S. Hrg. 112–952

OVERSIGHT: REVIEW OF EPA REGULATIONS REPLACING THE CLEAN AIR INTERSTATE RULE (CAIR) AND THE CLEAN AIR MERCURY RULE (CAMR)

HEARING

BEFORE THE

SUBCOMMITTEE ON CLEAN AIR AND NUCLEAR SAFETY

OF THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

JUNE 30, 2011

Printed for the use of the Committee on Environment and Public Works

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ONE HUNDRED TWELFTH CONGRESS
FIRST SESSION

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OVERSIGHT: REVIEW OF EPA REGULATIONS REPLACING THE CLEAN AIR INTERSTATE RULE (CAIR) AND THE CLEAN AIR MERCURY RULE (CAMR)

TUESDAY, JUNE 30, 2011

U.S. SENATE
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Subcommittee on Clean Air and Nuclear Safety
Washington, DC.

The committee met, pursuant to notice, at 10 a.m. in room 406, Dirksen Senate Office Building, Hon. Thomas Carper (chairman of the committee) presiding.

Present: Senators Carper, Lautenberg, Cardin, Merkley, Barrasso, and Sessions.

Also present: Senator Cornyn.

OPENING STATEMENT OF HON. THOMAS CARPER, U.S. SENATOR FROM THE STATE OF DELAWARE

Senator CARPER. The hearing will come to order. Good morning, one and all.

Senator Cornyn, nice to see you. We are together in the gym at the Y in the Senate gym earlier today, and they have a couple of guys here who work hard to stay in shape, trying to keep up with them.

We are going to kick this off, and we welcome, certainly, Senator Cornyn, who is going to introduce one of our witnesses and make some comments.

We welcome our witnesses.

I will speak for a few minutes and then recognize Senator Barrasso and other Senators that are here to make an opening statement, and then call on Senator Cornyn to, in fact, I think we will ask questions of Senator Cornyn. We are going to flip things here. He probably is ready.

Today's Subcommittee hearing will review the proposed replacements of the Clean Air InterState Rule, affectionately known as CAIR, and the Clean Air Mercury Rule, CAMR, and their economic, environmental, and health impacts.

Senators, again, will have 5 minutes for opening statements and I will recognize our panel of witnesses. Each witness will have about 5 minutes for his or her opening statement, and following each panel statements we will have one round of questions.

Since coming to the U.S. Senate a decade or so ago, I have made it my mission to work with our colleagues to ensure that EPA has the right tools to clean our air. As some of you may know, I have worked diligently across the aisle, even with guys like this guy, on clean air legislation to reduce deadly emissions of sulfur dioxide, nitrogen oxide, mercury, and other air toxics in our Country.

Oftentimes, I have been asked why I am so passionate about clean air and usually start off by giving a couple of reasons. First of all, I believe most of us in the room believe we ought to try to treat other people the way we want to be treated, and as many of you know, air pollution knows no State boundaries. As Governor of my State in the 1990's, I quickly realized that one State could do everything in its power to reduce its own air pollution, but could still itself with dirty air because of bad neighbors.

Many of you have heard me say that Delaware is at the end of America's tailpipe. It is not just Delaware, it is Maryland, it is New Jersey, it is Virginia, it is Pennsylvania. Other States to the north are less. We are at the end of America's tailpipe. In fact, our Secretary of Natural Resources and Environmental Control, who is here today, Collin O'Mara, has said that up to 90 percent of Delaware's pollution, at least air pollution, comes from other States.

As Governor, I think I could have just about shut down every source of pollution in our State and Delaware would have still been in non-attainment. Think about that. We pretty much shut down our State and we still would have been in non-attainment. Christy Whitman, my neighbor in New Jersey, was mindful of the same thing and equally unhappy about being in that situation. She and I quickly learned that our neighbors' dirty air meant higher health care costs for our own States. My neighbors' dirty air meant difficulty in attracting businesses to our State of Delaware and my neighbors' dirty air meant that we were paying the full price for their dirty energy.

And that is when I realized that we had to have a national solution to address our air quality problems. States can't do it alone; couldn't do it then and can't do it now. We are all in this together. We have to work together and we need to work with the EPA to continue cleaning up our air.

Second, I believe it is critical for us to achieve better health care results in America for less money. In fact, across the board, we need to achieve better results in just about everything, including health care, for less money, too. But over the 1990 to 2020 time period the EPA estimates that our Country will see over $12 trillion of health and economic benefits in the form of longer lives, healthier kids, and greater work force productivity from the implementation of the Clean Air Act. Clean Air Act benefits outweigh its costs by some 30 to 1. Not a bad bang for our buck. And although we have made great strides in reducing our Nation's air pollution, more must be done if we want to protect our children and compete in the emerging global clean energy economy.

Today we discuss two new clean air regulations, the Clean Air Transport Rule and the Utility Air Toxics Rule. These regulations target our largest emitters of many known toxics that cause cancer, brain defects, and respiratory stress: fossil fuel power plants. And we have a chart over here. This is a busy chart, but I think it shows in the U.S. power plants emit, among other things—I am almost tempted to take out my reading glasses so I can read this stuff—but organics. In fact, I am going to take out my glasses to read this stuff.

[Laughter.]

Senator CARPER. In a true sign of bipartisanship, Senator Barrasso—these aren't any good.

Senator BARRASSO. I have done surgery with these glasses.

Senator CARPER. That is what I have heard.

[Laughter.]

Senator CARPER. All right, here we go. From power plants, U.S. power plants, emissions, 60 percent of the arsenic, 60 percent of the SO2, 13 percent of the nitrogen oxide, 30 percent of the nickel, 20 percent of the chromium, 50 percent of the mercury, and over 50 percent of many acid gases. It is a good chart if you can read it.

These toxic pollutants know no State boundary and they send thousands of our children to the hospital every day and contribute to shorter life spans for thousands every year.

Just one of these rules, the Air Toxics Regulation, we could see from it some $13 in benefits for every dollar that we spend in compliance and, again, getting greater health care results for less money, and that is being demonstrated by a chart held by one of our—I was going to say one of our interns, but our interns are sitting over here, making him do all the work. This is a pretty good chart, I can actually read this. But we are looking at the billions of dollars in 2010 for the cost of implementation, it looks like about $11 billion. The payoff looks like about $145, $146 billion. That is a pretty good return.

And as we will hear today, these regulations are long overdue, addressing pollution that should have been cleaned up years ago, maybe even decades ago. We will also hear today that we have the technology to meet these new standards, and many States like Delaware have successfully implemented similar measures.

I look forward to hearing our testimony today on these important issues and regulations. We look forward to working with the Administration and with our colleagues, Democrat and Republican, to ensure that we have even cleaner air going forward.

Senator Barrasso, thank you.

[The prepared statement of Senator Carper follows:]

STATEMENT OF HON. TOM CARPER, U.S. SENATOR FROM THE STATE OF DELAWARE

Since coming to the U.S. Senate a decade ago, I have made it my mission to work with my colleagues to ensure that EPA has the right tools to clean our air. As some of you know, I have worked diligently across the aisle on clean air legislation to reduce deadly emissions of sulfur dioxide, nitrogen oxide, mercury and other air toxics in our country.

Often times, I'm asked why I am so passionate about clean air. Well here are a few reasons. First, I believe we ought to treat other people the way we'd want them to treat us. As many of you know, air pollution knows no State boundary.

As Governor of Delaware in the 1990's, I quickly realized that one State could do everything in its power to reduce its air pollution, but could still find itself with dirty air because of bad neighbors. Many of you have heard me say that Delaware is at the tailpipe of America. In fact, our Secretary of Natural Resources, Colin O'Mara who is here today, has said up to 90 percent of Delaware's pollution comes from other states.

As Governor, I could have shut down EVERY SOURCE OF POLLUTION IN THE STATE, and DELAWARE would still have been in nonattainment. As Governor, I quickly learned that my neighbor's dirty air meant higher health care costs for my state. My neighbor's dirty air meant difficulty attracting businesses to my state. And, my neighbor's dirty air meant WE were paying the full price of their dirty energy.

