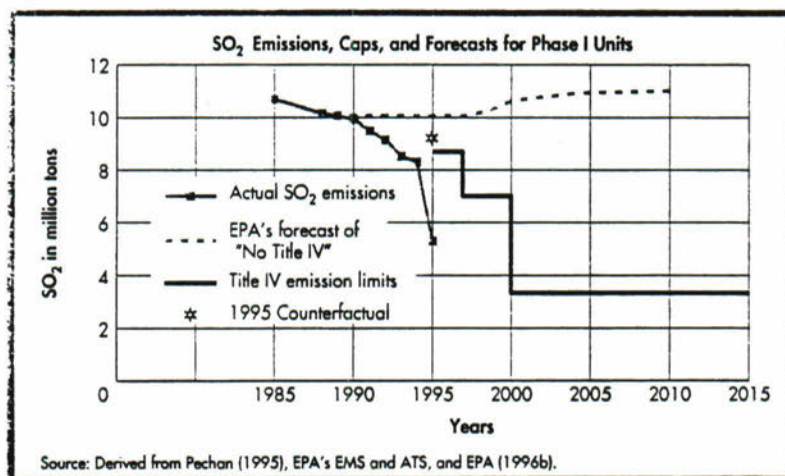
¹¹ Atkeson (1997) provides an analysis of the reasons for the low participation rate by industrial sources.

REDUCTION OF SO₂ EMISSIONS THROUGH 1995

The most significant fact about Title IV compliance in 1995 is the magnitude of *overcompliance*. The aggregate cap required that SO₂ emissions from Phase I-affected units be no greater than 8.7 million tons in 1995. In fact, emissions from those units that year totaled 5.3 million tons—3.4 million tons, or 40%, less than the aggregate limit.

The essential statistical details of compliance are presented in **Figure 1** and **Table 1**. Figure 1 compares actual aggregate emissions from all Phase I-affected units in 1995 and earlier years with the Title IV-mandated caps in 1995 and subsequent years, and with earlier expectations of emissions trends in the absence of Title IV.¹² More detailed statistics concerning emissions at Phase I-affected units are presented in Table 1, which further distinguishes between those units man-

Figure 1



¹² There exists no forecast from 1990 of emissions from what would become the 445 Phase I-affected units in 1995. The illustrative forecast in Figure 1 is obtained by scaling an earlier EPA

forecast (Pechan, 1995) for all electric utility generating sources to the proportion of emissions attributable to the 445 Phase I-affected units in 1990.

dated to be part of Phase I by Table A and those that voluntarily became subject to Phase I as a result of the substitution and compensation provisions. The sharp reduction of SO₂ emissions in 1995 to a level well below the newly instituted cap is not the only notable feature about SO₂ emission trends since the passage of Title IV in 1990. Sulfur dioxide emissions did not rise after 1990 as had been predicted at the time the legislation was passed. By 1993-94, SO₂ emissions from generating units that would become subject to the 1995 cap approximated that limit. While less dramatic than the drop in emissions during 1995, the still unex-

TABLE 1. STATISTICS OF PHASE I UNITS

Variables	Table A Units	Substitution Units ^a	Total Phase I
# Units	263	182	445
Total Capacity (MW)	88,007	41,643	129,650
Coal-Fired Units	257	154	411
Units with Scrubbers before 1990	1	25	26
Units with Title IV Scrubbers	26	0	26
Permanently Retired Units	7	6	13
Baseline Avg. 1985-87 (10 ¹² Btu)	4,365	1,740	6,105
Total Heat Input 1993 (10 ¹² Btu)	4,396	1,719	6,115
Total Heat Input 1995 (10 ¹² Btu)	4,708	1,932	6,640
SO ₂ Emissions 1985 (tons)	9.30	1.38	10.68
SO ₂ Emissions 1993 (tons)	7.58	0.97	8.55
SO ₂ Emissions 1995 (tons)	4.45	0.85	5.30
Average SO ₂ Rate 1985 (#/mmBtu)	4.24	1.58	3.48
Average SO ₂ Rate 1993 (#/mmBtu)	3.45	1.13	2.80
Average SO ₂ Rate 1995 (#/mmBtu)	1.89	0.88	1.60
Basic Allowances (10 ⁶)	5.55	0	-
Extension Allowances (10 ⁶)	1.35	0	-
Early Reduction Credits (10 ⁶)	0.31	0	-
Substitution and Compensating (10 ⁶)	0	1.33	-
Total 1995 Allowances (10 ⁶)	7.22	1.33	8.55
1995 Auction (10 ⁶)	-	-	0.15

^a Includes seven compensating units.

Source: Pechan (1995), EPA's Emissions Monitoring System (EMS) and Allowance Tracking System (ATS).

pected emissions reduction prior to the onset of Phase I raises the important question of whether it resulted from the Title IV enactment or from other independent factors.

*A. Pre-Phase I Reduction in Emissions*¹³

The pre-1995 reduction in SO₂ emissions is particularly interesting because few Table A units were required by other regulation to reduce emissions prior to 1995, and no cost-minimizing firm would be expected to incur the additional expense associated with such a reduction unless required to do so.¹⁴ Since SO₂ emissions from electric utilities had been declining throughout the 1980s despite rising coal use, it is possible this trend continued into the 1990s, though emission forecasts circa 1990 predicted otherwise. The pre-1995 reduction might also be explained by early compliance if regulated electric utilities were assured of cost recovery for the additional expenditures required by Title IV. In fact, this explanation is suggested by the fact that all SO₂ emissions reduction between 1990 and 1993¹⁵ occurred at Table A units; this statement, however, is equally valid for the reduction in emissions observed between 1985 and 1990—before Table A was created for the Title IV enactment. A distinct pattern is also observed in the geography of emissions reductions between 1985 and 1993: almost all occurred in midwestern power plants 600–1000 miles from a remarkable low-sulfur-coal-producing district, the Powder River Basin (PRB), located in the northeastern corner of Wyoming and adjacent counties of Montana. Most coal-fired power plants in this 600–1000-mile zone are Table A units. That similarly located non-Table A units also reduced emissions, while Table A units located further east did not, suggests that early compliance does not explain a significant amount of the pre-1995 emission decline.

The key to the real explanation for the phenomenon is the effect of railroad deregulation on access to this exceptional coal-producing province by midwestern

¹³ This section summarizes Ellerman and Montero (1996), to which the reader is referred for a more complete discussion.

¹⁴ Several states passed legislation requiring some form of early compliance, and a few units became subject to revisions in State Implementation Plan (SIP) limits; however, very little of the two-million-ton, pre-1995 reduction

observed at Table A units occurred in these states or in units subject to SIP revisions.

¹⁵ The year 1993 is a more appropriate reference point for gauging the pre-Phase I reduction than 1994 because fuel choice (and thus emissions) in 1994 were affected by preparations for compliance with Title IV.

utilities. Coal from the PRB enjoys the lowest production cost and lowest sulfur content of any coal in America: extraordinary geology permits the mining of coal with a sulfur content ranging from 0.5 to 1.2 #/mmBtu for less than \$0.25/mmBtu (equivalent to \$1.50 per barrel of crude oil). The astonishingly low cost and low sulfur content would be a winning combination except for geography: the northeastern corner of Wyoming offers little demand for coal, and the major potential markets lie far away. The cost of transporting PRB coals to major markets in the Midwest or Texas significantly erodes the mine-mouth cost advantage: the delivered coal price can be three to five times its mine-mouth price, depending on distance and transportation arrangements.

Railroad deregulation during the 1980s introduced competition into the haulage of coal from the PRB, and also led to significant productivity improvements in rail transportation. The result has been continually lower rail rates that have made distant western coals, primarily from the PRB, more competitive in midwestern markets solely on a Btu basis, without regard to the significant difference in sulfur content.¹⁶ As a result, the frontier for western, low-sulfur coals has advanced steadily eastward to the disadvantage of local, higher-sulfur midwestern coals. Long-term supply contracts signed in the 1970s and early 1980s have delayed the switch to PRB coals; however, as these contracts have expired and economics have become more compelling, the share of PRB coals in the Midwest has increased steadily. One consequence has been reduced SO₂ emissions as the economic frontier for lower-sulfur western coals has penetrated regions in which many Table A units are serendipitously located.

B. Counterfactual Emissions

Evaluation of the effect and cost of Title IV requires some estimate of what SO₂ emissions would have been in 1995 had Title IV never been passed. Such a reference point is called a "counterfactual"—a concept very different from actual emissions in some earlier year. For instance, SO₂ emissions from Phase I-affected units declined by 3.25 million tons in 1995 from the 1994 level, so this might be considered one measure of the emissions reduction that could be attributed to

¹⁶ The positive effects of railroad deregulation on costs and productivity are studied by Wilson (1997). The sharp decline of railroad coal transportation rates from PRB is reported in EIA (1995).

Title IV. Yet, demand for sulfur-emitting fuels to generate electricity increased between 1994 and 1995, so such a measure would understate the true magnitude of the emissions reduction effected by Title IV. Conversely, the effect of Title IV would be overstated to the extent that SO₂ emissions declined for other reasons, such as increased reliance on non- or lower-sulfur-emitting fuels, or because of other regulatory requirements. Clearly, if the reduction in emissions attributable to Title IV is to be measured properly, a reference level of emissions is needed that takes non-Title IV-related factors into account.

One reasonable, though imperfect, counterfactual estimate can be formed by summing the products of the 1993 emission rate and 1995 heat input for every Phase I-affected unit. The 1993 emission rate reflects changes in SO₂ emissions not related to Title IV, while the 1995 heat input reflects actual demand for SO₂-emitting fuels in 1995. In effect, this estimate assumes that 1) unit emission rates would not have changed between 1993 and 1995 in the absence of Title IV, and 2) Title IV did not affect unit-specific heat input. Under these assumptions, SO₂ emissions would have increased as a result of the increase in demand for coal-generated electricity. This estimate of the counterfactual is indicated in Figure 1 by the single star that lies 540,000 tons above the 1995 emissions limit.

As with any estimate, potential for error exists. This counterfactual may be a little high because it assumes no units would switch to PRB coals after 1993 for reasons unrelated to Title IV, such as contract expirations and continuing reductions in rail rates; it also errs on the low side, however, by ignoring that portion of the pre-Phase I emissions reduction in 1993 that can be attributed to Title IV.¹⁷ A detailed simulation model of the electric-utility and fuel-supply sectors might provide a better estimate of emissions without Title IV; lacking that, however, we believe the errors in this expedient but transparent approach offset one another.

The assumption that heat inputs at Phase I-affected units were not influenced by the onset of Phase I is another potentially serious source of error. Surprisingly, there does not appear to have been any shifting of load to units not affected by Phase I. The 8.57% aggregate increase in heat input at Phase I-affected units between 1993 and 1995 was comparable to the 8.29% increase during the same time period for all electricity-generating units (including those not yet subject to Title IV limits), and statistical tests of data at the unit level did not indicate a sig-

¹⁷ Ellerman and Montero (1996) estimate that about 20% of the pre-Phase I reduction is attributable to Title IV-related causes such as state acid rain laws and Clean Coal Technology projects that led to the early retrofitting of several Table A units.

nificant difference between the utilization of Phase I-affected units and others in 1995 as compared to 1993.¹⁸

A clear difference exists, however, between heat input at units subject to Title IV that employed scrubbers and those that switched fuels: heat input at the Table A "scrubbed" units was 21.5% greater in 1995 than in 1993—well above the corresponding 5.5% increase for "switched" units.¹⁹ The difference in heat input at scrubbed and nonscrubbed Phase I-affected units suggests that our estimation of counterfactual emissions could be incorrect, at least at the unit level, because Title IV appears to have influenced heat input among affected units, if not between affected and non-affected units. The most obvious alternative counterfactual assumption—that heat input would have increased in proportion with the 8.57% increase in heat input at all Phase I-affected units—is only 50,000 tons (0.5%) higher than the counterfactual we are using.

The reason scrubbed and unscrubbed units differed so markedly in their utilization during 1995 appears to be scrubbed units' lower *variable* cost of complying with Title IV. Unscrubbed units pay the cost of an allowance *and* the equivalent coal premium for lower sulfur content, while scrubbed units incur *only* the operating cost of scrubbing—which has been (and, we believe, always will be) lower than the cost of allowances. The differential impact of compliance with Title IV on utilization may also explain the absence of a shift in load dispatch to generating units not affected by Phase I. Units that could be expected to benefit from a shift in dispatch away from affected units are located in the same regions as the affected units, and, based on the criteria for selection of Table A units, these "non-Phase I-affected" units use lower-sulfur coal than Table A units have, historically. To the extent that the onset of Phase I created a premium for the lower-sulfur coal that non-Phase I-affected units burn, and that these units were prevented by state implementation plan (SIP) limits or locational costs from switching to cheaper, higher-sulfur coals, their fuel cost was increased by Title IV, and the relative merit of dispatching them diminished.

¹⁸ Utilization of Phase I-affected units was one question posed in the MIT/CEEPR questionnaire: the only responses given were "about the same" and "greater utilization."

¹⁹ This disparity is not the result of some peculiarity in the 1993 utilization of the comparatively

small number of units that were retrofitted with scrubbers for Phase I. Heat input to these 26 units in 1995 was 27% higher than average heat input at the same units for the years 1988–94, while the increase in 1995 heat input over the 1988–94 average for nonscrubbed Table A units was 3%.

C. The 1995 Reduction in Emissions

The aggregate emissions level attributable to Phase I-affected units in 1995 was 3.89 million tons less than the counterfactual for these units. This is more than the reduction in emissions observed between 1994 and 1995 due to the increase in aggregate heat input at these 445 units, but considerably less than would be indicated if the pre-Phase I reduction in emissions could be credited fully to Title IV. Whatever accounted for the pre-1995 reduction in emission rates, the 1995 reduction was significant and clearly attributable to Title IV.

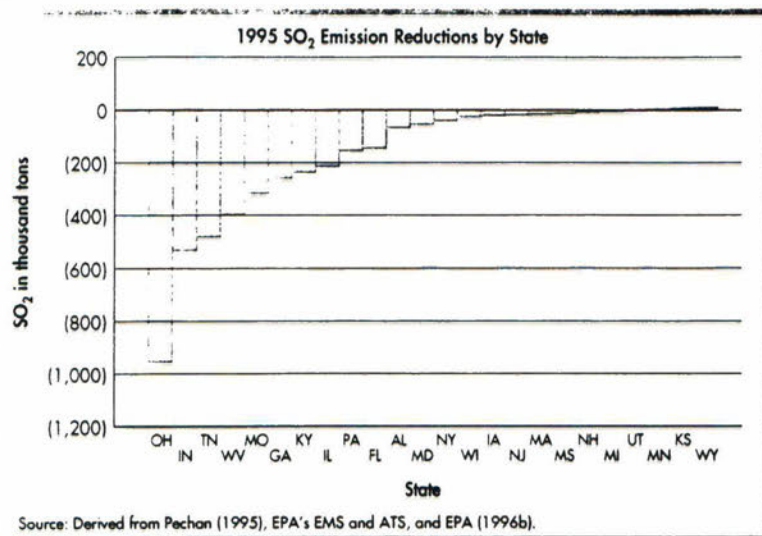
Much of the interest surrounding Title IV emissions reduction concerns the choice of abatement technique. Table 2 attributes the reduction in SO₂ emissions at Phase I-affected units to the method used: scrubbing or fuel switching. In cases where fuel was switched, the source of the lower-sulfur fuel is indicated. Sulfur dioxide emissions can also be reduced through improved heat rates, conservation measures, or shifts in load to lower-sulfur- or non-sulfur-emitting generating units. Our method for measuring the reduction in sulfur emissions would not capture the effects of improved heat rates and conservation measures; however, the compari-

TABLE 2. 1995 SO₂ REDUCTION AT PHASE I UNITS

Method/Region	Tons SO ₂ Removed (x10 ³)	% of Total
Scrubbing Total	1,754	45.1%
New Title IV scrubbers	1,734	44.6%
Other scrubbers	21	0.5%
Switching Total	2,133	54.9%
Northern Appalachia	205	5.3%
Central Appalachia	756	19.5%
Southern Appalachia	60	1.5%
Midwestern	406	10.4%
Powder River Basin	518	13.3%
Other western coal	146	3.8%
Imported coal	22	0.6%
Natural gas	20	0.5%
TOTAL	3,887	100.0%

Source: Derived from EPA Emissions Monitoring System (EMS), EPA (1996b), Pechan (1993 and 1995), Federal Energy Regulatory Commission (FERC) Form 423, and Fieldston (1994).