That's when I realized we had to have a national solution to address our air quality problems. States cannot do it alone. We're all in this together. We've got to work together, and we need to work with the EPA to continue cleaning up our air. Second, I believe it's critical for us to achieve better health care results in America for less money.

Over the 1990 to 2020 time period, the EPA estimates that our country will see over $12 trillion in health and economic benefits— in the form of longer lives, healthier kids, and greater workforce productivity —from the Clean Air Act. The Clean Air Act benefits outweigh the costs—30 to 1. That's a pretty big bang for the buck!

Although we've made great strides in reducing our nation's air pollution, more must be done if we want to protect our children and compete in the emerging global clean energy economy. Today, we discuss two new clean air regulations—the Clean Air Transport Rule and the Utility Air Toxics Rule. These regulations target our largest emitters of many known toxics that cause cancer, brain defects and respiratory stress—fossil-fuel fired power plants.

These toxic pollutants know no State boundary and send thousands of our children to the hospital everyday and contribute to shorter life spans for thousands every year. Just one of these rules—the air toxics regulation—we could see $13 in benefits for every $1 we spend in compliance. Again getting greater health care results for less money. And as we will hear today, these regulations are long overdue, addressing pollution that should have been cleaned up decades ago.

We will also hear today that we have the technology to meet these new standards, and many states, like Delaware, have successfully implemented similar measures. I look forward to hearing testimony on these important regulations and look forward to working with the Administration and my colleagues to ensure we have clean air.

OPENING STATEMENT OF HON. JOHN BARRASSO, U.S. SENATOR FROM THE STATE OF WYOMING

Senator BARRASSO. Thank you very much, Mr. Chairman. I appreciate having these hearings today about the regulations coming out of the EPA. We have held a number of hearings on these regulations and we have gotten some very useful testimony. I am happy to see Senator Cornyn here with us, and I am disappointed that the Chairman has ruled that Senator Cornyn is not permitted to participate fully and ask his important questions——

Senator CARPER. Hold that just for a second. This doesn't take away from your time.

I think most of us probably live by the Golden Rule. Senator Cornyn and I actually talked about this yesterday and I said, John, do you want to give an opening statement and have an extended opening statement in your introduction and make whatever points you want, and he actually said, that is fine, I would be pretty pleased to do that.

And we talked today and I said, you know, in this further Golden Rule, when I was in my first year, first 2 years in the U.S. Senate, I used to go to hearings of the Judiciary Committee. I wasn't on the committee, but they would actually let me sit at the dais with the committee, and at the end, after everybody else on the committee had asked their questions, if they had any extra time, they would let me ask questions too, at least for 5 minutes, and I offered that opportunity to Senator Cornyn. You don't know this, but I offered that opportunity to Senator Cornyn, and he said what he would really rather do is chair the hearing. So we have agreed to do that and I will questions from the dais over here. But I think we worked this out.

If you want to say that, you can go ahead, but I think we worked it out.

Senator BARRASSO. Well, Mr. Chairman, let me go on, because there has been a lot of talk about public health benefits of additional government restrictions on power plants, on factories, on small businesses, and on other job creators. We have also discussed the very real fact that American unemployment stands at 9.1 percent. These are people who are looking for work and cannot find someone to employ them. The rest of America wants to keep their jobs, and everyone wants good public health. The question is do the regulations coming out of the EPA accomplish all of those goals, and to me the answer is they do not.

According to the National Economic Research Associates' recent study, the EPA's Clean Air InterState Rule, the Transport Rule, and the Clean Air Mercury Rule, known as Utility MACT, the two rules that we are discussing today, would alone result in $184 billion in costs to power providers and consumers and 1.44 million jobs lost, as the poster shows.

Unemployment in this Country is high and the greenest State, California, where regulations such as these have been adopted for years, has one of the highest unemployment rates of all. California's unemployment rate stands at 11.7 percent.

The negative health benefits of high unemployment are also now well documented. In this very Committee, on June 15th, just 2 weeks ago, Dr. Harvey Brenner of Johns Hopkins University, testified, "The unemployment rate is well established as a risk factor for elevated illness and mortality rates in epidemiological studies performed since the early 1980's." He also found that "In addition to influences on mental disorders, suicide, alcohol abuse, and alcoholism, unemployment is also an important risk factor in heart disease and overall decreases in life expectancy." In addition, according to the National Cancer for Health Statistics, we learn that American children in poverty are 3.6 times more likely than nonpoor children to have poor health and 5 times more likely to die from an infectious disease.

We have here testifying today Ms. Gina McCarthy, and she has stated families shouldn't have to choose between a job and healthy air; they are entitled to both. But families need to be employed; otherwise, the 9.1 percent who are looking for worker, the older work in Michigan, the dock worker in Massachusetts, the fisherman in Connecticut, the miner in Wyoming, the stay-at-home moms and their children will feel the negative effects.

If we want to talk about public health, then let's focus on the major threat to the public, and that is unemployment. We must face the facts; otherwise, the health costs of not addressing unemployment will far exceed any health benefits of the regulations being proposed by the EPA today.

This Administration and this EPA are on the wrong track. They are doing so by proposing dozens of regulations to drive up the cost of doing business, and that includes energy costs, for whole sectors of the American economy that the Administration has basically shown that they don't like; the refiners, the coal mines, the rare earth mines, ranchers, dairy farmers, cement manufacturers, fertilizer producers, coal-fired nuclear power plants, to name a few.

This Administration, through its policies, is making it harder and more expensive for the private sector to create jobs. I am looking for ways to make it cheaper and easier for the private sector to create jobs.

This Administration has also been subsidizing sectors of the economy that they favor; renewable energy, manufacturing and production. In a June 25th Washington Post story entitled, Obama's Focus on Visiting Clean Tech Companies Raises Questions, the article went on to State, along with Capitol Hill fallout, the Administration's attention to certain clean tech companies has led to some industry concerns. Executives of some struggling startups ask whether the Administration rigorously examines companies and their products before endorsing a favored few.

This is the Washington Post. They give an example. The article points out that one solar panel manufacturing company that the President has backed "used an array of glass tubes that are expensive to produce, causing investment advisors to question whether the product could compete with less expensive Chinese models." The company received a $530 million Federal loan guaranty under the President's stimulus plan.

Many companies in the article said that they only got a fraction of the money that Obama doled out to those few winners that could produce much more with less. One CEO is quoted as saying the Administration is giving some companies massive advantages over others. And when the President touted the success of the LED light bulb manufacturer in North Carolina, he failed to mention that one of the companies he toured was having significant financial difficulties, the stock value was cut in half in the last year, and this was despite the company receiving a $39 million tax credit through the Obama stimulus plan. And financial analyst Jeffrey Benneck stated that company would have a hard time competing unless "anyone can get their cost down to compete with the Chinese companies."

Picking winners and losers just doesn't work. This Administration has had 2 years to get this right and has failed. Costly job crushing regulations, heavy tax burdens, and investment in uncompetitive industries does not foster economic growth; it does not create jobs; it does not promote commerce; and does not make the public healthier.

Thank you, Mr. Chairman. Look forward to the testimony.

Senator CARPER. You are welcome.

Senator CARDIN.

OPENING STATEMENT OF HON. BENJAMIN L. CARDIN, U.S. SENATOR FROM THE STATE OF MARYLAND

Senator CARDIN. First, Senator Carper, let me thank you very much, not just for holding this hearing, but for your leadership. You have devoted a good part of your career to the issues of clean air. We are neighboring States and we share the same challenges of being downwind. So I thank you very much for your continued leadership in this area. You are making a difference and I am proud to work with you on these issues.

I must say that I think it is a false dilemma to say that you have to choose between jobs and good health and clean air. I can tell you, in my own State of Maryland, we have created jobs by implementing the toughest standards on clean air in the region. I feel very fortunate to be a State where the power companies take responsibility for their actions. It is time that power companies around the Nation take responsibility for their actions and stop blaming EPA for doing its job. I might say if they used the millions of dollars they spend in fighting these regulations, whether in the courts or in the agencies, and use that to implement clean air technology, I think we would be further along today.

In 2007, Maryland experienced, as a downwind State, motivated the Maryland legislature and our Governor to take firm and decisive action to reduce mercury, SOx and NOx emissions in the State by implementing the toughest power plant emission laws on the East Coast, and we created jobs in doing that, Mr. Chairman, and we have a healthier environment. But it is not enough. Using 2002 as a submissions baseline, the Healthy Air Act has Maryland well on its way to reducing its inState NOx emissions by 75 percent by 2012, after already achieving an interim goal of a 70 percent reduction target for NOx in 2009. SO2 emissions will be reduced by 80 percent this year, with a second phase of controls in 2013 to achieve an 85 percent reduction of SO2 emissions.

Despite Maryland's success in reducing our emissions, as you point out, Mr. Chairman, pollution from upwind States prevents Maryland from reaching attainment under the Clean Air Act. So we can do all this, but if we don't have a national standard, we can't achieve the type of clean air necessary for public health in Maryland.

On most bad air days, somewhere between 50 percent and 75 percent of Maryland's air pollution originates in upwind States. This June, the Baltimore-Washington Metropolitan Area experienced 22 moderate and unhealthy air days. More than 2 million Marylanders suffer from respiratory and cardiovascular diseases like asthma, emphysema, and diabetes. Unhealthy air days exacerbate the health problems of at-risk populations and cost Americans billions of dollars in health care costs, loss of wages due to illness triggered by air days that leads to absences from work and school.

EPA's newly proposed Transport Rule is a step toward addressing the persistent clean air issues the Mid-Atlantic and Northeast States face. The rule's requirement for power plants to finally install modern pollution control technology across most of the eastern half of the United States is long overdue.

Baltimore City and Anne Arundel County, Maryland, are two jurisdictions that are projected to have maintenance problems even with the new Transport Rule in place. The new rule is an important first step, but clearly there is more work that needs to be done.

Fortunately, there are opportunities on the horizon to achieve emission reductions needed to allow all States to achieve attainment.

Mr. Chairman, I am committed to working with you, I am committed to working with all the members of this Committee to come up with the reasonable ways that we can address these issues at the national level, make sure the tools are available. But one thing I believe we can't compromise, and that is clean air. The Clean Air Act is critically important for the public health of this Nation. Air knows no geographical boundaries. We need to work together. This Committee has the primary jurisdiction and I hope that we will continue to find ways in which we can help our industries comply with the Clean Air Act.

I must tell you, to me this is about jobs, it is about creating the type of economic growth in this Nation that will allow us to have the job growth and healthy environment. We should not have to make a choice between the two.

Senator CARPER. Thanks very much for your statement. Thanks for your kind words, and I look forward to working with you in all this going forward.

All right, Senator Sessions. Good morning.

OPENING STATEMENT OF HON. JEFF SESSIONS, U.S. SENATOR FROM THE STATE OF ALABAMA

Senator SESSIONS. Good morning. Thank you.

Mr. Chairman, since its enactment 40 years ago, I do truly think it is incontestable that the Clean Air Act has produced a much cleaner environment. In fact, over the past 30 years total emissions of the six principal pollutants have been decreased by 57 percent. EPA national emission estimates show that in 1980 there were 267 millions tons per year produced of these emissions. That number has been decreased dramatically, to 107 million tons in 2009 and progress continues. And all of us on the Committee want to ensure that we continue that progress, and I believe that new restrictions can be effective and reasonable on particularly pollutants like mercury that we have had some good studies on in Alabama.

But I am concerned about the timing, cost, and manner of several of EPA's new rules, as well as the cumulative impacts of these regulations and rules on economic growth and development in a time of our Country's economic stress.

This chart—maybe you can hold it back so the Chairman can see too—is a chart produced by the American Legislative Exchange of State Legislators showing how these regulations are coming forward in ever-increasing numbers and having cumulatively a significant impact on American competitiveness economically throughout the world. So I thank you, Jeff, for that.

I think it indicates that the complaints I am hearing in record numbers from people all over my State about excessive new regulations are valid. There seems to be a train wreck of regulations and rules coming out of EPA. The ratepayers will be the ones who pay the cost. The increased cost of energy could drive companies away from the United States and harm our economy's ability to rebound from the recent recession. During this time of high unemployment, 9.1 percent, we really need to be looking at ways to produce cleaner, cheaper energy, not driving up costs.

There is no doubt. Those of us who have been involved in economic development know one of the most important questions businesses ask about where they are going to site a new plant and create jobs is how much the energy costs are. We have got to consider that as we go forward, so I would like to raise four concerns at the hearing today.

First, EPA issued the Transport Rule after the court cited concerns with the trading provision of the Bush administration's Clean

Air Rule. However, instead of simply correcting those deficiencies, the EPA went much further than was required by the courts and now has decided to impose new requirements. In addition, regarding the Utility MACT Rule, the EPA had originally decided to impose new restrictions on mercury emissions from power plants, but after executing an agreement with an environmental group, the have decided to cover all hazardous pollutants, changing the nature of that review.

Second, I am concerned about the deadlines for compliance with the Transport Rule and the Utility MACT Rule. Too fast a change can impose unnecessary costs. I am concerned about the cumulative impacts and costs from all the rules together and what impact that would have on job losses and increased electricity rates. One estimate is that increases in electricity rates of over 20 percent will occur. This is a tax, really. The articulate Larry Kudlow keeps talking about when you get a drop in energy prices, you get a tax cut, and an increase is a tax increase. It is the kind of thing you can't avoid, you have to pay, and paying more for the same amount of energy is the equivalent of a tax increase.

Finally, I want to be sure that EPA is listening to concerns of the regulated industry concerning the accuracy of the data that they rely on. I continually hear that EPA has incorrect data and incorrect calculations. I want to be sure that they constantly are willing to ensure that they are accurate in the assumptions they make when they impose new rules.

Thank you, Mr. Chairman.

Senator CARPER. You bet. Thank you, Senator Sessions.

Senator Lautenberg, thanks for joining us.

OPENING STATEMENT OF HON. FRANK R. LAUTENBERG, U.S. SENATOR FROM THE STATE OF NEW JERSEY

Senator LAUTENBERG. Thanks, Mr. Chairman, for your leadership on these issues. I think they rank among the primary concerns that all of us have.

We face a funny dilemma that says, well, you can choose between extending life, and I heard the Senator from Alabama very clearly talk about the benefits that we have gotten from the Clean Air Act, and I am a living example of what has happened with longevity in our society. So that has improved, and I would like it to continue, if that is not too selfish. But there we are. We see positive results. And I don't understand why it is that we can't do what we have to do in the economy as well as for people's health.

Mr. Chairman, I ask that a letter to the Wall Street Journal dated December 2010 from eight utilities that says we are OK with EPA's new air quality regulations, and these are outstanding companies, including Exelon and PSE&G in my State, other well known companies, and they say it is OK. So we know that the health of our children depends not only on what we do, but also on what our neighbors do, and that is why so many of us have worked so hard to keep second-hand smoke out of children's lungs. Yet, when the emissions from a power plant in one State threaten the citizens of another, too often little or nothing is done about it, and we can't make any mistakes.

Pollution doesn't recognize State boundaries. Dirty air blows into New Jersey from many other areas as well, including States in the Midwest, where companies continue to build taller smoke stacks that shield local residents from health risks, but put others in danger. The Environmental Protection Agency is attempting to correct this problem by cutting power plant emission from 31 upwind States. This could slash sulfur pollution in half and save as many as 36,000 lives a year. I don't know how you put a numerical value on that, but it has to be pretty high.

Power plants are also a major source of air toxics like dioxins, which can cause birth defects; lead, which damages nervous systems and reduces children's intelligence levels; and arsenic, which causes cancer. One of the worst of these air toxics is mercury. Brain poison for children. Mercury can seriously damage a child's kidney, liver, and nervous system. Pregnant women who are exposed to high levels of mercury are also very vulnerable. And there are newborns; they experience brain damage, learning disabilities, and hearing loss. So we don't discover these things until a much later period of time.