Figure 2



son of heat input at affected and nonaffected units suggests that these effects were negligible, as was load-shifting.

In aggregate, the 1995 emissions reduction was about evenly split between scrubbing and fuel switching, but the scrubbing contribution came from many fewer units. Only 26 of the 263 Table A units installed scrubbers, though these account for 45% of the total reduction.²⁰ Two-thirds of the contribution from these 26 units, or 1.14 million tons, came from only seven units, at three big plants: Cumberland, Gavin, and Harrison.²¹ These few units, totaling 7,200 MW^e, or slightly more than 5% of total affected capacity, account for almost a third of the 1995 emissions reduction from all sources throughout the country.

Powder River Basin coals continued to play an important role in reducing SO₂ emissions in 1995, but the main contribution to emissions reduction by fuel switching that year came from the bituminous coal-producing regions, particularly Central Appalachia. Notable among emissions reductions due to fuel switching is the contribution from units in the predominantly high-sulfur coal producing regions of the Midwest and North Appalachia that switched not to the 1.2 #/mmBtu coals available from such regions as Central Appalachia or the PRB,

²⁰ Twenty-five units with scrubbers installed to meet new source performance standards (NSPS) became subject to Phase I as a result of the substitution provisions; their contribution to emissions reduction was small, however.

²¹ These plants, located in Tennessee, Ohio, and West Virginia, are owned by the Tennessee Valley Authority, American Electric Power, and Allegheny Power, respectively.

TABLE 3. COAL DELIVERIES TO PHASE I PLANTS

(million short tons)			
Coal Region	1993	1995	Change
Appalachia	145.3	146.1	+ 0.8
<i>Northern</i>	78.0	72.3	- 5.7
<i>Central</i>	63.0	69.7	+ 6.7
<i>Southern</i>	4.2	4.1	- 0.1
Midwest	77.7	71.8	- 5.9
Powder River Basin	43.7	73.1	+ 29.4
Other western coal	15.5	20.4	+ 4.9
Imported coal	1.6	2.6	+ 1.0
TOTAL	283.8	314.0	+ 30.2

Source: Derived from FERC Form 423.

but rather to more local mid- or even high-sulfur coals that nevertheless contained less sulfur than the coal previously used.²²

Geographically, the reduction occasioned by Title IV concentrated in the heavy coal-burning states of the Midwest. Figure 2 shows 1995 reductions for the 24 states having Phase I-affected units. One quarter of the entire reduction occurred in Ohio; 90% occurred in the nine states extending from Pennsylvania and West Virginia west to Missouri and south to Tennessee and Georgia. There is also a decidedly more eastern cast to the 1995 reduction in SO₂ emissions compared to pre-1995 reductions. The states of Ohio, West Virginia, and Pennsylvania account for 40% of the 1995 reduction, whereas they accounted for none of the pre-Phase I emissions reduction, largely because they were then still east of the eastern frontier for western coals' effective market penetration.

The contribution of substitution units to the 1995 emissions reduction was small, despite their large number and the significant increase in generating capacity subject to Phase I restrictions. These 182 units account for only about 5%, or 213,000 tons, of the 3.89-million-ton reduction in 1995, though they represent almost a third of the generating capacity of Phase I-affected units. Although significant in number and aggregate capacity, their contribution to the 1995 emissions reduction was small because these units were less intensively used than Table A units, SO₂ emission rates at these units were lower initially (1.13 vs. 3.45

²² No definition of low-, mid-, or high-sulfur coal is universally accepted. In practice, any coal of 1.2 #/mmBtu or less is considered low-sulfur,

while any above 3.5 #/mmBtu is high-sulfur. Mid-sulfur coals lie between these extremes.

#/mmBtu for Table A units), and their reduction per unit of heat input was less (0.25 vs. 1.56 #/mmBtu for Table A units). More importantly, many of these units had already made emissions reductions relative to the reference year for the calculation of their allowance allocations—usually 1989–90.²³ As a result, substitution and compensation units received, in the aggregate, 243,000 allowances in excess of our estimate of counterfactual emissions for them.

From the standpoint of fuel suppliers and others (particularly in coal-supplying regions) whose livelihoods depend on the delivery of fuel to Phase I units, the number of tons of SO₂ reduced is of less interest than the change in the number of tons of coal delivered. It is noteworthy that the share of heat input from coal at Phase I-affected units was virtually unchanged (96.9% in 1995 vs. 96.6% in 1993). Although natural gas use at these units increased by 93 Bcf, this increase was entirely at the expense of oil, which declined by the equivalent of 123 Bcf. Coal use increased by 30 million tons, or the Btu equivalent of 530 Bcf. Table 3 shows 1993 and 1995 coal deliveries from various coal-producing regions to Phase I-affected plants.²⁴

Though virtually all of the increase in coal delivered to Phase I-affected plants came from the PRB, fuel-switching among the bituminous coal regions was also apparent. Deliveries from the predominantly high-sulfur regions of Northern Appalachia and the Midwest declined by 11.66 million tons from 1993 to 1995, or about 7.5%, while the lower-sulfur Central Appalachia and western bituminous regions experienced an increase of equal magnitude, 11.55 million tons. Since much of the 1995 reduction in emissions resulted from switching to lower-sulfur bituminous coals, these figures indicate that most of the reduction from switching among bituminous coals occurred within the same coal-producing region. To illustrate, if every switch from a high-sulfur to a low-sulfur bituminous region resulted in an average 2.0 #/mmBtu reduction in emissions, a net change of 12 million tons in coal deliveries in favor of the two low-sulfur regions would account for slightly less than 300,000 tons of SO₂ reduction. The total reduction in SO₂ emissions attributable to switching to bituminous coals is 1.6 million tons. The remaining 1.3 million tons reflects switching to lower-sulfur coals within the same supply region; of this amount, almost 45% took place within the high-sulfur regions of North Appalachia and the Midwest, and the remaining 55% was accomplished by units supplied by coals from Central and Southern Appalachia.

²³ Allowances are issued to substitution units according to complicated and heavily litigated rules whereby average 1985–87 heat input for a unit is multiplied by the least of three emission rates for that unit: (1) the lower of the actual or allowable 1985 SO₂ emissions rate, (2) the greater of the 1989 or 1990 actual emission rate, or (3) the most stringent Federal or State allowable SO₂ emissions rate applicable in 1995–99, as of November 15, 1990. Originally, substitution units were to receive allowances based only on the 1985 emission rate;

however, environmental groups brought suit against EPA to prevent issuance of “excess” allowances. This litigation led to the addition of the references to 1989–90 emission rates and other pre-Title IV limitations on 1995–99 emission rates, and effectively prevented issuance of allowances for reductions in the emission rate achieved between 1985 and 1989–90, as well as for any 1995–99 reductions otherwise required.

²⁴ A Phase I-affected plant is the site of at least one Phase I-affected unit.



SO₂ EMISSIONS TRADING UNDER TITLE IV

As noted earlier, the truly distinguishing feature of Title IV is its utilization of tradable emissions permits, or allowances, to achieve a 50% reduction in SO₂ emissions. Tradable permits and other market-based instruments have long been advocated as cost-effective means for achieving environmental goals, but the limited experience with emissions trading prior to 1990 was not particularly encouraging.²⁵ Consequently, it is not surprising there was considerable doubt whether this feature of Title IV would meet with any greater success than had earlier experiments with emissions trading.

Title IV embraces emissions trading with remarkably few restrictions. Allowances can be traded nationally, though the environmental problem being addressed is regional. No review or prior approval of trades is required so that, at least in theory, emissions trading could lead to regional patterns of emissions reduction that would exacerbate the problem being addressed (*i.e.*, create "hot spots"). The purchase and holding of allowances is not restricted to the utilities for whom these permits would become a necessary input for the generation of electricity from oil or coal. All sources receiving allowance allocations, as well as third parties, such as brokers and individuals, are free to buy or sell allowances with any other party. Neither the frequency nor the mechanisms for trading allowances are limited. Finally, a small fraction of the allowances to be issued to utilities (2.8%) are withheld and sold at an annual revenue-neutral, EPA-administered auction.

The boldness of Title IV's emissions-trading provisions offered little assurance to observers that this experiment would work. Some opposed the concept of emissions trading as wrong-headed, if not immoral.²⁶ The national press labeled the first publicly announced trades as the buying and selling of the "right to pollute."²⁷

²⁵ See Hahn (1989) and Hahn and Hester (1989) for a review of the limited results as of 1989. The relatively small-scale programs employing tradable permits to phase-out lead and CFCs were successful, however, as discussed in NERA (1994).

²⁶ For instance, a cartoon titled "Tom the Dancing Bug," reprinted in the *New York University Law Review*, parodied emissions trading as equivalent to the issuance and exchange of licenses to murder. The cartoon originally appeared in *Funny Times*, September 1992, p. 23, published by Rubin Bolling.

Among those more favorably disposed, concerns focused not only on the effects of misinformed publicity, but also on the regulatory framework within which electric utilities operated: regulation, it was feared, would not provide utility managers with the incentive, or even the ability, to pursue cost-saving opportunities possible with emissions trading.²⁸ After the first EPA-administered auction in March 1993, the design and role of the auction joined the list of suspects responsible for too little trading and for allowance prices that were considered to be too low.²⁹

Before we turn to these concerns, it bears emphasis that no critical volume of allowance trading indicates a well-functioning market. Trading is necessary to realize the potential savings in compliance costs, but the theoretically optimal amount of trading depends on how the government initially allocates permits. If, by chance, permits were distributed such that the marginal costs of compliance at all units would be equal when their emissions were reduced to the amount permitted by allowances issued to each unit, no cost savings would be possible and there would be no reason to trade. The more the allowances' allocation departs from such a distribution, the greater the cost savings possible by emissions trading, and the more trading is desirable. Furthermore, the optimal amount of trading will vary over time as the economics of dispatch and fuel supply alter marginal compliance cost at individual units.

*A. Development of the Allowance Market*³⁰

One way to assess market development is by observing prices and trading volume. When transactions are few and information poor, prices show considerable dispersion, whereas, in a reasonably competitive market with good information, transactions are sufficient in number and frequency for a readily recognizable "market price" to become established, around which bids and offers cluster. Figure 3 displays the pricing of "current vintage"³¹ allowances from May 1992, when the first trade of an allowance was reported, through the March 1997 auction. These data

²⁷ See, for instance, the *Wall Street Journal*, May 11, 1992, or the *New York Times*, May 12, 1992. A premature but typically pessimistic appraisal of the effect of the initial press coverage of the first publicly announced trade can be found in Malec (1993).

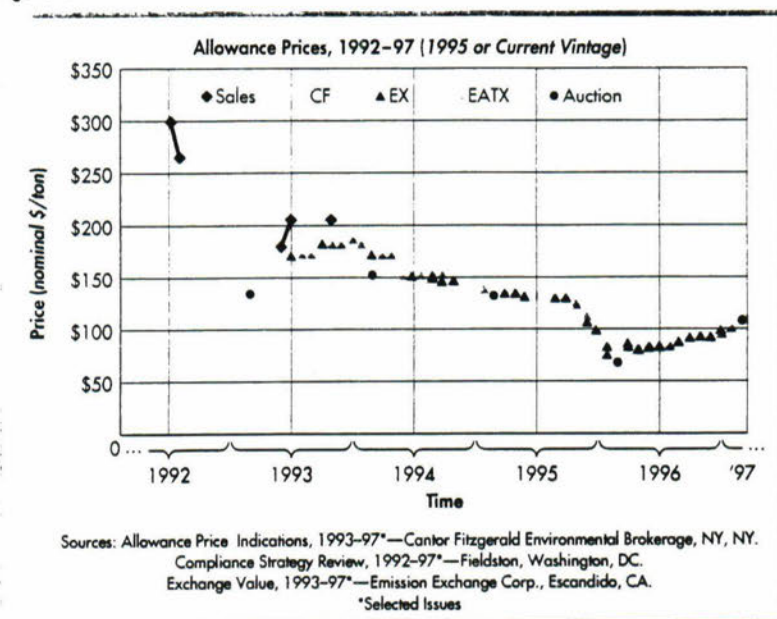
²⁸ Bohi and Burtraw (1991 and 1992).

²⁹ See GAO (1994), Cason (1993), and Cason and Plott (1996) for expressions of these concerns.

³⁰ This section draws heavily on Joskow, Schmalensee, and Bailey (1977), to which the reader is referred for more complete exposition of the arguments summarized here.

³¹ The current vintage can be defined as those allowances that can be used to cover current emissions. The current vintage would have been 1995 through the first year of compliance, 1995. In 1996, the current vintage would be the 1996 vintage plus all banked 1995 vintage allowances.

Figure 3



were compiled from three sources: (1) trade press reports of prices at which some private trades took place, (2) cash, spot-market price indices for current vintage allowances from three private market-making organizations, and (3) clearing prices from EPA's annual March auctions, from 1993 through 1997.

Few trades occurred before the first EPA auction in March 1993. Reports of parties actively seeking buyers and sellers for SO₂ allowances appeared in the trade press as early as 1991,³² but not until May and July 1992 were the first bilateral trades reported—at prices of \$265 and \$300 per allowance.³³ The trade press reported other bilateral trading, but no additional price information for private transactions appeared before the first auction. Allowance prices in the May and July 1992 transactions approximated the estimates of Phase I allowance prices

³² *Energy Daily*, May 15, 1991.

³³ Early reports of trades can be found in the *Wall Street Journal* (May 11, 1992, and July 1, 1992), the *New York Times* (May 12, 1992), *Energy Daily* (May 13, 1992, and July 1, 1992), and *Compliance Strategies Review* (various issues, 1992-93).

\$250-\$350)³⁴ that served as buyers' and sellers' primary source of information prior to the auction.

Results of the first EPA-administered auction generated some controversy about allowance prices and the adequacy of emissions trading. Contemporaneous trade-press reports suggested utilities and intermediaries were surprised by the low prices: \$131 for vintage 1995 allowances and \$122 for vintage 2000 allowances. One utility characterized its purchase of allowances in that auction as "quite a bargain."³⁵ At the same time, critics began to assert that shortcomings in the auction's design were biasing allowance prices downward.³⁶ The few private transactions reported subsequently, in 1993, appeared to support this criticism. In mid-1993, the Emissions Exchange (EX) began to report vintage 1995 allowance prices gathered confidentially from private parties; these prices remained at or slightly above \$170 for the remainder of the year. A few more private transactions were reported, at prices of \$178 and \$205, during the summer of 1993, and the last newsworthy private trade was reported in November 1993, at a price of \$205—significantly above both the EX price and the earlier auction price.

At the end of 1993, a clear, uniform market price would have been difficult to define from information then available; between mid-1994 and early 1995, however, various indicators of the market price for allowances converged. At the second EPA auction, in March 1994, clearing prices were \$150 for 1995 vintage allowances and \$140 for vintage 2000 and 2001 allowances. These prices were higher than the 1993 auction prices, but lower than prevailing EX prices—and still far below earlier projections of Phase I allowance prices. Soon after, in mid-1994, the EX price fell to the level established by the recent auction. At about the same time, two other third parties, Fieldston (EATX) and Cantor Fitzgerald (CF), began publishing allowance price information based on confidential private transactions. As Figure 3 makes evident, the prices reported by these three organizations were close. By the March 1995 EPA auction, convergence was complete: the auction clearing prices virtually matched what all three of these intermediaries were reporting as the private market price for allowances. The 1996 and 1997 auction clearing prices are also well in line with contemporaneous private spot-market transactions.

³⁴ Prices for allowances in Phase II were projected in the \$500–\$700 range. See, for instance, ICF (1990) and Braine (1991).

³⁵ Hoske, Mark T. (1993), "SO₂ Allowance Cost Falls to \$122/ton in First EPA Auction," *Electric Power and Light*, 71(5), p. 3.

³⁶ See, for example, Cason (1993, 1995) and Cason and Plott (1996). The feature most criticized was the discriminatory price mechanism, whereby each successful bidder buys at his bid price rather than at the lowest winning bid price. The central argument for why the EPA auction mechanism would generate a downward bias in prices is that voluntary sellers have an incentive to set an artificially low reservation price, thus dragging down the auction clearing price. The validity of this line of reasoning rests on the absence of an efficient private market outside of the auction.

TABLE 4. ALLOWANCES SOLD IN EPA AUCTIONS AND IN THE PRIVATE MARKET

	Number of Allowances Sold in EPA Auction	Number of Allowances Sold in the Private Market*	Total Allowances Sold
Through March 1993	150,010	130,000	280,010
April 1993-March 1994	176,200	226,384	402,584
April 1994-March 1995	176,400	1,466,996	1,643,396
April 1995-March 1996	275,000	4,917,560	5,292,560
April 1996-March 1997	300,000	5,105,924	5,405,924
TOTAL	1,077,610	11,846,864	12,924,474

* The number of allowances sold in the private market includes inter-utility trades, trades between utilities and third parties, and trades between two non-utility parties. This number excludes intra-utility trades (including intra-holding company trades), reallocations, and options to trade which have not been exercised.

Source: Compiled by MIT/CEEPR from EPA's Allowance Tracking System.

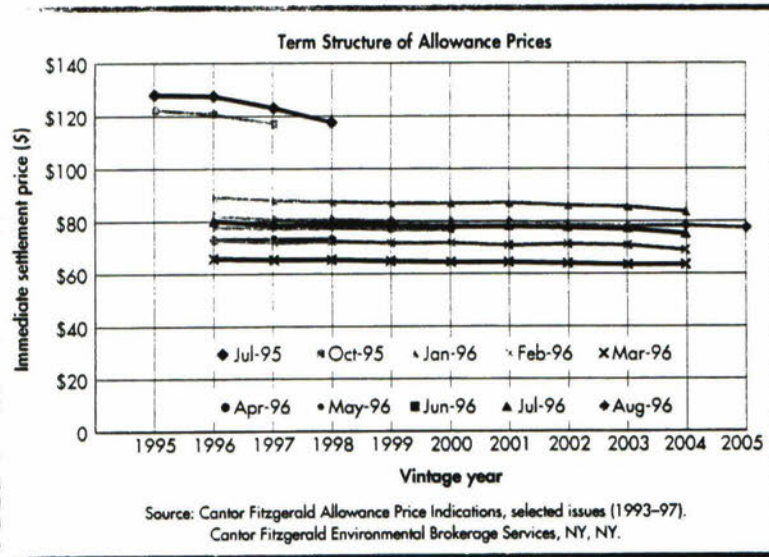
At the same time market price indicators for allowances were converging, trade activity was increasing significantly. No source reports the precise quantity of allowances traded privately, but a conservative estimate of arms-length, commercial trades can be made from the recorded movement of allowances between accounts in the EPA's Allowance Tracking System (ATS). The first two columns of Table 4 report the number of private allowance trades recorded in the ATS for the twelve-month period preceding each auction, and the total number of allowances sold in that auction.³⁷ Although little private trading of allowances took place prior to the second EPA auction in March 1994, the volume of such trades increased greatly during the following two years. As of March 1997, about 11.8 million allowances had been traded privately, according to the ATS, compared to 1.1 million through EPA auctions.

Since SO₂ abatement strategies generally involve investment and contracting decisions that affect emissions for many years, a futures market for allowances could be expected to emerge if utilities take advantage of opportunities for

³⁷ To eliminate noncommercial transactions, all allowance transfers associated with special allocations (e.g., bonus allowances made available for scrubbers) and trades involving generating units or accounts with common ownership were removed. Because there is no obligation to record trades until the holder desires to use allowances for compliance purposes, not all private trades are recorded in the ATS. Discussions with market participants lead us to believe that prompt recording of

private trades was the rule in the early years, but increasingly, as the private allowance market has developed, allowances have not been moved into buyers' accounts until needed for compliance. Furthermore, there has been enormous growth in options, forwards, and other derivative trading, which would be invisible to the ATS until exercised and the allowances are deposited in the buyers' accounts.

Figure 4



intertemporal cost savings made possible by the banking provisions of Title IV. In fact, this has happened, and the term structure of prices for current and future vintages suggests that the market for SO₂ allowances is liquid and effective. Figure 4 presents the term structure of immediate settlement (not future delivery) prices for allowances of successive vintages from summer 1995 through early 1997. This pricing structure is "weakly backwardated," *i.e.*, current prices for immediate delivery of future vintage allowances are lower than the spot-market price for current vintage allowances.

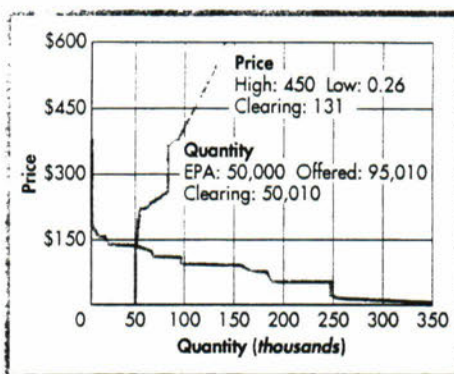
Several reasons follow, from theory and the observation of other markets, to explain this pattern. Assuming banking across all relevant periods, in a world of certainty with no transaction costs, arbitrage between current and expected future compliance costs and between allowances of differing vintages would cause the immediate settlement prices for allowances of differing vintages to be equal, so the plots in Figure 4 would be flat.³⁸ In reality, uncertainty about the value of future vintage allowances imparts option value to currently usable vin-

³⁸ In all periods, an individual holder of allowances chooses a level of SO₂ abatement such that the current marginal cost of abating in that period equals the current price of a spot-market allowance ($P_t = MC_t$). Across any two periods with banking, the individual will abate so that the discounted marginal cost of abatement is equal ($MC_t = MC_{t+1}$). Since the discounted marginal

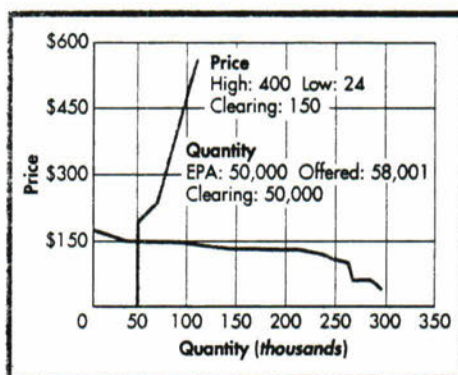
cost of abatement is equal across periods ($MC_t = MC_{t+1}$) and current marginal cost of abatement is equal to the current allowance price in every period ($P_t = MC_t$, $P_{t+1} = MC_{t+1}$), the immediate settlement prices for allowances of differing vintages would be equal ($P_t = P_{t+1}$). This also implies that the nominal price of an allowance should grow at the discount rate when banking occurs between period t and period $t+1$, *ceteris paribus*.

Figure 5: Evolution of Bids and Offers at the EPA Spot Auctions, 1993–95

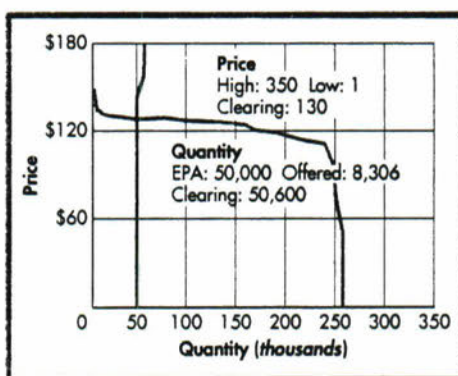
1993



1994

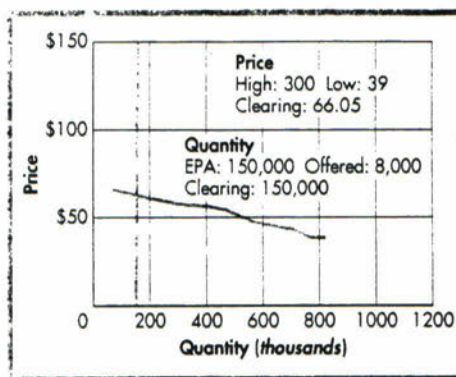


1995

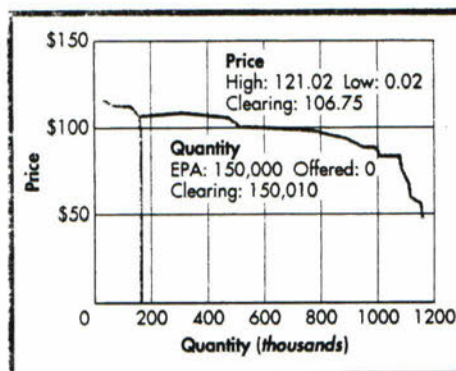


Source: EPA auction data.

1996



1997



Source: EPA auction data.

tages, and brokerage commissions add value (commonly termed the "convenience yield," in related contexts) to holding an allowance rather than selling one today and purchasing another tomorrow. Thus, in real markets with banking, where both uncertainty and transaction costs occur, the current vintage will cost more than future vintages—a difference in value reflected by a weakly backward-dated structure. Figure 4 demonstrates that the degree of backwardation diminished between the summers of 1995 and 1996. This flattening of the term structure may reflect the reduction in transaction costs,³⁹ increasing confidence in the value of future vintages, improved efficiency of spatial and intertemporal arbitrage as the allowance market has developed, or a combination of all three factors.

The development of an effective private market for allowances can also be seen in the dispersion of bid and offer prices in EPA auctions since 1993. In a well-functioning market with low transaction and information costs, little dispersion of bid and offer prices should be observed in auction, since there would be no point in bidding above—and it would be futile to bid below—the market price. Figure 5 presents the supply and demand curves for 1995 or current-year allowances in EPA auctions from 1993 through 1997.⁴⁰ For the March 1993 auction, the buyers' offer curve shows considerable dispersion: a significant volume of allowances traded at prices well above the "market-clearing price" (*i.e.*, the lowest price paid), and a large number of "low-ball" bids are observed. The bid curve for 1994 is much flatter, and the number of allowance sales at prices significantly higher than the auction-clearing price declined considerably. Finally, in 1995, 1996, and 1997, the buyers' offer curves are quite flat: few allowances have been traded at prices much above the market-clearing price, and offers at very low prices are similarly few. The same narrowing in dispersion of auction bids is shown quantitatively by Table 5, which presents the percentage difference between the market-clearing price and the average price paid in each auction. While it would be hard to argue that bidders in the 1993 auctions had a good

³⁹ As noted in Joskow, Schmalensee, and Bailey (1997), brokerage fees—one example of a transaction cost—fell from around \$1.75 per allowance in 1994 to about \$1.00 per allowance in August 1996, for each side of the transaction.

⁴⁰ The demand (or buyers' offer) curve is constructed by drawing, at a height corresponding to each bid price, a horizontal line with length corresponding to the associated bid quantity, starting with the highest bid price and working down to the lowest. On the supply side, the number of allowances offered for sale in the mandatory auction is represented by a vertical line at the relevant quantity on the horizontal axis. Since voluntary offers to sell in the EPA auction do not get

matched with offers to buy until the mandatory offering is fully sold, the sellers' offer curve is completed by drawing horizontal lines at heights corresponding to the reservation prices for these voluntary offers and with lengths corresponding to the quantities offered at those prices, beginning with the lowest reservation price and working up to the highest. The intersection of the buyers' offer curve and the sellers' offer curve defines the market-clearing price, the lowest bid price at which allowances were purchased. Note that dots frequently appear on the vertical axis. These represent bids for very small numbers of allowances (often only one) submitted by individuals, environmental groups, law schools, and other noncommercial organizations.

TABLE 5. PERCENTAGE DIFFERENCES BETWEEN AVERAGE WINNING BIDS AND LOWEST WINNING BIDS IN EPA AUCTIONS

Year	Spot Auction	6-Year Advance Auction	7-Year Advance Auction
1993	20.6	—	11.5
1994	6.0	5.7	6.4
1995	1.5	2.3	1.6
1996	3.2	1.9	1.9
1997	3.4	0.3	2.0

Source: MIT/CEEPR based on EPA auction data.

idea of the market-clearing price, it would be easier to make this argument for the 1994 auctions, despite the small number of private trades before March 1994. By the 1995, 1996, and 1997 auctions, a well-functioning allowance market had developed, so that prices bid in EPA auctions were determined by the outside, private market.

Although the EPA auction was designed to stimulate development of a private market for allowances and to provide a source of allowances for new entrants, should no allowances be available through private transactions, the auction's most important role may have been to establish visible market values. Buyers and sellers had little information about allowance prices when utilities were first planning for Title IV implementation, and the first EPA auctions provided important, if controversial, early data points concerning allowance values. At the time, it was thought that the discriminatory price feature of the annual auction might be creating a misleading downward bias, but later allowance prices in the private market and the auctions indicate otherwise. The expansion of trading volume, the convergence of price indicators, and the flattening of the buyers' offer curve in more recent auctions show that these later prices reflect a relatively robust market. Whatever the shortcomings in design of the annual EPA allowance auction, they did not adversely affect the development of the market for SO₂ allowances. In fact, the EPA auction may have helped to form this market by providing a reliable indicator of market value at an early date. By establishing a structured, highly visible mechanism for revealing market value, the early EPA auctions provided a reliable and, as it turned out, more correct indication of allowance values than the few early trades and then-existing consensus among pundits. It is at least as plausible to argue that the few observed early non-auction prices were unduly influenced by consensus projections of allowance values that were too high as it is to argue that the early auctions created a permanent downward bias in allowance prices.

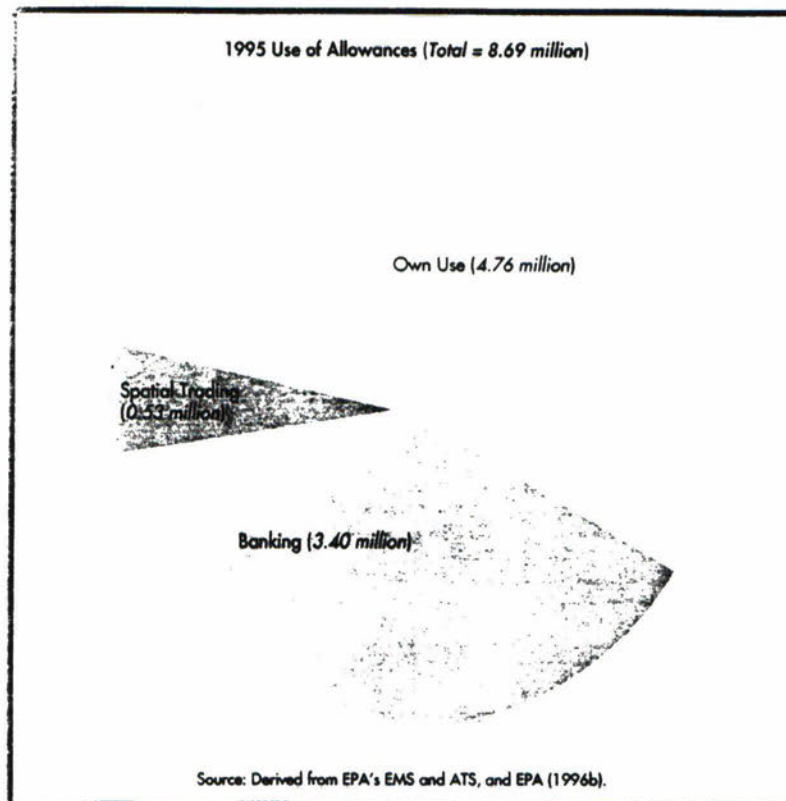
B. Use of Allowances by Electric Utilities

The cost savings possible with emissions trading are not limited to the arms-length commercial trading of allowances discussed in the preceding section. Utilities that reallocate allowances internally to shift compliance from affected units where abatement costs are high to units where abatement costs are low should be presumed to be saving costs as surely as if they were purchasing or selling allowances with third parties. Both forms of emissions trading—intra-utility as well as interutility—must be considered to assess the extent to which utilities have taken advantage of the flexibility afforded by Title IV to reduce compliance costs.

The use of allowances for compliance in 1995 provides a readily observable measure of the extent to which cost savings from emissions trading have been pursued. Of course, units whose 1995 emissions equalled the allowance allocation did not trade, and therefore showed no cost savings from emissions trading. Units whose 1995 emissions exceeded their allowance allocation obtained allowances from other accounts by internal transfer or by purchase from third parties. The number of allowances so obtained indicates the tons of emissions reduction avoided by emissions trading—presumably because any reduction would cost more than the allowances surrendered. Conversely, units whose 1995 emissions were less than the allowances issued to them had allowances available to transfer or sell to others or, alternatively, to bank for later use, transfer, or sale. The number of such allowances indicates the tons of emissions reduction incurred, presumably to free up allowances to sell or to avoid more costly current or future emissions reductions.