The EPA wants to cut the emissions of air toxics like mercury by as much as 90 percent and I would like them to do it. The proposed rule has been in the making since 1990, when both parties came together to pass the Clean Air Act amendment. But now big polluters and their friends in Congress are stalling, claiming it is going to cost businesses too much money to comply, and I believe it is nonsense. EPA simply wants to hold all companies to the standards used at the cleanest plants, which have shown that they can succeed by investing in clean technology.

To our colleagues who claim these measures will be too costly to businesses, we have to ask what about the health cost of breathing dirty air? How do you put a price on human life? EPA's proposed pollution control measures are now more than a decade overdue and children a paying a price while industry and its lawyers and lobbyists create delays. The bottom line is rules and regulations aren't making our children sick; pollution is making our children sick. And we have to do a heck of a lot more to protect kids from dangerous of dirty air.

My oldest grandchild, 17 years old, has asthma and we know what happens with him when the polluted air is heavy. My daughter, when she takes him to play sports, he is pretty athletic, she first looks for an emergency clinic to make sure that, if he starts wheezing, she can get him there on time, because in our family my sister, who was asthmatic, tried to get to her car where she had her respirator, from a school board meeting and she didn't make it out of the parking lot, collapsed, and died 3 days later from asthma.

So when we have a chance to do something to keep people healthy, keep them alive, then why look at the dark side? Look at the positive side.

I look forward to hearing our witnesses about how we can work together to ensure all Americans have clean, safe air to breathe, and I thank you, Mr. Chairman.

Senator CARPER. Mr. Lautenberg, thank you for sharing that with us.

The first panel is going to be one witness. On the second panel we have several witnesses who are going to be testifying.

Senator Cornyn has been good enough to come by to introduce one of his own, the Chairman of the Texas Commission on Environmental Quality, Bryan Shaw. Senator Cornyn, you are recognized at this time. Welcome.

OPENING STATEMENT OF HON. JOHN CORNYN, U.S. SENATOR FROM THE STATE OF TEXAS

Senator CORNYN. Well, Mr. Chairman, thank you very much. I appreciate your courtesy. I could only imagine if the Golden Rule were applied by the Senate and Congress in Washington on a daily basis, I can't help but think this would be a better place to work and we would do a better job representing our constituents. But I appreciate Senator Barrasso and Senator Inhofe making a formal request for me to participate as though I were a member of the panel, but as you and I discussed when you were kind enough to come by my office yesterday, I think my concerns are going to be adequately expressed by this statement, and I know the panel members will ask further questions that will elucidate the matters that I thought needed covering.

But I want to be here particularly to welcome the Chairman of the Texas Council on Environmental Quality, Dr. Bryan Shaw, and to speak on behalf of Texas, who may be significantly impacted by the Clean Air Transport Rule. I appreciate the opportunity to speak and I know Dr Shaw will address several issues concerning EPA's action on the second panel, but I want to focus my limited time on reports that EPA is planning to sweep Texas into the final CATR sulfur dioxide program without due process. And what I mean by due process, I mean simply notice and the opportunity to be heard, a matter of fundamental fairness, which I believe, if Texas will be swept into this rule, will be denied.

I hope this worst kept secret in town proves to be wrong, or, if it is right, that it is appropriately reconsidered. This anticipated inclusion was brought to my attention recently, and I have serious concerns regarding the legality of this action and the projected harm it will do to electricity producers and consumers and job creators in my home State. I agree with the panel that we all want clean air and clean water. We also need to consider, I don't think it is unreasonable to consider the impact on consumers who are already suffering from high gasoline prices, high food prices, and, many places, high unemployment. So I think it is important to consider all of those factors in determining the cost-benefit of any rule.

By way of background, the EPA did propose to include Texas in the CATR nitrogen oxides program, but Texas was not one of the 28 States EPA proposed to include in the CATR SO2 program. While EPA did request comments on the hypothetical future emissions as a basis for potentially including Texas in the SO2 annual standard program, it is critical that the EPA never altered its original position excluding Texas or proposal for comment in SO2 emissions budget for Texas or specified any other type of SO2 requirement, despite issuing three supplemental notices regarding aspects of the proposed CATR rule since it was originally published.

My understanding is that if included in the CATR annual program, the State of Texas will be required to reduce its SO2 emissions by around 45 percent in just 6 months. Forty-five percent in 6 months, due to several incorrect assumptions about the State's ability to comply in that period of time. EPA assumes that most Texas power plants have or will immediately stop using Texas lignite as fuel and that dramatic reductions can be achieved with existing and currently planned pollution controls, or fuel switching, without a significant impact on the Texas economy and on Texas consumers.

Yet, a diverse group of stakeholders, including union workers, chemical companies, investor-owned utilities, municipally owned utilities, and others, have expressed significant concerns that compliance costs will require significant capital investment estimated at about $1 billion. Jobs will be lost due to closures and drastic reductions in plant operations, and between 7,000 and 13,000 megawatts of generation would be immediately be at risk in the State, and the loss of generation would drastically reduce our power grid's reverse margin.

Earlier this week we had a hot day, and that won't surprise you, in Texas and the Electricity Reliability Council of Texas, or ERCOT, issued an energy emergency alert level 1 for power reserves falling to less than 2300 megawatts. If reserves fall to less than 1750 megawatts, power loads can be interrupted.

This is only the beginning of the summer, and the EPA's anticipated rules will force significant base load to shut down and reserve margins to dip down even further. If we have an unplanned significant outage due to a storm or other unforeseen event, many people in Texas could end up without power and air conditioning on some of the hottest days of the year.

And I would just point out that last week, when I was in Austin, I was startled by the news that Amarillo, Texas, in the northern part of Texas, usually a little cooler than the rest of the State, had temperatures at 111 degrees. So that is a threat to health and life like some of the other factors that Senator Lautenberg and others have mentioned.

Any inclusion of Texas in CATR's SO2 program should be done with a full and open process in compliance with the Administrative Procedures Act. I believe to include Texas without notice and an opportunity to be heard would be a violation of that law. Instead, stakeholders have had to rely on tidbits from those inside the agency about the fate of our State. This, if it is true, would be an abuse of power. Every State deserves to know what is being asked of it and the opportunity to comment on proposed emission reduction budgets and other requirements that will impact the lives of its citizens. This rule will impact the elderly and children who depend on air conditioning at their homes in a hot summer, and the livelihoods of millions of hardworking Texas.

My home State has created 37 percent of new jobs in this Country in the last year. In fact, the one thing I hear over and over again is the enormous strain that the uncertainty of regulation is having on job creators not just in my State, but around the Country.

If EPA believes that Texas should be included in CATR's annual program, it should demonstrate that inclusion is necessary, that it is justified, and that it is beneficial through a transparent process. I know the Administration has heard from Democrats, this is not a partisan issue, heard from Democrats, Republicans, members in labor and management, and other job creators in the State. I am hopeful that the EPA will reconsider including Texas in the final rule without due process. The stakes are too high to forego adequate process for the citizens of our State and, frankly, we deserve better from the Federal Government and the EPA.

So thank you very much, Mr. Chairman, for allowing me to make this statement, and I want to thank you for allowing me to welcome Chairman Shaw for coming here, and I hope you will enjoy his testimony. Thank you so much.

Senator CARPER. Thank you, Senator Cornyn. Good to see you. Thank you for the introduction.

With that, I think we will turn to our first panel, a one-woman show. We welcome Gina McCarthy back for this panel. Gina McCarthy is the Assistant Administrator for the Office of Air and Radiation at the U.S. Environmental Protection Agency. She has served in that capacity now for just over 2 years.

Ms. McCarthy, you will have 5 minutes to deliver your opening statement. The full content of your written statement will be included in the record, and then we would like to ask some questions of you . But you are recognized at this time. Welcome. It is great to have you here. Thank you.