Three basic uses for the 8.69 million allowances issued for 1995 are shown in Figure 6. The number of allowances used to cover emissions equal to or less than the initial allowance allocation to the 445 Phase I-affected units was 4.77 million, most of which were probably initially issued to those units. The wedge labeled “spatial trading” represents 534,000 allowances acquired by transfer or purchase to cover 1995 emissions greater than the allowance allocation at 98 Phase I-affected generating units owned by half (34) of the operating utilities with Phase I-affected units, located in 18 of the 24 Phase I-affected states. The wedge labeled “banking” represents 3.40 million allowances not used to cover emissions at any unit in 1995, but reserved instead for future compliance. Most of these (2.91 million) were retained by Phase I-affected utilities, but 0.29 million were sold to utilities not affected until Phase II, and 0.22 million were held in accounts maintained by third-party intermediaries—mostly brokers, but also fuel suppliers. In all, 3.95 million, or 45%, of all 1995 vintage allowances were used to reduce current or expected costs of compliance.

Figure 6



Early fears about the effect of state public utility commission (PUC) regulation on emissions trading focused on the extent to which state PUCs would allow utilities under their jurisdiction to transfer allowances to other utilities—particularly to those in other states. The effect of PUC regulation can be assessed by examining the transfer of allowances in and out of accounts in the Allowance Tracking System and determining whether the pattern is affected by state regulatory procedures.⁴¹ Table 6 presents allowance transfers, by state, for all vintages between 1992 and 1995, and Table 7 summarizes these data for the 47 Phase I and Phase II states, according to whether the net balance of transfers resulted in an increase (“buyer”) or decrease (“seller”) of allowances available to the state.⁴²

⁴¹ Following the classifications and terminology developed by Bailey (1996), three broad types of allowance transfers can be identified: 1) administrative reallocations to conform the initial issuance of allowances to ownership and operating agreements concerning specific units, 2) economically motivated transfers among units owned by the same utility, and

3) arms-length commercial transactions among utilities. As we use the term, emissions trading encompasses the last two categories.

⁴² Alaska and Hawaii are exempt from Title IV, and there is no sulfur-generating electricity production in the state of Idaho.

TABLE 6. ALLOWANCE TRANSACTION ACTIVITY BY STATE, 1992-95

(All Vintage Years, Utility Accounts Only)

State	Allowances Purchased	Allowances Sold	Net Balance of Transactions
Alabama	63,856	63,260	596
Arizona	1,901,430	2,248,126	-346,696
California	350,084	130,628	219,456
Florida	689,095	171,715	517,380
Georgia	2,221,010	2,873,109	-652,099
Illinois	324,290	173,581	150,709
Indiana	1,170,311	971,824	198,487
Iowa	3,511	1,725	1,786
Kansas	29,834	7,038	22,796
Kentucky	607,594	620,170	-12,576
Massachusetts	12,500	53,000	-40,500
Maryland	527,621	215,839	311,782
Michigan	24,500	16,234	8,266
Minnesota	15	15	0
Missouri	321,579	389,113	-67,534
Mississippi	50,859	23,295	27,564
Nevada	0	139,636	-139,636
New Hampshire	16,378	8,378	8,000
New Jersey	555,195	120,626	434,569
New Mexico	0	170,738	-170,738
New York	68,777	190,865	-122,088
North Carolina	518,153	35,000	483,153
North Dakota	6,400	0	6,400
Ohio	1,499,917	1,994,548	-494,631
Oregon	299,788	332,930	-33,142
Pennsylvania	9,976,742	5,192,210	4,784,532
South Carolina	348,162	130,674	217,488
Tennessee	684,964	870,258	-185,294
Texas	1,604	102,104	-100,500
Utah	769,126	75,028	694,098
Virginia	149,841	114,645	35,196
Wisconsin	162,514	227,466	-64,952
West Virginia	527,918	5,888,305	-5,360,387
Wyoming	19,340	611,761	-592,421
Total	23,902,908	24,163,844	-260,936*

*This column does not sum to zero because the table only covers purchases and sales by utilities. Purchases and sales made by brokers and other third parties are not included, nor is the sale side of the EPA auction transactions. The negative total net balance of transactions means that, on balance, utilities sold 260,936 allowances to third parties.

Source: Derived from EPA Allowance Tracking System.

TABLE 7. NET ALLOWANCE TRANSFERS BY STATE

	States With Phase I Utilities	States With Only Phase II Utilities	Total
"Buyer"	13	5	18
No Net Change	1	13	14
"Seller"	10	5	15
TOTAL	24	23	47

Source: Derived from EPA Allowance Tracking System.

Allowances were transferred among accounts in all states containing Phase I-affected units. The net effect ranged from zero for Minnesota to 4.78 million allowances acquired from out of state by utilities in Pennsylvania, and 5.36 million sold or otherwise transferred out of West Virginia. Transfer activity was observed in ten of the 23 states with only Phase II utilities, with a net effect evenly split between "sellers" and "buyers"; in the aggregate, however, utilities in states with only Phase II units have been net "buyers" (960,000 allowances "purchased" vs. 792,000 "sold"). Some of these transfers are known (through press report or auction result) to have been commercial transactions.

As discussed more fully in Bailey (1996), there is little evidence that state public utility commission regulation—or the lack thereof—has adversely affected electric utilities' decisions to trade. As of January 1996, only 15 state PUCs (of the 34 where allowance transfers have occurred) had explicitly addressed the treatment of allowances through issuance of a formal generic order and/or informal guideline, and in these states, PUC guidance is associated with a higher volume of transfer activity. More significantly, transfers have not been deterred in the 19 states where state commissions have yet to concern themselves with rate-making treatment for allowances. Queries to commission staff in all states without a generic order or informal guideline indicate that no guidance had been issued because no request for such had been received from utilities under their jurisdiction. While such response is an imperfect, and perhaps biased, measure of the need for regulatory rulings, it does suggest that some utilities are comfortable trading without formal rules specifying how allowances will be treated for rate-making purposes. Increasing competitive pressures to cut costs, as well as regulatory lag and several incentive features that affect all operating costs, are likely stimulating cost-reducing emissions trading.



COST OF COMPLIANCE WITH TITLE IV

The evidence presented above does not suggest widespread reluctance on the part of electric utilities to avail themselves of the cost-saving flexibility afforded by the emissions-trading provisions of Title IV. In this section, we present an estimate of the cost to make the 3.9-million-ton reduction of SO₂ emissions in 1995, and compare that estimate with earlier predictions of compliance cost in 1995. We also examine the largest cost component—scrubbing—in more detail. Finally, we note an important ancillary cost of tradable permits: monitoring—specifically, the installation of continuous emissions monitors.

A. Total and Average Costs of Compliance

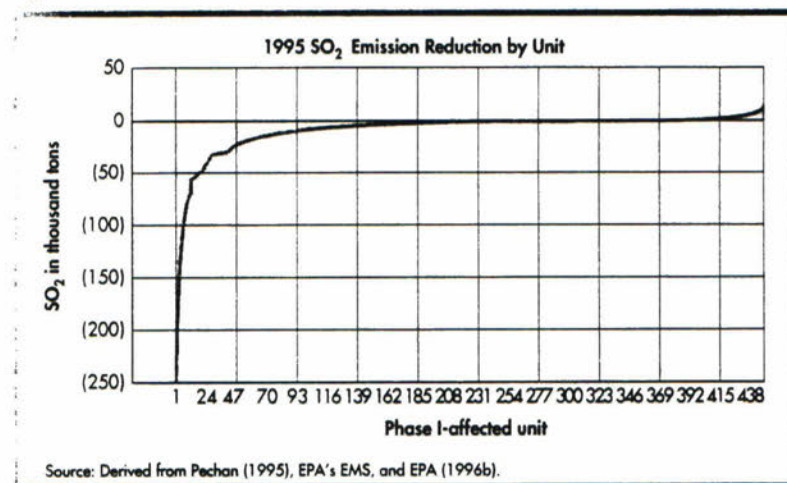
The main points concerning methods and data used to estimate compliance costs are summarized here; details are offered in the appendix. The cost of compliance is the additional cost incurred by generating units to meet new environmental requirements. This additional cost can be broken into two components: First is the annual capital charge for additional investment that will provide service in and after 1995 (examples are scrubbers and changes in boilers or coal-handling equipment to handle lower-sulfur coals). The second cost component is annually recurring operating or variable costs. For scrubbers, such operating costs include the costs of power to run the scrubber, of limestone or other reagent to absorb the SO₂, and of the disposal of wet or dry residue. Where fuel switching is the means of compliance, the principal variable cost is the extra expense for lower-sulfur fuel. Much of the data required to estimate cost are publicly available. In addition, we used responses to the confidential MIT/CEEPR survey of utilities to provide missing data, as well as to confirm the publicly available data and resolve ambiguities in the public data. When all else failed, we relied on interviews with plant and utility compliance managers to explain the intricacies of compliance at particular plants.

Identifying the cost of compliance at each of the 445 Phase I-affected units would be a formidable task; the task can be greatly simplified, however, because

virtually all of the aggregate reduction in emissions can be attributed to about 40% of the units. In Figure 7, the 445 Phase I-affected units are arrayed by the magnitude of their reduction of SO₂ emissions in 1995. Starting from the right-hand side of Figure 7, the first 89 units actually increased emissions relative to the counterfactual; for the next 175 units (reading toward the figure's left side), individual unit reductions were small and, in the aggregate, approximately equalled the increase of emissions by the first 89 units. Most of these changes in SO₂ emissions resulted from the normal variations in utilization and fuel input that could be expected to occur at these units. The entire net reduction in 1995 can thus be attributed to the first 181 units from the left of Figure 7. Accordingly, in estimating the cost of the 3.9-million-ton reduction of SO₂ emissions in 1995, we ignore the 264 units that increased or only slightly reduced emissions.⁴³

The total annualized cost of the 3.9-million-ton reduction of SO₂ in 1995 was about \$726 million, as shown in Table 8. The average total cost of compliance is between \$187 and \$210 per ton, depending on how units switching to lower-cost

Figure 7



⁴³ Since fuel-delivery data is available only on a plant basis, the analysis is conducted on the basis of *all* Phase I-affected units at any plant where a Phase I unit reduced emissions by 5,000 tons or more. As a result, some Phase I units that showed little change or an increase in emissions are included. In the end, the analysis

is based on 206 Phase I units at 70 plants that, in the aggregate, account for 3.89 of the net 3.94-million-ton reduction of emissions.

fuels are treated. The 425,000 tons of SO₂ emissions reduction labeled "No Cost PRB" denotes units that switched to a lower-sulfur fuel that was cheaper, on a total cost basis, than the higher-sulfur coal used formerly.⁴⁴ In some cases, the switching to cheaper PRB coals in 1995 was due to contract expirations; in other

TABLE 8. 1995 COST OF COMPLIANCE WITH TITLE IV

Method	Reduction (x10 ³ tons)	Total Cost of Compliance (million \$)			Average Cost (\$/ton SO ₂)
		Fixed	Variable	Total	
Scrubbing	1,754	375.0	89.3	464.4	265
Switching	1,709	57.2	204.1	261.3	153
SUBTOTAL	3,462	432.2	293.5	725.7	210
No Cost PRB	425	0	0	0	0
TOTAL	3,888	432.2	293.5	725.7	187

Source: Derived from MIT/CEEPR Title IV Questionnaire (1996), FERC Form 423, EPRI (1993 and 1995; hereafter, EPRI93 and EPRI95, respectively), EPA Emissions Monitoring System (ongoing reports), EPA (1996b), Pechan (1995), Fieldston (1994), and Pasha (1993 and 1995).

cases, however, the contract remained in place but appears to have been modified in response to Title IV, changing the coal source to the same company's PRB mine.

These estimates of the total and average total costs of compliance in 1995 are compared with earlier predictions of the emissions reduction and associated cost in Table 9.⁴⁵ Our cost estimates are substantially lower than the first ICF Resources Incorporated (ICF) estimates, which assumed no trading, and the later Electric Power Research Institute (EPRI) and Government Accounting Office (GAO) studies, which assumed limited trading, but our estimates are comparable on a per-ton basis with the 1989 and 1990 ICF studies that assumed flexible implementation (*e.g.*, relatively more emissions trading).

These comparisons must be used with caution. The cost data provided by these studies have been converted to 1995 dollars using the GDP deflator, but other incomparabilities cannot be so easily addressed. Earlier studies may have used a fixed annual capital charge based on a nominal interest rate, instead of an esca-

⁴⁴ Almost all of this coal came from PRB; less than 3% originated in Colorado and Utah. Also, 4% of the "No Cost PRB" reduction is due to switching from oil to natural gas.

lating capital rental price based on the real interest rate in 1995, as we have employed. In addition, we used a uniform lifetime of 20 years for all capital equipment in computing the depreciation component of the capital charge, while others, such as EPRI93, used a fifteen-year lifetime for scrubbers. Our assump-

TABLE 9. ESTIMATES OF PHASE I COMPLIANCE COSTS⁴⁵

Source	'95 Emissions w/o CAAA	Title IV Reduction (million tons)	Total Cost (million '95\$)	Average Cost (\$/ton)
ICF89L (constrained)	16.64	3.56	871	245
ICF89L (flexible)	16.64	3.32	599	180
ICF90L (flexible)	16.64	3.12	573	184
EPRI93	16.29	4.36	1338	307
GAO94	9.37*	3.90	1163	298
EPRI95	14.65	3.18	894	281
Actual '95 (MIT)	15.70	3.46–3.89	726	187–210

*Table A only.

Source: ICF (1989, Tables B1 and B5), ICF (1990, Tables B1 and B5), EPRI93 (Table C-1), GAO (1994, pp. 26 and 74), and EPRI95 (Table A-3).

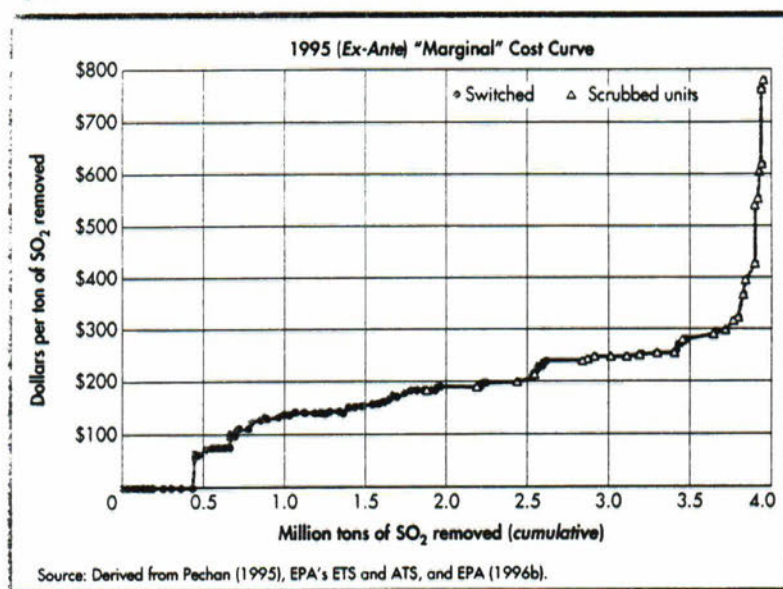
tions yield lower capital charges, but a more definitive statement of differences in cost-estimating methods cannot be made without more detailed information than is provided by the earlier studies. Still, we believe it unlikely that differences in cost accounting would change the basic conclusion that the actual costs of abatement in 1995 have been at the lower end of what had been predicted.

⁴⁵ The ICF Low Base Case predictions are the only ones cited because they are closer to the actual growth in electricity demand between 1989–90 and 1995 and the amount of coal used to generate electricity in 1995. The ICF 1990 projection cited here is that for the Senate bill, which more closely approximated the final legislation than did the House bill. The ICF89

predictions of cost and emissions reduction do not include any banking, whereas all the other predictions do.

Another way of presenting the cost of compliance in 1995 is indicated by Figure 8, in which the 3.9-million-ton reduction in SO₂ emissions is arrayed by units' average total cost, in ascending order, based on 1995 utilization. Figure 8 approximates the national supply curve for Title IV compliance observed in 1995; it is not a "classic textbook" supply curve in that it includes mistakes and other departures from the most efficient, least-cost choices.

Figure 8



B. Cost and Performance of Scrubbers

The largest single component of compliance cost in 1995 was the interest and depreciation expense associated with the \$3.5 billion investment in new Title IV scrubbers. Table 8 and Figure 8 clearly indicate that, on average, scrubbing has been a more expensive means of compliance than fuel switching; however, the cost of scrubbing has been considerably lower than predicted.

The average total cost of scrubbing in 1995—\$265 per ton of SO₂ removed—masks great diversity among the units employing this abatement method. As indi-

cated by Figure 8, the average total cost ranges from \$189 to almost \$800, reflecting variations among units in initial capital cost, utilization in 1995, and the amount of SO₂ removed per unit of heat input. The average initial capital cost for these retrofits is \$249/KW^e, but the range varies by a factor of almost three, from \$143 to \$361. This variation in capital cost reflects variations in unit capacity, from 100 MW^e to 1300 MW^e, and in unit age, from 17 to 45 years of service as of 1995—and any other idiosyncratic features of the particular units being retrofitted. Eighty percent of this retrofitted capacity was brought on line between 1970 and 1975, and these units were among the last to be exempted from the new source performance standards imposed by the 1970 Clean Air Act Amendments.

Both ICF90 and EPRI93 provide sufficient data to compute expected average total cost for scrubbing as anticipated during the planning for Phase I compliance. Table 10 compares the expected SO₂ removal cost for a representative retrofitted unit, using the predicted cost and performance data from ICF90 and EPRI93, with actual SO₂ removal cost based on the observed or calculated average cost and performance for the 21 scrubbed units that were fully operational in

TABLE 10. SCRUBBER AVERAGE COST AND PERFORMANCE DATA

(1994 \$)	ICF90	EPRI93	MIT /Actual
Basic Cost Data			
Initial Capital (\$/KW ^e)	\$249.00	\$229.00	\$249.00
Fixed O&M (\$/KW-yr)	\$6.55	\$8.19	\$2.00
Variable O&M (\$/MWh)	\$1.81	2.24	1.26
Performance Data			
Removal Efficiency (%)	90	90	94
Utilization (%)	65	65	83
Coal SO ₂ (#SO ₂ /mmBtu)	3.97	3.97	4.14
Gross Heat Rate (Btu/kwh)	9722	9722	9800
Tons SO ₂ /MW ^e	99	99	139
Cost per Ton SO₂			
Capital Charge (@ 11.33%)	\$285	\$262	\$203
Fixed O&M	\$66	\$83	\$14
Variable O&M	\$104	\$129	\$65
Average Total Cost	\$455	\$474	\$282

Source: Derived from EPRI93, ICF (1990), MIT/CEEPR Questionnaire, EPRI95.

1995.⁴⁶ The 21 fully operational Phase I scrubbers were removing sulfur at an average total cost of \$282 per ton in 1995—about 60% of what had been predicted by earlier estimates.⁴⁷ The cost savings of about \$180 per ton of SO₂ removed arises from two factors: lower operating and maintenance (O&M) costs, particularly the fixed costs, and more intensive utilization of scrubbed units.

Let us consider O&M costs first. Based on responses to the MIT/CEEPR questionnaire, fixed O&M expenditure appears to be a third of what had been projected—or less—in the earlier ICF and EPRI studies. This finding was corroborated by subsequent queries to equipment suppliers and scrubber operators. The reduction in variable cost is not as dramatic, but at two-thirds of earlier predictions, the cost savings are still significant. The reasons for this cost reduction warrant further study, but explanations received from scrubber operators and equipment suppliers point mostly to reduced personnel costs, which show up as fixed O&M, resulting from both greatly improved instrumentation and controls on new scrubbers, and competitive pressures to cut costs. Variable O&M costs also appear to be lower than earlier projections because of the reduced requirement for power to run scrubbers as a result of the better controls, and some innovative sludge-disposal techniques, such as dry stacking.

The second factor leading to a lower average cost of scrubbing is higher utilization. In simplest form, the cost per ton of SO₂ removed by scrubbing is the amount spent per KW^e of capacity divided by the number of tons of SO₂ removed. In particular, higher-sulfur coal, better removal efficiency, and greater dispatch of the generating unit imply more tons removed per unit of capacity. In 1995, the sulfur content of coal and the removal efficiency were each a little higher than previously assumed, but the major difference was the significantly higher utilization of generating units to which scrubbers had been retrofitted. Heat input to the 21 scrubbed units that were fully operational in 1995 was 30% higher in 1995 than the average for the preceding seven years. A summary index of all these factors is indicated by the number of tons removed divided by MW^e capacity. The representative scrubber in EPRI93 was predicted to remove 99

⁴⁶ The representative retrofitted unit in EPRI93 is a 300 MW^e unit with retrofit difficulty factor of 1.27. The unit is assumed to remove 90% of the sulfur from a 3.97# coal and to operate at a 65% capacity factor and gross heat rate of 9,722 Btu/kwh. ICF89 provides more complete cost data for scrubbing; that shown here is what would apply to the representative retrofitted unit used by EPRI93.

⁴⁷ This computation of average total cost is higher than that shown in Table 8 for two reasons. First, five units were excluded from Table 10, since their scrubbers were not operating from the beginning of the year. Second, Table 8 includes fuel savings assumed to result from shifts to cheaper, higher-sulfur coals by some retrofitted units, whereas these savings are not included in Table 10, which offers a comparison with earlier estimates that did not take such savings into account.

tons per MW" of retrofitted capacity; in fact, the 21 units on line for all of 1995 removed, on average, 139 tons of SO₂ per MW" of capacity. The 40% increase in SO₂ removal per MW" spread the capital and fixed O&M charges over more tons of SO₂ and led to a further reduction in the average cost of scrubbing.

If the operational experience in 1995 is any guide, the average total cost for scrubbing is not between \$450 and \$500 per ton of SO₂ removed, as was expected in the planning for Phase I, but about half this amount. The significant improvement in cost performance implies lower marginal cost of compliance in Phase II and, with a well-functioning allowance market that is arbitraging present and future compliance, lower allowance prices in Phase I.

C. Other Compliance Costs: CEMS

Every regulatory program incurs administrative costs that are usually not included in estimates of direct compliance cost. We have made no attempt to estimate the cost of personnel and equipment required to administer Title IV at electric utilities or at the EPA, but we do wish to highlight one element of the cost associated with Title IV: the requirement to have a continuous emission monitoring system (CEMS) on the stack of every affected unit. As its name indicates, a CEMS monitors flue gas emissions continuously, by means of electronic probes in the exhaust stack of generating units. These monitors are the basis upon which total emissions are measured for purposes of determining compliance and deducting allowances from unit accounts in the EPA's Allowance Tracking System.

The requirement to install continuous emissions monitoring systems at every coal-fired Title IV unit was controversial because CEMS are costly and may provide no better estimate of emissions than conventional methods. Prior to Title IV, most stacks did not have CEMS; emissions were estimated by a materials balance approach based on a sampling of fuel input that is performed routinely to ensure the quality of fuel delivered to the plant and to gauge the generating unit's operational performance. Although billions of dollars of coal supply transactions rely on the accuracy of commercial protocols for measuring in-fuel sulfur content, estimates based on these measures were not thought to be sufficiently trustworthy for emissions trading. For instance, an administrative adjustment would be required to account for sulfur retained in the bottom ash and for any sulfur reduction achieved by the use of additives or sorbents in combustion (as with fluidized beds) or in the exhaust stack (as with scrubbers). The effect of such factors is well-known based on engineering studies; however, assumptions are intro-

duced inevitably not only about the effect at the particular generating unit, but also about operating conditions at the unit. In contrast, a CEMS provides a direct measure of emissions exiting the stack: getting from the CEMS observation to tons emitted, however, also requires a number of assumptions—concerning, for instance, the homogeneity and velocity of the flue gas stream—that are arguably as problematic as those involved in the materials balance approach.

Whatever the comparative merits of the assumptions required to estimate emissions by the two approaches, a CEMS does reduce transaction costs by allowing operators to pursue flexible, cost-effective emission reductions without renegotiating the adjustments required by a materials balance approach to get from in-fuel sulfur content to SO₂ emissions. Although such adjustments could be renegotiated, the costs incurred to do so would dampen the response. Furthermore, without a CEMS, the regulator's relatively simple task of compliance—essentially matching recorded emissions with allowances—is complicated by more problematic requirements of ensuring that the indicated sulfur-reduction methods are indeed removing sulfur by at least the specified percentage. In effect, use of a CEMS separates the problem of estimating emissions from the operator's actions to control emissions.

Information concerning the capital and operating costs of CEMS was solicited in the confidential questionnaire that MIT/CEEPR sent to electric utilities as part of this research project. Responses were obtained from 130 Phase I units possessing 48,256 MW^e of generating capacity (29% and 37% of the respective totals for the number and capacity of Phase I-affected units). The total cost for these 130 units and the average cost per unit and per KW^e of capacity are reported in Table 11. Assuming these costs are representative of the whole, the additional cost of monitoring for Title IV in 1995 amounted to \$48–54 million, depending on whether extrapolation is made by capacity or by the number of active Phase I units that installed CEMS that year (*i.e.*, 432).⁴⁸ At 7% of the observed cost of compliance, this extra requirement is noticeable, but not overwhelming; we provide no estimate of what alternative methods for monitoring emissions might have cost.

In the end, CEMS represents an additional administrative cost that may have encouraged more emissions trading and greater cost savings than would have been the case otherwise. Emissions trading requires low transaction costs and confidence that the tradable permit will be regarded as valid when presented for

⁴⁸ Subject to some exemptions for alternative measuring devices, Title IV also required that CEMS be installed by 1995 on all Phase II stacks as well as on Phase I stacks: 447 additional units, totaling 98.6 GW^e of capacity, will be sub-

ject to Title IV controls in Phase II, beginning in the year 2000. By the same methods of extrapolation described above, another \$36–55 million in compliance costs were incurred by 1995 for Phase II monitoring.

compliance. To the extent that CEMS has imbued the environmental regulator with sufficient confidence in the accuracy of emissions accounting to dispense with ancillary review and approval of emissions reductions, transaction costs have been reduced and greater emissions trading enabled. And, if more trading implies greater cost savings, as we believe it does, what began as political expediency may have proved to be a worthwhile investment.

TABLE 11. COST OF CEMS

Cost Category	Total (x10 ³)	Per Unit	Per Kw ^a
Initial Capital Cost	\$92,135	\$709,000	\$1.91
Annualized @11%	\$10,135	\$ 77,227	\$.21
Annual Operating Cost	\$ 6,080	\$ 46,780	\$.16
Total Cost for 1995	\$16,215	\$124,007	\$.37

Source: MIT/CEEPR Title IV Questionnaire.

VI.

WHY ALLOWANCE PRICES ARE SO LOW

One of the greater surprises in the implementation of Title IV has been the lower-than-expected price of allowances. While total costs, as we have seen, have also been on the low side of predictions, allowance prices have been much lower than the long-run marginal cost of abatement, which they would approximate in a well-functioning market at long-run equilibrium with reasonably good information and low transaction costs. Even more surprising, they are less than the average total cost of abatement which, in a world of efficient compliance decisions and varying abatement cost among units, would be lower than long-run marginal cost. As presented in Table 8 and Figure 8, the average total cost and the long-run marginal cost of abatement in 1995 were approximately \$200 and \$300 a ton, respectively; yet, since Phase I began, allowance prices have ranged from only \$70 to \$130.

Two explanations for the unexpectedly low allowance prices are frequently advanced. The first is that the disparity reflects serious imperfections in the allowance market, driven largely by defects in the EPA auctions. Like all real markets, the allowance market has not operated perfectly at all times. However, our analysis of its evolution strongly suggests that it evolved quickly into a well-functioning market with low transaction costs, price transparency, and extensive trading activity.

A second explanation for the gap between allowance prices and average abatement costs is that some utilities were forced by political pressures, reinforced by the utilities' status as geographic monopolies subject to cost-plus regulation, to invest in high-cost abatement technologies—in particular, scrubbers—which facilitated their continued use of local high-sulfur coal deposits, thereby helping to protect local businesses and jobs. Indeed, Title IV explicitly encourages the use of scrubbers through special bonus-allowance provisions. This type of behavior has two effects. First, it increases compliance costs above the "least cost" level and makes it difficult to identify a textbook "least cost" marginal compliance cost curve. Second, since scrubbers remove about 95% of the sulfur in flue gas, units installing scrubbers require many fewer allowances to cover emissions than they were issued for Phase I. Thus, "inefficient" scrubbing effectively increases the

supply of allowances available for sale or banking for future use, and helps to drive down allowance prices.

Some of the investment in scrubbing has been driven by a combination of political pressures and subsidies provided by Title IV; however, we do not believe this is the primary explanation for low allowance prices. Many scrubbers that had been planned at the time Title IV was passed were subsequently canceled for economic reasons—including scrubbers in areas where there was substantial pressure to continue using local high-sulfur coal. Moreover, implementation of Title IV coincided with the introduction of public policies for increasing competitive pressures on traditional, regulated monopoly utilities. This in turn has increased utilities' reluctance to make long-lived investments that might not be recovered in a competitive market. We believe, instead, that the gap between allowance prices and observed average total and long-run incremental abatement costs reflects the fact that long-lived investments in compliance technology and long-term fuel commitments were made well in advance of compliance deadlines, when future allowance prices, fuel prices, abatement costs, and electricity prices were all still uncertain.

One of the two principal means of abatement under Title IV—scrubbing—is capital-intensive, and the contracting and construction lead time for placing a scrubber in service is two to three years. Consequently, decisions to comply with Title IV by scrubbing required commitments in 1992–93, when information about allowance prices was not particularly good.⁴⁹ The economics of scrubbing may have looked relatively attractive in 1992, when allowance prices were expected to be \$300 or higher. In retrospect, with allowance prices around \$100 in 1995, the *ex ante* economics of building scrubbers are much less favorable; the capital is already sunk, however, and, with operating costs at about \$65 per ton, the *ex post* economics of operating scrubbers are favorable. As a result, today's supply of allowances reflects past expectations about allowance prices, now embedded in irreversible investments.

⁴⁹ For instance, it is now evident that there was a general failure to appreciate the extent to which switching to PRB coals for purely economic reasons would reduce the demand for abatement and increase the supply of allowances. In this regard, one key assumption in ICF's early studies of compliance cost deserves quotation in full: "These analyses assume that no subbituminous coals can be used in boilers designed for bituminous coals. However, many boilers in the Midwest have begun to experiment with subbituminous coals (either wholly or in

blends), and this could be a low-cost emissions reduction option in many applications. As such, compliance costs . . . could be lower than presented herein, and coal market impacts different. Recent analysis conducted by ICF Resources suggests that about 40–50 million tons of subbituminous coals could penetrate the bituminous boiler markets, largely displacing bituminous coal shipments from the West, but also displacing some midwestern high-sulfur coal use." [ICF (1990), p. 36] As it turned out, 70 million tons of PRB coal were burned in Phase I-affected units in 1995.

The role of expectations in the choice to scrub is clearly indicated by responses to the MIT/CEEPR questionnaire. Respondents accounted for about half of the total retrofitted scrubber capacity. Of this group, operators representing 5000 MW⁵⁰ of retrofitted capacity (75% of the retrofitted capacity operated by respondents) indicated that expectations of allowance prices of \$300 to \$400 were "very important" in decisions to scrub, which were made before the EPA auction in March 1993 offered the first signal that allowance prices might be significantly lower than expected. Responses also identified about 3600 MW⁵⁰ of capacity for which scrubbing had been the initial—but not the final—choice; one-third of these responses stated that the initial decision was reversed due to "low allowance prices."⁵⁰

Although fuel switching is generally a more flexible form of compliance, contracts can and do contain irreversible elements that operate analogously to those complicating investments in scrubbers. Any utility fuel manager planning to comply at a Phase I-affected unit by switching to lower-sulfur coal would be faced with the decision of whether to sign a contract prior to 1995 for low-sulfur coal supplies during part or all of Phase I, procure coal on the spot market, or some combination thereof. A premium would be paid for the lower-sulfur coal in either case, and the choice would be whether to lock in a premium (and the Btu value of the coal) in 1993 or 1994, or pay whatever the spot market required in 1995 and thereafter. Fears of "fly-ups" for low-sulfur coal prices [*cf.* ICF (1990), p. 37] and other uncertainties motivated many to sign contracts for low-sulfur coal in 1992–94 at the premiums then prevailing. Although such contracts do provide the buyer protection against price increases, they also prevent the buyer from taking advantage of lower-than-expected prices—in this case, purchasing less low-sulfur coal and using more allowances. As a result, the supply of compliance from such sources was, like that from scrubbers, more a reflection of price expectations when contracting and investment decisions were made than a response to prices realized *ex post*.

⁵⁰ Among those who initially planned to scrub but decided otherwise, two-thirds stated that the decision was based upon a fall in low-sulfur coal prices relative to scrubber costs. The CEEPR/MIT questionnaire responses also make it clear that allowance prices were not the only consideration in decisions to retrofit a scrubber.

One quarter of respondents with scrubbers stated that allowance prices were not an important consideration in the choice to scrub; for instance, one operator made the commitment to scrub prior to passage of the 1990 CAAA, as the result of a Clean Coal Technology Program award.