STATEMENT OF HON. GINA MCCARTHY, ASSISTANT ADMINISTRATOR FOR THE OFFICE OF AIR AND RADIATION, U.S. ENVIRONMENTAL PROTECTION AGENCY

Ms. MCCARTHY. Good morning, Chairman Carper, Ranking Member Barrasso, and members of the Subcommittee. I really appreciate the opportunity to testify on the need to reduce harmful air pollution from power plants.

It is time to start cleaning up. That is what the Administrator told the Edison Electric Institute. The Administrator discussed the need to begin investing now to reduce emissions of sulfur dioxide, nitrogen oxides, and mercury from power plants. But it wasn't Administrator Jackson; that was Administrator Leavitt, who made those statements more than 7 years ago.

As acknowledged by the title of this hearing, we are not the first administration to recognize the need to clean up power plants and to issue rules to address that need.

Over the years, many power plants have invested in modern pollution control equipment to reduce their emissions and to help provide healthier air to all our citizens. Many other power plants, however, have simply not made those investments.

Effective technologies for controlling SOx, NOx, and mercury emissions from power plants have been available for more than 30 years, yet a substantial portion of the coal fleet lacks these advanced pollution control equipment. For example, although SO2 scrubbers have been available for 35 years, well over a third of the coal capacity has yet to apply them. Many of these uncontrolled units are small and were built before the Clean Air Act was enacted more than 40 years ago.

Electric power plants today are the Country's largest source of SO2 and mercury and the largest stationary source of NOx. These plants cause smog and fine particle pollution, acid rain, and exposure to mercury and other toxic pollutants which contribute significantly to a wide variety of public health and environmental problems. At recent air pollution levels, exposure to fine particles from all types of sources, including power plants, is believed to still cause between 130,000 and 320,000 premature deaths each and every year, while smog exposure prematurely ends the lives of an additional 4700 Americans.

The Bush administration recognized the need to clean up power plants and issued two rules to do so, the Clean Air InterState Rule and the Clean Air Mercury Rule. The Court of Appeals, however, held that these rules did not meet the Clean Air Act requirements and they told EPA to redo them.

To replace these two overturned rules, we will soon be issuing two rules, the Clean Air Transport Rule, which we are talking about today, as well as finalize the Mercury and Air Toxic Standards in November.

We are not pursuing these rules, however, just because the Clean Air Act requires it and because the courts told us we had to do it. We are pursuing these rules because they will dramatically improve public health. They are affordable and they are technologically achievable.

The Clean Air Transport Rule is designed to help States achieve the health-based ambient air quality standards for both smog and soot. It will require reductions in power plant emissions in NOx and SO2 in the middle and eastern portions of the Country.

We have also proposed the Mercury and Air Toxics Standards to control emissions of toxic air pollutants from power plants.

The Transport Rule and the Mercury Air Toxics Standards are projected to avoid tens of thousands of premature deaths, heart attacks, cases of acute bronchitis, hospital and emergency room department visits, as well as hundreds of thousands of cases of aggravated asthma and millions of days when people will miss work or school each and every year.

Some in industry are calling us to move quickly, even more quickly than they are proposing on these rules. The Clean Energy Group recently said needed regulatory certainty will result from EPA's timely implementation of regulations consistent with the Clean Air Act, which is in the best interests of the electricity industry, the market, and customers.

Over the last 40 years, the Clean Air Act has provided a success story of which all Americans can and should be proud. Key air pollutants are down more than 60 percent, while our economy has grown by over 200 percent. Each dollar we have spent cleaning up the air has given us more than $30 in benefits. And the investments in the cleaner energy sector required by these standards will keep people working and it will create jobs.

The Clean Air Transport Rule and Mercury Air Toxics Standards are continuing the successful history of the Clean Air Act and EPA's implementation of it.

Thank you very much.

[The prepared statement of Ms. McCarthy follows:]

Opening Statement of Regina McCarthy
Assistant Administrator for Air and Radiation
U.S. Environmental Protection Agency

Subcommittee on Clean Air and Nuclear Safety
Committee on Environment and Public Works
U.S. Senate

Hearing Entitled "Oversight: Review of EPA Regulations Replacing the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR)"
June 30, 2011

Chairman Carper, Ranking Member Barrasso, and members of the subcommittee, I appreciate the opportunity to appear before you today to testify on EPA's work to replace the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR).

When the Administrator spoke to the Board of Directors of the Edison Electric Institute, the message was clear -- "It's time to start cleaning up." The Administrator discussed the need to begin investing "now" to reduce emissions of sulfur dioxide, nitrogen oxides and mercury from power plants.

It wasn't Administrator Jackson though – it was Administrator Leavitt that delivered that message in January of 2004 – more than 7 years ago.

As acknowledged by the title of this hearing, we are not the first Administration to recognize the need to clean up power plants and to issue rules to address that need. In fact, since 1989, when President George H.W. Bush proposed what became the Clean Air Act Amendments of 1990, power plant clean up has been the continuous policy of the U.S. government under two Democratic and two Republican presidents.

Over the years, many power plants have invested in modern pollution controls to reduce their emissions and have contributed to the significant progress this country has made in providing healthy air to our citizens. Many other power plants, however, have delayed the investments that Administrator Leavitt urged them to make.

Effective technologies for controlling SO2, NOx and mercury emissions from power plants have been available for years, yet a substantial portion of the coal fleet lacks advanced controls for NOx, SO2, or mercury.[1] Although SO2 scrubbers have been available for more than 35 years, well over a third of the coal capacity has yet to apply SO2 scrubbers.[2] Many of these uncontrolled units are small and were built before the Clean Air Act was enacted.

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[1] NEEDS v.4.10 PTox Database
http://www.epa.gov/airmarkets/progsregs/epa-ipm/docs/NEEDSv410_PTox.xlsx
[2] Id.

Elements of the power industry sought for many years to delay the congressional mandate to control toxic air pollution. Meanwhile, more than 50 other industries have complied with federal standards for toxic air emissions. Municipal waste combustors and medical waste incinerators, which were the other two largest sources of mercury, have reduced their emissions by more than 95 percent since 1990. It is time to level the playing field and reduce the public health threat.

Electric power plants today are the country's largest source of SO2 and of mercury, and the largest stationary source of NOx. These plants cause smog and fine particle pollution, acid rain, and exposure to mercury and other toxic pollutants, which contribute significantly to a wide variety of public health and environmental problems. At recent air pollution levels, exposure to fine particles from all types of sources, including power plants, is believed to cause between 130,000 and 320,000 premature deaths each year, while smog exposure prematurely ends the lives of an additional 4,700 Americans.[3] In other words, 1 in 20 deaths in the U.S. occurs prematurely due to this harmful air pollution. Each year, smog and soot also cause 2.5 million cases of aggravated asthma among children, about 150,000 hospital admissions for respiratory and cardiovascular illness, and nearly 200,000 non-fatal heart attacks.[4] While past EPA rules for power plants, vehicles, and other sources have made some progress reducing these effects, much more remains to be done.

The last Bush Administration recognized the need to clean up the power sector to address these public health issues. For example, in explaining the need to reduce power plant emissions, Jeff Holmstead, my predecessor, testified to Congress that the Bush Administration plan would "dramatically reduc[e] fine particle pollution caused by SO2 and NOx emissions," and noted that "Of the many air pollutants regulated by EPA, fine particle pollution is perhaps the greatest threat to public health."[5] The Bush Administration issued two rules to clean up power plants – the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR). The U.S. Court of Appeals for the District of Columbia Circuit, however, held these rules did not meet Clean Air Act requirements and remanded both rules to EPA for revision consistent with the Court's decisions.

To replace these two overturned rules, and, more importantly, to achieve reductions that are long overdue, we will soon be issuing the Clean Air Transport Rule and are on schedule to finalize the Mercury and Air Toxics Standards in November.

We are not pursuing these rules just because the Clean Air Act requires it or because the Court told us to do so. We are pursuing these rules because they will

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[3] Fann N, Lamson A, Wesson K, Risley D, Anenberg SC, Hubbell BJ. Estimating the National Public Health Burden Associated with Exposure to Ambient $PM_{2.5}$ and Ozone. Risk Analysis; 2011b. doi: 10.1111/j.1539-6924.2011.01630.x

[4] Id.