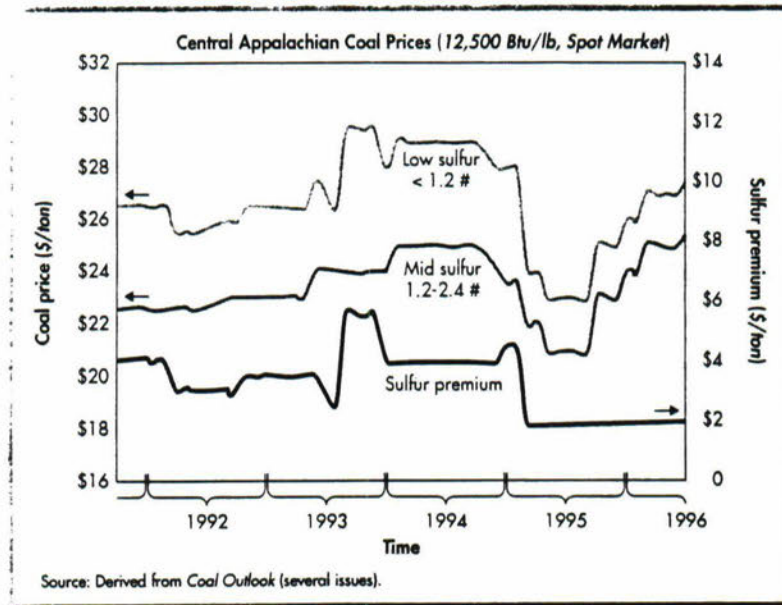
Many utilities subject to Phase I committed to abatement strategies by making investment and contractual decisions in the early 1990s based on expectations then prevailing about Phase I allowance and fuel prices. Looking forward from 1993, these decisions looked like they would be economical because allowance prices were expected to be much higher than what now appears to be their Phase I equilibrium level, and low-sulfur coal and transportation costs were expected to be higher than they have turned out to be. As time passed, allowance prices and abatement costs proved to be lower than expected, and alternatives to scrubbing now look much more attractive than they did when commitments to build scrubbers were made and long-term coal supply contracts were signed. However, once the investment and contractual commitments had been made, the supply of allowances from these sources was fixed, so that when the demand for allowances turned out to be less than expected, the current market was over-supplied. As a result, both short-run allowance prices and (because of banking) the trajectory of future allowance prices are below what they would have been, had investment and contracting decisions been made in a world where decision-makers had perfect foresight.

Evidence for the oversupply of abatement can be seen in the evolution of the premium paid for lower-sulfur coal in Central Appalachia, the main coal-producing region. The top two lines in Figure 9 show the spot prices of low- and mid-sulfur coal, respectively, produced in Central Appalachia from late 1991 through early 1996. The bottom line—for which the value is plotted on the right-hand axis—is the sulfur premium: the difference in price between these two coals. The premium fell from \$4/ton to \$2/ton of coal at the beginning of 1995, when Title IV—and thus compliance with it—first came into effect. A reduction in the premium paid for lower-sulfur coal was not a predicted effect of Title IV, but it did reflect the balance of supply and demand for abatement in 1995: every dollar difference between the two coals shown in Figure 9 equates to approximately \$65 of allowance value.⁵¹ At the equivalent of an allowance price of \$260, the coal sulfur premium during 1993 and 1994 was in line with earlier predictions of allowance value; when compliance became mandatory in 1995 and allowances were available at \$130 and lower, however, it made no sense to pay \$4 per ton of coal more for the lower-sulfur product. Suppliers of low-sulfur coal may have been hoping that the onset of actual compliance with Title IV would justify the

⁵¹ The prices in Figure 9 are representative for typical coals; the premium calculation for specific coals will differ. The Figure 9 premium calculation compares a 1.2 #/mmBtu coal with a 2.4 #/mmBtu coal. With 12,500 Btu/lb, each short ton of these coals would emit 30 or 60 lb

of SO₂, respectively $((12,500 \times 2,000 + 10^6) \times 1.2 \text{ or } 2.4)$. Thus, for every ton of 1.2 #/mmBtu coal burned in place of 2.4 #/mmBtu coal, SO₂ emissions are reduced by 30 lb. Every dollar difference in the price of these coals is worth \$67 in allowance value $(\$1.00 \div 30 \times 2,000)$.

Figure 9



expectation-based premium that existed prior to 1995; but that premium would be sustained only if allowance prices rose. When they did not, because there was more than enough current abatement being supplied at the existing allowance price, the absence of demand for low-sulfur coal left no alternative but to reduce spot prices for low-sulfur coal so that the difference between them and the spot prices of mid-sulfur coals was consistent with the value being accorded additional abatement by the (spot) allowance market.

In the short run, the price of an allowance reflects the current demand for and supply of abatement, given the investment in scrubbers and contract commitments.⁵² Once capital costs are sunk, long-run cost is no longer relevant for existing scrubbers, which will be utilized so long as allowance prices cover operating costs. Indeed, given the magnitude of abatement supplied by scrubbers, the operating cost for scrubbing constitutes the effective floor for allowance prices.⁵³

⁵² About 70% of coal deliveries (in Btu) to Phase I plants in 1993 were under contracts lasting two to 20 years or more, and 67% for the case of Central Appalachian coals (FERC Form 423; Pasha, 1993 and 1995).

⁵³ We were informed that when allowance prices sank to around \$70 in the first quarter of 1996, some scrubbers were pulled off-line for maintenance; other operators have told us they considered shut-down or actually reduced removal efficiencies.

Contracts for low-sulfur coal similarly limit the response to current price, but their influence is more limited, since contracts expire. In fact, the short-run marginal price of allowances is largely determined by the supply of and demand for abatement from uncommitted parties who have the flexibility to purchase or supply lower- or higher-sulfur coals as allowance prices and delivered costs warrant.

It is evident, *ex post*, that there has been overinvestment in abatement. Additional abatement can be supplied very cheaply in Phase I because of the now-sunk investment in scrubbers and their now-evident, lower-than-expected operating cost. When coupled with low-sulfur coal contract commitments, the supply of abatement in 1995 was more than enough to meet the 1995 emission cap. However, with current abatement so cheap, the demand for future abatement generated by Title IV's banking provisions has been sufficient to ensure that most unused allowances are reserved for later use. In effect, banking compensates for today's overinvestment by deferring the time when additional investment in abatement will be required.

Mistaken expectations assume a large role in explaining what we believe to have been overinvestment in abatement in 1995, but not all investment in scrubbers should be attributed to this cause. Various initiatives have been taken at the state level to encourage the building of scrubbers to protect local coal production, and Title IV itself provided significant incentives in the form of Phase I extension bonus allowances to build scrubbers during Phase I. Neither the bonus allowance provisions nor state initiatives can be considered unexpected developments, although it is possible that market participants did not adequately appreciate the extent to which the resulting supply of allowances would affect Phase I prices. Had predictions of future allowance values been more prescient prior to 1995, the disparity observed today between long-run and short-run marginal costs would not be so great because there would have been less investment in scrubbers and perhaps lower-volume contract commitments to low-sulfur coal. At the same time, it must be recognized that today's short-run marginal cost (and allowance price) would not have prevailed had there been perfect foresight. Had fewer scrubbers been built and lower-volume contract commitments to low-sulfur coal been made, the supply of abatement in 1995 would have been less and allowance prices higher.

All this suggests that the allowance and coal markets, like all real markets, are neither perfectly informed nor continually in long-run equilibrium. Were they so, allowance prices would have been higher and the average total cost of abatement in 1995 would no doubt have been somewhat lower. As we shall now argue, however, costs would most likely have been substantially higher had a market-based policy not been adopted.

COST SAVINGS FROM EMISSIONS TRADING

Since the time Title IV was proposed, it has been generally accepted that emissions trading could reduce the cost of compliance, but questions of how much emissions trading would occur and what its impact on cost would be have generated considerable disagreement. The emergence of an allowance market, as discussed in Section IV above, indicates that electric utilities have been trading allowances. More specifically, the reconciliation of allowances and emissions, as shown by Figure 6, provides a precise measure of the importance of emissions trading in 1995: 45 percent of 1995 vintage allowances were used in a manner that implied cost savings from either spatial or intertemporal emissions trading. It can reasonably be assumed that the cost of the 534,000 allowances acquired by transfer or purchase to cover emissions in excess of the allowances issued to 98 Phase I-affected units was less than the cost of the emissions reduction thereby avoided. Similarly, it is likely that the 3.25 million allowances not used to cover emissions in 1995 were banked⁵⁴ in order to avoid future emissions reductions expected to be at least as expensive (when discounted) as the cost of any alternative use of those allowances. Setting aside the actual cost of acquiring allowances (which may have been zero), there was an opportunity cost: any allowance could have been sold in 1995 at a market price ranging from \$109 to \$138.

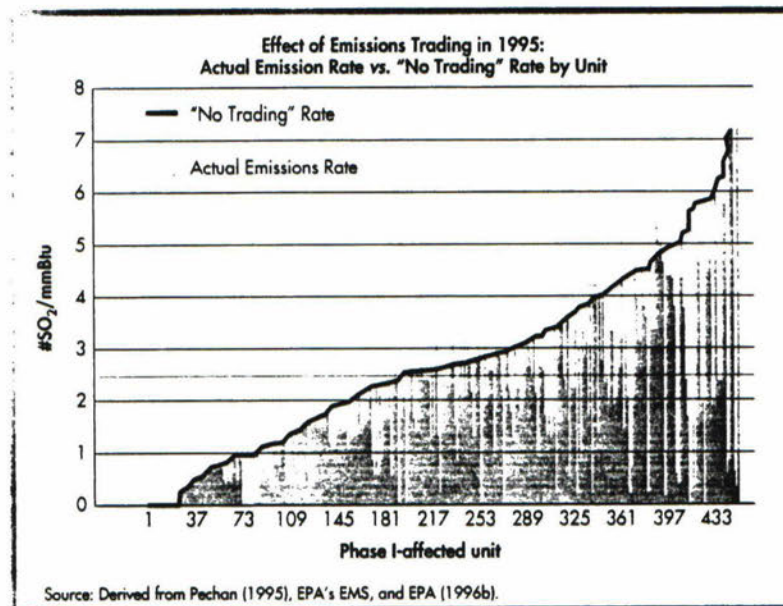
Further evidence of cost-saving emissions trading is provided by the extent to which the actual 1995 emission rate at affected units deviated from what it would have been, had operators not been permitted to trade allowances and been required instead to keep emissions within the allowance allocation for each affected unit. In such a case, one of two emission rates would be relevant for every affected unit: a "1995 allowance rate"—what would have been "permitted" by the allowance issuance to the unit, given 1995 heat input—or the counterfactual (1993) emission rate. Operators of units for which the counterfactual rate was higher than the allowance rate would have to reduce emissions to achieve the latter rate, while operators of units for which the allowance rate was not con-

⁵⁴ This number includes only those allowances distributed to utilities in 1995. The total bank of 3.4 million allowances includes another 150,000 allowances sold through EPA auctions.

straining would have no reason to change from the counterfactual rate. Figure 10 arrays the 445 Phase I-affected units by the lesser of these two rates at each unit, and compares the resulting "no trading" emissions rate with the actual 1995 rate. Most units' actual rates deviate significantly above or below the "no trading" rate. Those with a higher 1995 emissions rate were mostly units short of allowances that found it cheaper to acquire additional allowances than to incur the cost of reducing emissions to match the number of allowances issued them. Conversely, for those units with a lower actual 1995 emissions rate, the value of additional allowances justified the *short-run* marginal cost of further emissions reduction. Although some change from the "no trading" emissions rate could have been expected as a result of normal variability in sulfur content, the magnitude and number of deviations observed strongly indicate that managers of Phase I-affected units were not taking the allocation of allowances to particular units as given. As Figure 10 shows, operators of most Phase I-affected units took advantage of emissions trading, presumably to reduce the cost of compliance with Title IV.

Other evidence of cost-saving emissions trading can be found in the collapse of the sulfur premium in Central Appalachia. If utilities had not been equating the current marginal cost of abatement to allowance prices, there would have been

Figure 10



no downward pressure on the coal sulfur premium in 1995. Utility coal-buyers would have continued to buy lower-sulfur coal at comparatively high premiums and continued to supply an increasingly glutted allowance market. Instead, arbitrage was effective between the paper (allowance) and real (coal) markets for sulfur removal, as buyers and suppliers of higher-sulfur coals realized that the higher-sulfur product bundled with allowances was a cheaper means of compliance than lower-sulfur coal at prices then being offered. The bundling of allowances with higher-sulfur coals (typically exceeding some contractually specified level, such as 2.5 #/mmBtu) has been frequently reported in the trade press; in fact, coal companies have established accounts in EPA's Allowance Tracking System to facilitate bundling.⁵⁵ The arbitrage between allowance and coal markets also demonstrates that utility buyers are taking advantage of the cost-saving opportunities made possible by emissions trading. Furthermore, the bundling of allowances shows that, independently of utility actions, cost-saving compliance is being supplied innovatively by parties that otherwise receive no allocation of allowances to use for final compliance.

The behavior observed in 1995 provides compelling evidence that emissions trading has lowered costs of compliance, but does not indicate the magnitude of savings achieved. Earlier studies of compliance costs with Title IV have provided estimates of the potential savings, derived by both the differences in predicted costs between scenarios that assumed more and less trading, and variations among these studies in the amount of assumed emissions trading and in the corresponding costs:

- ICF's 1989 analysis predicted the cost savings for limited trading among utilities within the same state to be approximately \$225 million (in 1988 dollars), about 33% of the predicted cost of compliance in the "less trading" case.⁵⁶ In addition, ICF89 estimated that banking provisions might result in an additional annual reduction of emissions in Phase I of between 0.8 and 1.2 million tons, resulting in a present-value cost savings of \$150 million, about a third of the predicted cost of avoided Phase II emissions reductions.

⁵⁵ Since the ATS was established in March 1994, accounts have been opened and maintained by Peabody Coal Company, Cyprus Amax Coal Sales Co., Canterbury Coal Company, Cooney Brothers Coal Co., Courmey F. Foos Coal Company, Eastern Associated Coal Corp., Kerr-McGee Coal Corp., Marine Coal Sales Co., and no doubt others for which the name of the account holder does not reveal coal industry affiliation. As of the end of the reconciliation of accounts for 1995, 71,577 allowances had been deposited into these accounts and 54,883 had been withdrawn. These amounts are not large,

given the volume of coal sales, mostly because utility-fuel buyers can perform the same bundling function as coal companies by using their own allowances.

⁵⁶ ICF90 does not provide a comparable estimate of cost savings from emissions trading because it assumed flexible implementation ("trading to the fullest extent permitted") for both the higher- and lower-growth scenarios modelled (ICF90, p. 1).

- EPA's 1992 Regulatory Impact Analysis (RIA) predicted cost savings of 40%, or \$400 million (in 1990 dollars), from a "national SO₂ trading program" as compared with a "traditional SO₂ control program."

- The 1994 GAO report provided an estimate for intra-utility trading only, because very little interutility trading was expected: \$230 million (in 1992 dollars), or 18% of the predicted cost of compliance under a "traditional command-and-control" approach.

Both the ICF and EPRI/GAO⁵⁷ studies projected some emissions trading, but the earlier ICF studies appear to have been more optimistic about the amount of trading. When normalized for the amount of abatement projected, the ICF studies predicted average costs of compliance at around \$200 per ton, whereas the EPRI/GAO studies predicted costs of \$300 per ton. If this difference is due mostly to the apparent differences in assumption about emissions trading, cost savings from trading of about 33% are indicated.

An estimate of the cost savings from emissions trading requires not only a measure of the amount of emissions trading, but also an estimate of the cost of an assumed and unobserved alternative in which there was no trading. The amount of emissions trading in 1995 is no longer a matter of conjecture so that, at least in principle, this component of the difference that constitutes cost savings is fixed; the other component—the alternative command-and-control program from which savings are measured—is not, however. If the comparison were made with a theoretically ideal command-and-control system, cost savings would be small and perhaps nonexistent. On the other hand, a comparison with the worst imaginable command-and-control system could produce unbounded cost savings. There is plenty of room for disagreement about the command-and-control alternative and the resulting magnitude of cost savings, so any choice is at best illustrative.

The alternative we specify assumes that annual SO₂ emissions limits are established for each generating unit equal to the number of allowances allocated to individual units under Title IV. However, we permit no trading between units—either intra- or interutility. Under this "no-trading" alternative, each unit effectively cannot produce more emissions than its initial allocation of allowances. Moreover, any generating unit that produces a lower level of emissions cannot sell its unused allowances, and thus cannot benefit from operating below its

⁵⁷ The two EPRI studies and GAO study are grouped together here because their estimates of average cost are so similar and these studies were also conducted by the same contractor.

emissions cap. This alternative is inherently a lower-cost benchmark against which to compare Title IV's trading program than other potential "command-and-control" alternatives would be. For example, if we were to assume that the alternative regulations require all generating units to achieve equal maximum emissions rates or equal percentage reductions of emissions, or that the law mandates scrubbing for a large fraction of units, the baseline costs of the alternative command-and-control program would be much higher.

Our "no-trading" alternative can be viewed as appropriate for several reasons. First, the objective is to estimate savings from emissions trading, broadly defined—among units owned by the same operator as well as among operators. Although most observers assumed that *intra*-utility trading would occur, neither the novelty nor the cost savings of unrestricted *intra*-utility emissions trading should be minimized. Second, a "no trading" formulation of the alternative to Title IV's innovative emissions trading provisions is consistent with the well-established precedent of source-specific emission limitations under the existing Clean Air Act (CAA). While CAA legislation and regulation prior to 1990 permitted "bubbles" and "offsets" of varying scope, such emissions trading was not a matter of right, as in Title IV, but could be obtained only by detailed application, with explicit, case-specific approval of the regulatory authority.⁵⁸ Lastly, this formulation of the alternative to emissions trading seems less arbitrary than either taking some degree of *intra*-utility emissions trading for granted, as did some earlier studies, or adopting other plausible command-and-control alternatives, such as incorporated in earlier legislative proposals.

Specification of an appropriate measure of cost savings is a necessary first step, but obtaining a reliable estimate from actual data *ex post* poses further difficulties. In contrast to the consistent behavior assumed in model simulations upon which earlier estimates of potential cost savings were based, actual data include all the consequences of the uncertainties and mistakes characterizing real markets. Simplifying assumptions can impart sufficient order to observed data to obtain an estimate, but those assumptions can be debated; indeed, data are often subject to differing interpretations.

A first issue of interpretation concerns the treatment of "excess" allowances. Of the 263 Table A units, only 155 were constrained in 1995 by the unit-level allowance allocation; the other 108 faced no requirement to reduce emissions since they received more allowances than needed to cover counterfactual emissions. With no emissions trading, the 155 constrained units would have been

⁵⁸ See Hahn (1989), Hahn and Hester (1989), and Montero (1997b) for information on the limited response to such trading opportunities.

required to reduce emissions by 2.02 million tons, in the aggregate, while the 108 units that were not constrained would have received a total of 0.96 million "excess" but worthless allowances. With emissions trading, these "excess" allowances could be used to avoid the costs associated with emissions reductions, currently or prospectively.

It is important to recognize that these "excess" allowances are not so much the result of an inappropriate or arbitrary allocation of emission permits as they are a

TABLE 12. CONSTRAINED TABLE A UNITS, 1985 AND 1995

	Constrained in 1985	Unconstrained in 1985	Total
Constrained in 1995	134	21	155
More than in 1985	62	21	83
Less than in 1985	72	NA	72
Unconstrained in 1995	80	28	108
Total	214	49	263

Source: Derived from EPA Emissions Monitoring System.

Note: "Constrained" means that the number of allowances issued to the unit in a given year (for 1985, baseline—average 1985–87—heat input times the 1985 emissions rate; for 1995, 1995 heat input times the counterfactual—1993—emission rate) is less than the number of tons of emissions that year. "More than" and "less than" here relate to the absolute difference between allowances and emissions. For example, a unit that is *less* constrained in 1995 than in 1985 is one for which the emission rate, heat input, or both, have changed such that counterfactual 1995 emissions are less than baseline 1985 emissions.

consequence of changes that inevitably accompany the passage of time. Table A units were selected based on 1985 emission rates, and allowances were allocated based on average heat input during the three years 1985–87; yet, the allowances would not be used until 1995. In the intervening ten years, heat input varied because of load growth and changes in relative operating costs at particular units, and emission rates varied because of changes in the economics of fuel supply. Table 12 shows how many units would have been constrained by the allowance issuance based both on 1985 emission rates and baseline (average 1985–87) heat input, and on counterfactual 1995 emission rates and heat input.

For instance, 152 (= 72 + 80) of the 214 units that appeared constrained in 1985 experienced changes in emission rates and heat input over the next decade that rendered the allowance constraint *less* binding; for 80 of these units, the changes were sufficient to make the allowance constraint nonbinding. Over the same time period, 62 of the 214 units became *more* constrained, primarily because of

increasing heat input, as did 21 of the 49 Table A units that appeared not to be constrained in 1985. In the end, for about 60% of Table A units, intervening changes rendered the Title IV constraint less binding and less costly, while about a third of the units experienced the opposite effect.

The 960,000 "excess" allowances in 1995 are one source of cost savings from emissions trading. The cost of these allowances was zero, and they could have been used to avoid the cost of emission reductions in like amount at units that were constrained in 1995. Although some of these allowances may have been so used, in the aggregate they were not. Rather, they were banked, as were 2.4 million other allowances, presumably because avoiding the more stringent Phase II reductions offered greater cost savings. Since any one of these "excess" allowances could have been sold in the allowance market in 1995 for somewhat more than \$100 each, cost savings of at least \$100 million are indicated.

Banking leads to another complication: the future cost that will be avoided by banking has yet to be realized. The banking and the motivating expectation of cost savings are real, but the latter is subject to some variation. Every electric utility compliance manager has a good current estimate of the cost of further emission reductions in Phase II for his system; but, with a well-functioning allowance market, the amount of further reduction on any given system will depend on the future market value of allowances. And however well the cost of further reduction on the manager's system is known, all would likely admit to considerable uncertainty concerning future allowance prices, which depend on compliance costs at other utilities and, more generally, on the magnitude of the aggregate emissions reduction required to comply with Phase II. The supply of allowances is fixed, but factors affecting the demand for allowances are not: for instance, load growth for all systems, the further penetration of PRB coals, the effects of electric utility restructuring, and the effect of other environmental regulation (such as the fine particulate matter standard) on the demand for electricity and on the choice of generating fuel. Thus, although no compliance manager expects to lose money by banking, the possibility exists that the future costs avoided as allowance banks are drawn down will be less on a discounted basis than the actual or opportunity costs currently incurred.

The overinvestment in compliance due to pre-1995 expectations of compliance costs and allowance prices also complicates an estimate of cost savings from banking. Overinvestment in compliance leads to both greater costs in the current period and lower allowance prices than would be the case in long-run equilibrium. The lower Phase I-allowance price economically justifies more banking, but the sunk capital costs do not figure in that current price, while future costs of

deferred Phase II reductions include the capital component of least-cost Phase II abatement options. As a result, cost savings from banking depend on which present costs are subtracted from the avoided future costs. If the cost of sunk capital is treated as a bygone, as it is in the oversupplied current market, cost savings from the banking occasioned by overinvestment in compliance are likely to be large. However, if the cost of sunk capital is included, no cost savings whatsoever may be realized.

Uncertainty about the higher costs avoided by emissions trading impacts decisions affecting current-year operations, as well as decisions to bank allowances for future use. In 1995, 71 of the 155 constrained Table A units did not reduce emissions by the amount implied by their allowance issuance; instead, they obtained a total of 456,000 additional allowances from other, overcomplying sources. Even though these cost savings were actual—in contrast to what can be only prospective savings with banked allowances—the cost savings estimate is uncertain because costs avoided by acquisition of these additional allowances cannot be observed.

The treatment of substitution and compensation units presents a further confounding factor in any estimate of cost savings from emissions trading in 1995. This provision of Title IV sought to provide further opportunities for cost savings by allowing Phase II units to make voluntary emissions reductions in Phase I. Though this option generated a large response, its contribution to the aggregate emissions reduction in 1995 was relatively small: about 213,000 tons, or about 5%, of the total 3.9-million-ton reduction. Moreover, some 242,000 “excess” allowances were distributed to these units in the aggregate that, like the analogous allowances for Table A units, can be used to avoid costs associated with current or prospective emissions reductions.⁵⁹ Although actual or prospective cost savings can be presumed for the additional 213,000-ton emissions reduction attributable to substitution and compensation units, interpretation of the abatement costs avoided by the 242,000 “excess” allowances is more problematical, in that an argument can be made that the cap has been violated.⁶⁰

⁵⁹ In theory, there should be no issuance of “excess” allowances for substitution units, but the same problem is encountered here as with the Table A units: changes occurring between the time when the baseline is determined and actual implementation. Specification of the appropriate baseline for distributing allowances to substitution units was the major point of litigation in implementation of Title IV; the result was an updated but more complex baseline. The reality of the issuance of allowances to sub-

stitution and compensation units is more complex than suggested here. Actually, 394,000 “excess” allowances were distributed to 132 substitution and compensation units; the remaining 60 substitution units, however, were short a total of 152,000 allowances.

⁶⁰ See Montero (1997a and 1997b) for extensive discussions of the empirical and theoretical aspects of Title IV’s voluntary compliance program.

A final challenge in estimating cost savings involves the identification and inclusion of cost-reducing innovations that may have been induced by the flexibility associated with emissions trading. The penetration of PRB coals would not have been as great, had ways not been found to adapt midwestern boilers built for local bituminous coals to blends with these sub-bituminous coals. While such adaptation was observed prior to 1990 in response to the increasingly attractive delivered price of PRB coals, the diffusion of this innovation may well have been accelerated by Title IV. Similarly, the lower operating cost and greater utilization of Title IV scrubbers reduced compliance costs in 1995, but it is unclear whether the cause of this reduction had to do with exogenous change in information technology, a more competitive regulatory environment, or the incentives for lower cost and greater utilization provided by emissions trading. No doubt, other examples of innovation that reduced compliance costs exist, but the problem of attribution to emissions trading remains.

Such a summary of qualifications and ambiguities should offer the reader a fuller appreciation of the difficulties of reliably estimating cost savings from Title IV's emissions trading provisions—or of even posing the question well. A tentative estimate by one of the present authors indicates savings of \$225–375 million dollars (1995), or what amounts to 25–34% of the cost of abatement for the same emissions reduction in the absence of trading.⁶¹ This estimate indicates cost savings within the range that can be derived from the earlier studies of compliance cost with Title IV, though it is low, given that the volume of emissions trading in 1995 was much higher than that predicted by all earlier studies.⁶² In any case, this estimate is less than the magnitudes often attributed to the use of market-based instruments in the academic literature. In a frequently used textbook, Tietenberg (1992)⁶³ cites earlier studies covering a variety of pollutants, for which the ratio of cost for a traditional command-and-control program compared to a least-cost market-based approach is usually greater than 4 and may be as high as 22 (equivalently, savings range from 75% to 95%), although the two studies cited for SO₂ control have ratios of 1.78 and 4.25 (savings of 45% and 76%).

⁶¹ See Ellerman (1997).

⁶² All earlier studies predicted much less banking than actually occurred. For instance, ICF90 projected 243,000 allowances banked in 1995, and while the later EPRI and GAO reports were closer to the mark, with 1.76 million and 2.1 million allowances, respectively, they were still well below the 3.4 million allowances actually banked. A considerable amount of the observed banking must be attributed to the unexpected extent of overinvestment in compliance. In contrast, the

amount of spatial trading in 1995 was less than the more optimistic earlier predictions. For instance, ICF90 anticipated trades totalling 663,000 allowances among states—more than the 540,000 allowances traded spatially in 1995, including intra-utility trades within the same state. In comparison, EPRI93's prediction of 103,000 allowances traded spatially among utilities in 1995 was not far from the actual number of 148,000.

⁶³ *Cf.* p. 403.

Our lower estimates of cost savings from emissions trading under Title IV may reflect little more than the many different ways to define and measure cost savings, but it is also likely that neither the earlier predictions nor actual implementation in 1995 have realized the full potential of cost savings from emissions trading. In any case, savings of even 25% in 1995 are not to be dismissed simply because they are not larger.

It is likely that cost savings from emissions trading are lower than might be supposed because we are evaluating the real—not the ideal—implementation of Title IV. It is all too easy to confound cost savings from emissions trading with the cost savings that might have been realized had compliance been achieved in the most efficient manner possible, in a world with perfect foresight. Hindsight facilitates the identification of investments in retrofitted scrubbers and contractual commitments for low-sulfur coal supplies that would not have been made had it been known at the time of commitment that allowances would be worth significantly less than the \$250–350 commonly predicted for Phase I. The cost of compliance with Title IV would have been lower had the parties not made these irreversible commitments—although, had most parties forestalled their commitments, allowance prices and coal sulfur premia in 1995 would likely have been higher. Finally, the most efficient compliance scenario was precluded by Title IV's own Phase I extension provisions, which provided extra allowances for scrubbers that would operate during Phase I. Although separating overinvestment due to bonus allowances from overinvestment due to mistaken expectations of allowance value would be difficult, the extension provisions almost surely led to more scrubbers than otherwise would have been built during Phase I. In any case, the estimate of 1995 cost savings from emissions trading that is offered here is conditional on Title IV, with respect to both its design and its implementation.



CONCLUDING OBSERVATIONS

The U.S. Acid Rain Program—Title IV of the 1990 Clean Air Act Amendments—is significant both as environmental policy for reducing SO₂ emissions that contribute to acid rain and as a more general experiment in environmental policy. While it is still too early to evaluate fully the performance of Title IV, experience to date suggests a number of conclusions. As environmental policy, and when judged from the perspective of reducing SO₂ emissions at reasonable cost,⁶⁴ Title IV has clearly been a success. Not only did the program more than achieve the SO₂ emissions goal established for Phase I, but it did so on time, without extensive litigation, and at costs lower than predicted. Few environmental programs have succeeded in all these dimensions.

When Title IV is viewed as a more general experiment in environmental policy, however, conclusions must be drawn cautiously. The difficulty of specifying an alternative scenario to which Title IV should be compared is an important complication. A good deal has been written comparing real command-and-control policies with ideal market-based policies. This report has considered a real—and thus imperfect—market-based policy. Comparing it with an unfeasible ideal—whether market-based or command-and-control—makes little sense. Furthermore, there is inevitably arbitrariness in comparisons with hypothetical policies that are also imperfect. Despite these conceptual problems, we believe several important general lessons follow from experience so far with Title IV:

⁶⁴ Inquiry into the benefits of reduced emissions is beyond the scope of this study. NAPAP (1997) provides a discussion of the effects and benefits of the reduction of SO₂ emissions effected so far by Title IV. In general, the pertinent sections state that a statistically significant reduction in sulfur deposition has been observed in 1995 by monitors located in the Northeast and the Ohio River Valley, but that similarly significant changes in the acidity of waters or other indicia of ecosystem response

have not been observed, because of the longer response times of these complex processes.

1. *Foremost, we have learned that large-scale tradable permit programs can work more or less as textbooks describe.* By providing flexibility to emitters, such programs can achieve both the environmental objective and a reduction in compliance costs. Though it is difficult in both principle and practice to quantify the cost savings achieved thus far by Title IV, we believe our analysis establishes that those savings have been substantial. Given the controversy this approach to environmental policy sparked when first proposed, it is heartening that this lesson appears to have been widely learned.

Indeed, some observers seem to have learned this lesson too well, coming to regard the tradable permit approach as a viable solution for almost any environmental problem. Available evidence from Title IV does not support this view. While allowance prices have been less than half of earlier forecasts, the difference between expected and actual compliance cost has been much less dramatic. In addition, some of the difference in cost has been unrelated to Title IV—for instance, the significant and apparently unforeseen lower delivered price of low-sulfur coal from the Powder River Basin. A fair conclusion to be drawn from experience to date with Title IV is that tradable allowances offer a valuable policy tool—not a panacea or even necessarily the best approach to all environmental challenges.

2. *One can expect a tradable allowance program both to produce surprises and to adapt reasonably efficiently to them.* The more flexible a regulatory program, the more unexpected behavior it will produce as regulated firms exercise ingenuity in adapting to the new requirement and to unexpected events in related markets that affect efficient control strategies and optimal emission levels. Fundamentally, the fixed emissions ceiling of a tradable allowance program minimizes the potential environmental harm such cleverness can produce. The big surprise here was the rapid expansion of the market area for Powder River Basin coal, due mostly to the reduction of rail rates caused by the deregulation of railroads in the 1980s. As a result, the emissions reduction required in the Midwest was less than expected, but the allowances thereby made available were not used to lessen emission reductions at units located closer to the sensitive environmental areas in the Northeast. Instead, these extra allowances were saved for later use to ease the transition to more stringent Phase II emission reduction requirements.