[5] Testimony of Jeffrey Holmstead, Assistant Administrator, U.S. Environmental Protection Agency, Before the Energy and Air Quality Subcommittee, Energy and Commerce Committee, U.S. House of Representatives (May 26, 2005).

dramatically improve public health, they are affordable, and they are technologically achievable.

The Clean Air Transport Rule is designed to help states achieve the health-based ambient air quality standards for ozone and fine particles, more commonly called smog and soot. When finalized, it will require reductions in power plant emissions of NOx and SO2 in the middle and eastern portions of the country. We estimated that the proposed rule would prevent each year between 14,000 and 36,000 premature deaths, avoid hundreds of thousands of illnesses, and prevent nearly two million days when people would otherwise miss work or school.

We have also proposed the Mercury and Air Toxics Standards to control emissions of toxic air pollutants from power plants. In 2016, these standards will reduce emissions of mercury, other toxic metals such as cadmium, nickel and arsenic, and acid gases. Mercury, depending on the form and dose, may cause neurological damage, including lost IQ points, in children who are exposed before birth and is also associated with impacts on children's cognitive thinking, memory, attention, language, and fine motor and visual spatial skills. Metals such as arsenic, chromium, and nickel cause cancer and other health risks. Acid gases cause lung damage and contribute to asthma, bronchitis and other chronic respiratory disease, especially in children and the elderly. Controls for these toxics also will reduce fine particle pollution and prevent:

- 17,000 premature deaths
- 11,000 heart attacks
- 120,000 cases of childhood asthma symptoms
- 11,000 cases of acute bronchitis among children
- 12,000 emergency room visits and hospital admissions
- 850,000 days of work missed due to illness.

Some in industry are calling for us to move quickly on the rules. For example, the Clean Energy Group[6] recently said, "Needed regulatory certainty will result from EPA's timely implementation of regulations consistent with the Clean Air Act, which is in the best interests of the electric industry, the market, and customers."[7] Also, the Chairman and CEO of Wisconsin Energy said, "We see very little impact on customer electric rates or our capital plan between now and 2015 as a result of the new EPA regulations." [8] Similarly, the President of PPL Generation says that his company has a "proactive approach to environmental compliance" that positions them well to comply with the new regulations.[9] Undoubtedly, you will also hear from some in industry that

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[6] The Clean Energy Group's Clean Air Policy Initiative members include Austin Energy, Avista Corporation, Calpine Corporation, Constellation Energy, Exelon Corporation, National Grid, New York Power Authority, NextEra Energy, PG&E Corporation, Public Service Enterprise Group, Inc., and Seattle City Light.

[7] Letter to Lisa Jackson, Administrator, EPA, from Michael Bradley, Executive Director of the Clean Energy Group's Clean Air Policy Initiative (June 15, 2011), http://www.thecleanenergygroup.com/documents/Letter_Jackson_UtilityToxicsRule.pdf

[8] May 3, 2011 Wisconsin Energy Corporation 1st Quarter 2011 Earnings Call.

[9] February 4, 2011, PPL 4th Quarter 2010 Earnings Call.

object to these rules. They will claim that electricity rates will increase drastically, reductions are unachievable given multiple rules, the timeframe is too short, or that these regulations will put people out of work.

These rules are affordable. We estimate that, taking into account the combined effect of the proposed Clean Air Transport Rule and the Mercury and Air Toxics Standards, electricity rates will not rise above historic levels, although this will vary by region across the country. Even with increased rates, consumers could see reductions in their electricity bills if certain actions are taken by utilities and federal, state and local governments, such as the timely establishment of appliance efficiency standards and the establishment or expansion of energy efficiency programs for consumers.

The reductions we are requiring are achievable and can be met using controls that are well understood and available. Issuing the two rules in the same timeframe helps provide power companies with the certainty they need to make smart and cost-effective investments in control technology. The rules work together efficiently; controls applied to meet the requirements of one regulation will help meet other obligations.

The standards will allow adequate time for compliance, especially since the industry has known for years that additional requirements were coming -- since well before Administrator Leavitt's talk seven years ago. Industry has moved rapidly to comply with past requirements. For example, they installed an average of 20GW of scrubbers each year between 2008 and 2010. They also added 150 GW of new generating capacity between 2001 and 2003.

The investments in a cleaner energy sector required by these standards will keep people working and create jobs. EPA estimates that the proposed mercury and air toxics rule will support 31,000 job years of short-term construction work and net 9,000 long-term utility jobs.[10] Money spent on pollution controls at power plants provides high quality American jobs in manufacturing steel, cement, and other materials needed to build the pollution control equipment; in creating and assembling control equipment; in installing the equipment; and in operating and maintaining the equipment. And many of these are jobs that cannot be shipped overseas.

Over the last 40 years, the Clean Air Act has provided a success story of which all Americans can be proud. Key air pollutants are down more than 60 percent, while our economy has grown by over 200 percent. According to EPA's peer-reviewed estimates, every dollar we have spent cleaning up the air has given us more than 30 dollars in benefits. The Clean Air Transport Rule and Mercury and Air Toxics Standards continue that success story.

Thank you for the opportunity to testify today. I look forward to your questions.

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[10] Regulatory Impact Analysis for the Proposed Toxics (now MATS) Rule, U.S. EPA, March 2011. http://www.epa.gov/ttn/ecas/regdata/RIAs/ToxicsRuleRIA.pdf. Last viewed June 23, 2011.

Environment and Public Works Committee Hearing
June 30, 2011
Follow-Up Questions for Written Submission

Questions for McCarthy

Senator Thomas R. Carper

1. **In 1998, the EPA completed a report to Congress on the health impacts of air toxic emissions from utilities and whether utilities should be regulated under the air toxics framework in the Clean Air Act. Can you describe this report and the results?**

   Response: The 1998 report, "Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units -- Final Report to Congress," detailed the results of EPA's study of hazardous air pollutants (also known as air toxics) emitted by the utility industry, along with the potential human health impacts of exposure to these pollutants. A tiered analysis approach (involving an initial screening followed by more detailed analysis of certain pollutants) was used to determine which air toxics were most likely to be emitted by coal- and oil-fired utilities and which had the greatest potential adverse effects on human health. A number of priority air toxics, including nickel, arsenic, chromium, dioxins and mercury, were identified from both coal- and oil-fired utilities, based on their potential to increase the risk of cancer and/or produce other adverse health effects.

   A more detailed analysis of some of these priority toxics revealed important information about how emissions from utilities may affect humans and the environment. For example, the detailed analysis conducted for mercury, together with other available scientific information, supported the connection between mercury emissions from utilities and mercury found in freshwater fish nationwide.

2. **As you stated in your testimony, your agency has had a long history of issuing air toxic regulations for other sources. How many sources currently have MACT standards for air toxics? Once a source is listed, does your agency have to regulate all the air toxics emitted from the source – or can your agency pick and choose pollutants to regulate?**

   Response: The Clean Air Act (CAA) requires EPA to establish emission standards for listed categories and subcategories of industrial sources of air toxics, also known as hazardous air pollutants. There are 187 listed air toxics, all of which the Agency must regulate.

   EPA has promulgated 96 air toxics emission standards that apply to 174 industrial source categories. These rules are expected to reduce industrial emissions of air toxics by 1.7

million tons annually.[1]

EPA is required to establish standards for the air toxics that are emitted from the listed source categories. The agency cannot pick and choose pollutants to regulate but rather must regulate all hazardous air pollutants from a major source category that are reasonably expected to be emitted. National Lime Association v. EPA, 233 F 3d 625(D.C. Cir. 2000). The CAA requires that EPA establish technology-based emission standards, or alternatively in certain cases, work practice standards, for each of the listed major source categories. The technology-based standards require facilities to meet standards that are based on average emission limitation achieved by the best-performing 12 percent of existing sources for which the Agency has emissions information (or the best-performing five sources for source categories with fewer than 30 sources).