The Title IV program did not adapt perfectly to this surprise. More investment in scrubbing occurred than would have been optimal had the required emission reductions and allowance prices been predicted more accurately *ex ante*. But the market did react to the information contained in the allowance prices revealed by the first EPA auction, and orders for some scrubbers were canceled. The banking provisions then ensured emission reductions beyond what was

required to meet the cap, without new legislation or regulation, because these reductions were cheap *ex post*. It is hard to imagine any command-and-control regime adapting as sensibly to such an important exogenous event, particularly since such programs generally lack any incentives for the production or dissemination of information. The response here was not only cost-effective, but also environmentally beneficial, particularly for a pollutant whose effects are thought to be cumulative. From this experience, banking appears to be a potentially important source of cost savings in tradable-permit programs.

3. *"Opt-in" provisions need to be carefully considered, as they may not always be advantageous.* Many of the complexities and administrative difficulties encountered thus far in the Acid Rain Program reflect the fact that Phase I covers some—but not all—sources of SO₂ emissions. The program included substitution and compensation provisions for electric utility generating units and opt-in provisions for industrial sources to permit the substitution of lower-cost emissions reductions where possible. The response by electric utility units was substantial; however, the overall contribution of these units to the 1995 emissions reduction was small, as was the cost savings from emissions trading with these units. The widespread participation by electric utility sources appears to have been induced by over-generous allowance allocations that will result, in all likelihood, in some increase in emissions. The slight increase of emissions over the course of the program will occur because any "opt-in" provision that is attractive to some emitters for cost-saving reasons is almost certain to involve provision of unneeded allowances to at least a few who are likely also to opt in. In retrospect, it appears that the most cost-effective Title IV emission reductions were to be found at the more highly emitting units—which were, by design, those required to participate in Phase I.
4. *Efficient, competitive markets for tradable permits can develop when program design and implementation are favorable.* Title IV was signed into law in November 1990, and its final rules adopted in January 1993. Our analysis indicates that by around the middle of 1994, an efficient market for allowances had emerged. Important contributing factors to the development of this market were the fundamental design of an "allowance" and the subsequent implementation of the Acid Rain Program by the EPA. The key design elements were, first, that *de facto* rights to emit SO₂ were being traded rather than reductions of SO₂ emissions, and second, that each allowance was worth the same amount (one ton of SO₂) regardless of when or between whom it was traded. The distinction between trading rights and trading reductions may seem sophistical, since the number of permits implied a significant emissions reduction; however, it is important for the development of a market.

Emissions are what damage the environment, and measuring them is, at least in this case, a relatively routine engineering problem. Specifying and fixing emissions reductions, on the other hand, cannot be done so easily unless it is known in advance what emissions would have been. Such counterfactual emissions levels are never easily ascertained; and the need for administrative review and approval of counterfactual emissions baselines increases transaction costs enormously. In implementation, the EPA deserves significant credit for resisting opportunities to review and approve compliance and trading decisions by private parties and for focusing instead on the integrity of emissions monitoring and on a strict, no-excuse, banker-type accountability for emissions and allowances. The commendable focus on result, without regard to intent or effort, minimized transaction costs and further encouraged the development of the allowance market. Finally, regardless of the theoretical strengths and weaknesses in the design of the EPA-administered allowance auction, the simple fact that a transparent mechanism existed in the early stages of implementation to facilitate the revelation of an allowance price encouraged the development of a market.

One misconception about the allowance market that has appeared several times in the press deserves correction. Trading volume *per se* is no measure of a tradable allowance program's success. A relatively low volume could mean either that transaction costs are so high that many socially beneficial trades are not economic, or that the volume of socially beneficial trades is relatively low. For example, if allowances are allocated to match exactly the cost-minimizing emissions pattern, no trades will occur in an efficient equilibrium because compliance costs cannot be reduced by trading. In the Acid Rain Program, we have seen a remarkable increase in the volume of trading since the program's inception, which suggests both that transaction costs are low and that participants are taking advantage of many opportunities for socially beneficial trades.

5. Experience to date with Title IV makes it clear that *tradable permit programs can neither achieve textbook perfection nor guarantee breakthrough innovations in practice*. The glass is both half empty and half full. We have noted, with 20/20 hindsight, that overinvestment in scrubbing almost certainly occurred because allowance markets took time to develop, and because investment decisions about scrubbers and boiler modifications had to be based on price expectations for low-sulfur coal that proved to be high. In an ideal, textbook world, price discovery would have been instantaneous, resulting in no overinvestment. While one can imagine program design changes that would move toward this ideal, there is no way to reach it in the real world, in which information becomes available over time, and its discovery and dissemination

are costly. On the other hand, since command-and-control programs do not generally embody incentives for information discovery and dissemination, a command-and-control program would likely have translated the initial expectation error into even greater excess cost. Finally, while we have seen instances of innovation that may be attributable at least in part to Title IV—most notably, the sharp fall in the cost of scrubbing compared to expectations, and extensive use of fuel blends involving sub-bituminous PRB coal—we have seen nothing that would qualify as a “breakthrough” in SO₂ abatement technology.

All this suggests one final observation: *experience with and lessons learned from the Acid Rain Program must be applied with care to other environmental objectives.* The Title IV experience provides some support for those who argue that a well-designed tradable allowance program for greenhouse gases is likely to outperform alternative responses to global climate change. However, the Title IV experience also illustrates the complexity of the problem of designing an emissions trading program in the climate change context.⁶⁵ The Title IV program was built on accurate emissions monitoring and strong penalties for violations—elements almost certain to be absent from international agreements on climate. In addition, much of the complexity in Phase I of the Acid Rain Program stems from its partial coverage of relevant sources, a design element almost certain to be present in any international climate agreement. Finally, the Acid Rain Program was designed to specify emission limits once and for all; any sensible climate change regime must permit emission limits to be changed several times, at least, over the course of a century or so. These and other differences can have major impacts on both optimal design and program performance.

⁶⁵ See Schmalensee (1996).

METHODOLOGY OF COST ESTIMATION

The cost of compliance is an incremental concept; it is the additional cost incurred to comply with some environmental or other legal requirement. In the case of Title IV, the cost of compliance is the additional cost of generating electricity at affected units, and consists of components for both capital and operating cost. The capital cost takes the form of an appropriate annual amortization of the initial investment in scrubbers and in equipment required to switch to coals other than those for which a boiler was originally designed. The incremental operating costs are typically the premia attaching to lower-sulfur fuels and the operating costs of running scrubbers. This appendix explains the sources of data and the several conventions we have adopted to arrive at the estimate for the cost of compliance with Title IV that is presented in the body of this report.

The largest single category of expenditure for complying with Title IV is the \$3.5 billion investment in retrofitted scrubbers at 26 Table A units at 15 electricity-generating plants. Because of the cost and the implications for coal choice, electric utility decisions to retrofit scrubbers have been extensively reported in the trade press, and the estimated cost of retrofits has been covered in some detail by earlier studies of Phase I compliance strategies, particularly in the excellent reports sponsored by the Electric Power Research Institute.⁶⁶ The figures reported for investment in retrofitted scrubbers in EPRI95 are nearly identical to those given in response to the MIT/CEEPR questionnaire. Accordingly, for those utilities that did not respond to the questionnaire, we have used the estimates of capital expenditure contained in EPRI95.

The capital investment for switching is not nearly as significant as that for scrubbing, and there is much less information available on this component of compliance cost. As a result, we have placed greater reliance on responses to the MIT/CEEPR questionnaire and also on inference based on changes observed in emissions and the sulfur content of fuel deliveries in 1995. The questionnaire responses indicate that the capital cost associated with switching to a sub-bituminous PRB coal ranges from \$15 to \$75/KW^e, depending on the plant, and that the cost of a switch to other bituminous coals ranges from zero to \$15/KW^e. Where a questionnaire response (and in some cases, other sources) provided the

⁶⁶ EPRI93 and EPRI95.

initial capital investment for switching, that data has been used; otherwise, a default value of \$50/KW⁶⁷ has been adopted where a switch to PRB coal is observed, and a default value of \$10/KW⁶⁸ has been applied to those units where switching to lower-sulfur bituminous coals resulted in an emissions reduction of more than 0.5 #/mmBtu. Both default values are based on responses to the MIT/CEEPR questionnaire.

The initial capital investments in scrubbing and switching are amortized using a simple formula that recognizes interest cost, an allowance for depreciation, and inflation:

$$F_t = \left(\frac{K_0}{T} + rK_t \right) (1 + i)^t$$

where F_t is annual fixed cost for year t , K_0 is the initial investment cost, T is the life of the capital equipment, r is a real interest rate, K_t is the undepreciated investment at the beginning of each year, and i is the inflation rate. All capital is assumed to have a life of 20 years, the real interest rate is estimated at 6.0%, and the inflation rate at 3.0%. Based on this formula, we applied an annual capital charge of 11.33% to the reported or inferred capital investment at the 70 plants that reduced SO₂ emissions noticeably in 1995.⁶⁷

Turning now to the incremental operating costs associated with Title IV compliance, those for scrubbing consist of a charge and, in some cases, a credit. The charge is the nonfuel operating expense: limestone or other absorbent material, sludge disposal, and the "parasitic" loss of power to run the scrubber. Based on questionnaire responses and further inquiry, we estimate this cost to be \$65 for every ton of SO₂ removed by scrubbing.⁶⁸ A credit is recognized where units retrofitted with scrubbers switched in 1995 to a higher-sulfur coal than was used in prior years. Additional sulfur requires more removal by a scrubber, but so long as the value of an allowance exceeds the operating cost of the scrubber, the switch to a cheaper, higher-sulfur coal reduces the cost of generation from what it otherwise would be. This credit reflects the savings in fuel cost that is the mirror image of the additional cost for units switching to lower-sulfur coals. As is the case with the charge for switching to a lower-sulfur coal, this credit is computed using the spot-market sulfur premium observed in the region supplying the coal.

⁶⁷ The nominal interest rate is often applied in such calculations; however, use of the nominal interest rate when inflation is positive leads to different rental rates for different vintages of capital that provide identical services. This problem is avoided by recognizing that real capital services are properly discounted by the real interest rate, and the payment or rental rate for those services is then inflated. Our 6% real interest rate was obtained by subtracting an estimate of 3.0% for inflation from a nominal

weighted average cost of capital for electric utilities in 1995 of 9.0% that was kindly provided by Paul Maleh of Charles River Associates, Inc., to whom we are appropriately indebted.

⁶⁸ The variable cost of scrubbing is usually given as so many mills per kwh, depending on the sulfur content of the coal being scrubbed: the relationship between the mills/kwh charge and sulfur content is highly linear and positive, so that when converted to dollars per ton of SO₂ removed, the cost is approximately constant at \$65 per ton of SO₂ removed.

For switching, the principal operating cost is the premium for lower-sulfur fuel that would not have been chosen except for Title IV. In contrast to units with retrofitted scrubbers, switched units have little, if any, additional non-fuel operating costs, so none are included in these estimates.

Unfortunately, and despite the ready availability of monthly data on the cost of coal delivered to power plants, the premia paid for lower-sulfur fuel are not easily observable. Not only do delivered prices include transportation costs unrelated to sulfur premia, but changes in contract terms and conditions further confound delivered prices' interpretation. Even when contract and transportation factors can be held constant, inter-year comparisons can mislead. The sulfur premium is at best 20% of the price of a coal (usually less), and the more significant value of heat content not only varies from year to year, but has also declined steadily. In particular, coal prices generally declined in 1995, and lower-sulfur coal was frequently delivered at lower prices that year than higher-sulfur fuel delivered to the same plant in 1993 or 1994.

Fortunately, in most cases it is not necessary to look at delivered prices. Most bituminous coal-switching in 1995 involved coals from the same coal-supply region. Therefore, if mine-mouth prices can be observed in the coal-supply regions, the confounding influence of transportation charges and contract factors can be avoided. The trade press regularly reports mine-mouth prices for the principal types of coal produced in all coal-supplying regions. If the reasonable assumption is made that buyers and sellers of coal are well informed of all the components of value, including sulfur content, then attempts to decipher sulfur premia from delivered prices are unnecessary. Those premia can be calculated for 1995 and earlier years from the differences observed between representative spot-market prices reported for coals of differing sulfur content in each coal-producing region.

For our calculations of the premia for lower-sulfur coal, we relied on spot-market prices reported by *Coal Outlook* since late 1991. Where switching among bituminous coals from the same supplying region was observed, we assigned the sulfur premium prevailing in the region. Most 1995 contract deliveries would have been negotiated prior to 1995, so we assigned the average spot-market sulfur premium for the originating region in 1993 or 1994, on the assumption that no additional *contract* premium was paid for lower-sulfur content. For 1995 spot deliveries, we assigned the spot-market premium prevailing for the region in 1995. When the switch to lower-sulfur coal also involved a change of supply region, we had no recourse but to look at delivered prices; in those cases, we assigned a premium based on differences observed in the 1995 prices for coals of differing sulfur content delivered to the plant in question and to nearby plants.

Two special cases of switching deserve further comment. First, for any plant switching to PRB coals, the delivered cost of the PRB coal will always be less than the delivered cost of the higher-sulfur coal it is replacing: the significant investments for upgraded precipitators and coal- and ash-handling equipment that must be made to accommodate sub-bituminous coal in a generating unit designed to burn bituminous coals are not made unless the capital outlay can be justified by compensating savings in fuel cost, including (beginning in 1995) the value of allowances.⁶⁹ We handled the 12 plants containing 31 units switching to or increasing the blend of PRB coal in 1995 on a case-by-case basis. If a unit's observed savings in fuel cost exceeded its annualized capital cost, we recorded no compliance cost; otherwise, the positive difference represented compliance cost. For most units switching to PRB coals in 1995, as for those that switched earlier, no net cost of compliance is apparent.⁷⁰ Nevertheless, several plants on the eastern frontier for PRB coals did record positive costs for switching to PRB coals in 1995, which are included in our estimates. Although the predominant source of no-cost compliance was PRB coal, in several instances western bituminous coals also became economic in the Midwest due to falling rail rates, and in other instances, units lowered their total generating cost by switching to natural gas from oil.

The second special case involves long-term supply contracts. A number of Phase I-affected units have been supplied with coal under 20-, 30-, and even 40-year contracts, signed mostly before the 1980s, that linked mine to power plant for the term of the contract.⁷¹ Like all contracts, these are enforceable in the courts, and Title IV explicitly did not provide grounds to renege on agreements.⁷² The

⁶⁹ The same argument applies for switching to a lower-sulfur bituminous coal; however, the additional capital investment is sufficiently small that the compensating difference in delivered fuel cost lies within the usual variation of delivered fuel prices.

⁷⁰ The timing of these switches was likely determined by contract expiration or a reformation of the contract to accommodate Title IV. In the latter case, termination payments may have been made, but do not constitute part of the cost of compliance with Title IV. Contract law would require damages approximately equal to the present value of the difference between contract and market price, should the contract be breached. Since contract law is enforced in American courts, we assume that suppliers

extract such payments or equivalent value from the buyer when contracts are reformed voluntarily.

⁷¹ See Joskow (1987) for a discussion of these contracts.

⁷² A number of contracts signed from the mid-1980s on specifically included provisions that allowed termination or appropriate modification if and when proposed acid rain legislation became effective.

pricing provisions of these contracts reflect energy price expectations at the time of signature, so current contract prices are often higher than the current market prices for new contracts or for spot coal of the same quality. The increasing disparity in contract and market prices over the past ten years has led not only to considerable dispute—judicial and otherwise—but also to an accommodation with respect to Title IV that provides lower-sulfur coal at no extra cost. Several electric utilities encumbered by such contracts and by Phase I-affected units appear to have prevailed upon their suppliers to provide lower-sulfur coal at the same contract price. The utility pays no fuel premium in these cases, but there is a resource cost to society: the additional cost of supplying the substitute coal. In effect, the supplier foregoes some profit to deliver a higher-cost, lower-sulfur coal in exchange for a reduced chance of litigation or other form of buyer harassment (for instance, rejection of slightly out-of-spec coal) and, more importantly, for an improved prospect of continuing to supply the buyer when the current contract expires. From a societal standpoint, the extra costs incurred by the supplier are resources devoted to compliance, just as surely as had the utility paid the producer more explicitly. In fact, the supplier would have received that premium for the coal, had the supplier not decided to supply the coal under the favorable pre-existing contract. To reflect this cost, the sulfur premium obtaining in the supplying region is assigned in those instances where a lower-sulfur coal is delivered under an existing contract at little or no additional cost.

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UNDER THE U.S.
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EVALUATION OF
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