3. **Do any EPA regulations force retirements – or is that a business decision for the utility?**

   Response: EPA rules set emissions limits – they do not require plant closures. Companies will make independent business decisions about how best to achieve compliance with the regulations.

4. **In previous hearings, we've heard from a few witnesses that have cited independent studies conducted last fall that tried to analyze reliability, coal retirements, and your new utility clean air regulations. These studies show a much bleaker picture for our electricity sector than your analysis. However, none of the new utility clean air regulations were final last fall. In fact, the utility air toxics rule was just proposed this March. Were assumptions made about your regulations in these studies that are no longer valid today? I would like you to specifically comment on the 2010 National Electric Reliability Council Assessment on the Resource Adequacy Impacts of Potential U.S. Environmental Regulations.**

   Response: Many of the independent, industry reports released last fall, including reports by NERC, Credit Suisse, and Brattle, overstate the impact of EPA's rules on reliability and coal retirements due to pessimistic assumptions of the rules' requirements. These assumptions were unfounded and were made prior to EPA's proposal of several rules, most significantly EPA's Mercury Air Toxics Standards (MATS) and Cooling Water Intake Structures (CWIS) rules, which were not proposed until March and April of this year, respectively. A review by the Congressional Research Service (CRS) found that the NERC report "assumed requirements that appear to be substantially more stringent than what EPA proposed" for the MATS rule. As such, NERC's assessment of necessary pollution control equipment for coal-fired plants to comply with the MATS rule is exorbitantly high. CRS also found that NERC's assessment of the CWIS rule (which NERC concluded would be the most costly of the four EPA rules that it examined) assumed that the agency would propose a more stringent rule with a more rapid timeline for compliance than was actually proposed by the agency. These findings were

[1] National Air Toxics Assessment: http://www.epa.gov/ttn/atw/nata2005/airtoxred.html

corroborated for the NERC report and extended to the Credit Suisse and Brattle reports by an assessment conducted by the Bipartisan Policy Center. Due to incorrect assumptions, made in advance of several rule proposals, the conclusions of these industry reports do not apply to the MATS and CWIS rules as they exist today.

5. **On May 13, 2011, you wrote to Senator Inhofe regarding the reconsideration of the national health standards for ozone. You stated that the 2008 standards "were not defensible given the scientific evidence in the record and the requirements of the Clean Air Act." What is the status of the Ozone reconsideration? Will you complete the reconsideration by July 29, 2011? And how will the Transport Rule and the Air Toxics Rule help states meet the new ozone standard?**

Response: In September, President Obama requested that Administrator Jackson withdraw the draft Ozone National Ambient Air Quality Standards. On September 2, 2011, the Administration withdrew the final rule for the reconsidered 2008 ozone National Ambient Air Quality Standards (NAAQS) from interagency review and is now proceeding with implementation of the current ozone NAAQS of 0.075 ppm (or 75 parts per billion). This standard will provide additional public health and welfare protection until the next regular review is completed, and EPA fully intends to implement this current standard as required under the Clean Air Act. EPA is working with state and local governments to help areas reach attainment with the 0.075 ppm standards through federal rules, planning assistance for state, tribal and local air agencies, and by providing flexibility where appropriate and allowed by law. For example, the Cross-State Air Pollution Rule (CSAPR) requires states to reduce power plant emissions that cross state lines and contribute to ozone pollution in other states. This will help those downwind states meet the 0.075 ppm ozone standard.

6. **Many of our ports are in designated "non-attainment" areas and are required to reduce overall port emissions. With foreign trade expected to increase in the coming decade, the increased ship traffic will inevitably lead to greater emissions from all port based sources, including tugs and harbor service vessels. In order for our ports to reduce emissions, while accommodating increased port traffic, it is imperative that EPA's technology verification process effectively support rapid deployment of additional technologies to our ports. It is my understanding that efforts are underway to verify hybrid tugboat technology. Can you please provide an update on the status of these efforts?**

Response: The National Clean Diesel Campaign promotes the reduction of emissions from existing diesel engines through a variety of innovative strategies and technologies such as engine retrofits, rebuilds and replacements; switching to cleaner fuels; idle reduction and other clean diesel strategies.

The Clean Diesel Technology Verification Program evaluates the emission reduction performance and durability of clean diesel technologies and provides users with confidence the technology will perform as expected. EPA has been working with several manufacturers regarding their hybrid technologies. One prototype hybrid tug has been introduced into service and tested to evaluate performance and develop design improvements. Based on the prototype, a significantly redesigned hybrid tug system has been developed and just recently deployed on the West Coast. EPA is working closely with the manufacturer to monitor the performance of this newly designed hybrid tug system and assist the manufacturer in pursuing verification.

Senator James M. Inhofe

1. **As stated in the Cross State Air Pollution Rule (CSAPR), EPA bases the inclusion of Texas in the program on the purported contribution of emissions from Texas sources to air quality impairment in Madison County, Illinois related to the annual $PM_{2.5}$ national ambient air quality standards (NAAQS). EPA has, however, formally determined that Madison County, which is a part of the Saint Louis area, is now in attainment for the 1997 $PM_{2.5}$ NAAQS. Accordingly, the Agency has suspended many of the Clean Air Act's requirements applicable to nonattainment areas for Madison County, even though the Agency has yet to formally redesignate the area as an attainment area.**

   a. **Because Madison County is now formally in attainment of the relevant NAAQS and is on a clear path to redesignation as an attainment area, how does EPA justify relying on Texas' purported contribution to air quality impacts in this area as a basis for including Texas in the CSAPR program?**

   Response: States were included in CSAPR for $PM_{2.5}$ if they were projected to significantly contribute to nonattainment or interfere with maintenance of the $PM_{2.5}$ standards in another state.

   Madison County's recent and current air quality benefits from pollution reductions required by the Clean Air Interstate Rule (CAIR). Since the Cross State Rule will replace CAIR, we had to project what would happen in Madison County if CAIR was not in effect.

   The modeling conducted for the final CSAPR rule demonstrated that Texas significantly contributes to $PM_{2.5}$ levels in Madison County, Ill. Madison County violated both the annual and 24-hr $PM_{2.5}$ NAAQS during the 2003-2007 base-year and was among the receptor areas that were projected to violate the annual and 24-hour $PM_{2.5}$ NAAQS in 2012 without CAIR or CSAPR controls.

   In the final CSAPR, EPA identified future year (2012) nonattainment and maintenance "receptor areas" (areas that may be nonattainment or maintenance because of transported pollution), based on modeled projections of ambient air quality from the 2003-2007 time period. Madison County is expected to be a maintenance area in 2012, and Texas was found to be a contributor to this projected nonattainment.

   In the CSAPR methodology, the future year nonattainment and maintenance receptors were compared to modeling showing air quality *without* CAIR or

CSAPR controls. The most recent monitoring data (2007-2009 and 2008-2010 design values) already are affected by large emission reductions as a result of CAIR. Because CSAPR replaced CAIR, for emissions reductions we modeled a future year base case that does not assume that CAIR-required technology is in operation though in some cases it is installed (a "no-CAIR" case). EPA determined that it is simply not appropriate to examine the current monitoring data, which represent air quality with CAIR emission reductions in place, and compare the values to 2012 projected air quality that is based on a no-CAIR modeling case.

1b. What threshold for significant contribution has EPA used to measure Texas' contribution to air quality impacts in Madison County and how does that threshold relate to Madison County's current attainment of the annual 1997 PM2.5 NAAQS and likely redesignation?

Response: For CSAPR, EPA used air quality modeling to determine which states are projected to contribute at or above threshold levels to the air quality problems at downwind nonattainment and/or maintenance areas. States whose contributions met or exceeded these thresholds were analyzed further, as detailed in the CSAPR preamble in section VI, to determine whether they significantly contribute to nonattainment or interfere with maintenance of a relevant NAAQS -- and if so, the quantity of emissions that constitute their significant contribution and interference with maintenance.

EPA estimates the air quality threshold to which the Texas 24-hour average $PM_{2.5}$ contribution was compared is 0.35 ug/m3, which is 1 percent of the 2006 24-hour $PM_{2.5}$ NAAQS (the current 24-hour standard. We found that Texas and 12 other states individually contributed to Madison County being above the threshold for either the annual or 24-hour $PM_{2.5}$ NAAQS.

The contribution thresholds used in CSAPR are 1 percent of each of the respective $PM_{2.5}$ and ozone NAAQS. There is no direct relationship between the contribution threshold and the current status of ambient air quality in Madison County Illinois.

c: What precisely is Texas' contribution to air quality impairment in Madison County and how does that contribution relate to the contribution of sources in other states, including the state of Illinois itself?

Response: EPA estimates the annual average PM2.5 contribution from Texas to Madison County is 0.18 ug/m3. There are 10 states (including Texas) that contribute to Madison County at levels above the 1 percent threshold. The contribution from Illinois to Madison County is 1.51 ug/m3. Other states with similar contributions as Texas are Wisconsin (0.16 ug/m3) and Tennessee (0.19 ug/m3).

EPA estimates the 24-hour average PM2.5 contribution from Texas to Madison County is 0.37 ug/m3. There are 12 states (including Texas) that contribute to

Madison County at levels above the 1 percent threshold. The contribution from Illinois to Madison County is 4.03 ug/m3. Other states with similar contributions as Texas are Kansas (0.37 ug/m3) and Iowa (0.45 ug/m3).

d: Please provide any data and/or technical analysis conducted, considered, or relied upon by the Agency in making determinations related to the impact of Texas emissions on Madison County air quality.

Response: All of the modeling data and analyses used to support the CSAPR are on the EPA CSAPR Technical Information website (http://www.epa.gov/airtransport/techinfo.html) and in the CSAPR docket. Some specific documents that may be helpful are:

1) The final CSAPR air quality modeling technical support document http://www.epa.gov/airtransport/pdfs/AQModeling.pdf
2) The final CSAPR emissions inventory technical support document http://www.epa.gov/airtransport/pdfs/EmissionsInventory.pdf
3) The final CSAPR state-by-state ozone and PM2.5 contributions spreadsheet http://www.epa.gov/airtransport/pdfs/CSAPR_Ozone%20and%20PM2.5_Contributions.xls
4) A trajectory analysis which examines the observed wind patterns between upwind states and downwind nonattainment/maintenance receptors - Docket number EPA-HQ-OAR-2009-0491-4360
5) All of the air quality modeling data (inputs and outputs) is contained on hard drives that are in the docket. The data files total approximately 8TB- Docket number EPA-HQ-OAR-2009-0491-4228

2. **While the proposed Clean Air Transport Rule (CATR) performed some modeling on Texas, the proposed CATR, nevertheless, identified Texas as a non-contributing state. However, the CSPAR appears to have conducted new modeling in coming to the conclusion that Texas does significantly contribute to non-attainment in a downwind state.**

   Please explain the difference in data, techniques, assumptions or other modeling and analysis that lead EPA to change Texas' status from a non-contributing state in the proposed CATR to a significantly contributing state in the CSAPR.

   Response: There were numerous updates made to the emissions inventory and to EGU emissions data between the proposed and final rule. EPA made it clear to the public at proposal and in the subsequent Notices of Data Availability (NODAs) that the final rule's geography and budgets for each state would be based on revised analysis using new information provided by commenters. EPA received many detailed comments on

CSAPR from Texas state officials, power plant operators, industry associations, and other interested Texas stakeholders and updated its data accordingly in the final rule.[2]

In the proposed rule, EPA solicited comment on the inclusion of Texas for fine particles based on projected emissions, which in turn are based in part on the types of coal projected to be burned at Texas facilities. EPA's modeling at proposal showed that certain facilities in Texas would increase consumption of higher-sulfur coals if left out of the CSAPR annual programs, effectively raising their emissions to a level that would significantly contribute to downwind nonattainment. The Texas Commission on Environmental Quality (TCEQ) responded to the Agency's request for comment on this issue by observing that "Four of the [power plant] facilities identified by EPA [at proposal] as being 100 percent subbituminous are lignite or lignite-blend units. This indicates that the base assumptions the EPA has used in its base case modeling are in error..." TCEQ's comments observed that instead of increasing consumption of these higher-sulfur coals in response to being left out of the annual CSAPR programs, these facilities would already be consuming that higher-sulfur coal even without the rule in place at all (i.e., the base case). EPA revised its modeling in accordance with this comment and found that under these conditions, Texas significantly contributes to downwind nonattainment of the 1997 PM2.5 standard. The basis for including Texas in the final CSAPR is identical to the basis considered at proposal and the basis for including all other states covered by the CSAPR programs: namely, whether emissions in an upwind state contribute at least 1% of the relevant NAAQS at a downwind site with projected nonattainment or maintenance concerns with that standard, and whether cost-effective reductions can be identified in that upwind state to eliminate that state's significant contribution to nonattainment or interference with maintenance.

b. **The CSAPR states that EPA updated its modeling inputs used to identify states with contributions to downwind receptors, as well as identifying emissions within such states that constitute the state's significant contribution to nonattainment. Please explain how these modifications impacted Texas' status under CSAPR.**

Response: As explained above, EPA updated data inputs for air quality modeling (which determined the degree to which emissions in each state contribute to air quality concentrations at downwind monitors) and for power sector cost modeling (which determined the ability of each state to make cost-effective emission reductions in response to the cost thresholds considered in the development of the rule). The updated air quality modeling for the final CSAPR found that Texas met the air quality threshold test for inclusion of contributing at least 1% of the 2006 24-hour PM2.5 NAAQS to a downwind location with projected nonattainment or maintenance issues with that standard. The updated power sector cost modeling for the final CSAPR found that

[2] After we finalized the rule, EPA became aware of information updating, correcting or completing the earlier information. This allowed the agency to identify data discrepancies and to remedy those discrepancies. Accordingly, on February 7, 2012, EPA finalized technical adjustments that result in an approximately 50,000 ton increase to Texas' SO2 budget and small increases to both Texas' ozone season NOx and annual NOx budgets with corresponding revisions to assurance levels and new unit set-asides.

electric generating units in Texas are able to make cost-effective emission reductions in annual NOx and SO2 that will assist downwind areas in attaining and maintaining the 2006 24-hour PM2.5 NAAQS.

c. **Please provide all documentation pertaining to the modeling modifications that lead EPA to identify Texas as a contributing state in the CSAPR.**

Response: See CD.

3. **EPA's final rule states that Texas is capable of meeting its CSAPR emission budgets cost-effectively even while maintaining its current levels of lignite consumption. EPA bases this conclusion on a sensitivity analysis and states that additional information regarding this issue is contained in its Response to Comments Document and in the IPM model output files.**

a. **Please provide an explanation of EPA's conclusion that Texas can comply with CSAPR while maintaining current lignite consumption and explain the Agency's technical support for this conclusion.**

Response: As part of the rule's development, EPA considered the ability and cost-effectiveness of increasing sub-bituminous consumption at units currently blending various shares of Texas lignite. EPA conducted a sensitivity analysis to address the cost-effectiveness of units continuing to blend lignite coal under the 2012 SO_2 budget for Texas in the final rule. The purpose of this analysis was to determine if the CSAPR's SO_2 assurance level for Texas was robust to varying levels of blending lignite and sub-bituminous coals at Texas facilities; in other words, the analysis investigated whether other cost-effective emission reductions exist in Texas aside from coal-switching to meet the state's CSAPR SO_2 assurance level in 2012.

In this analysis, EPA assumed that Texas units would not increase their blending of sub-bituminous coal beyond the blending level each unit reported to EIA for 2010. This is a conservative scenario for fuel blending, as EIA data shows that these units have significantly increased their level of sub-bituminous blending over several years leading to 2010 and thus already exhibit a multi-year trend of decreasing lignite consumption before CSAPR was promulgated. For the purposes of this sensitivity analysis, however, their sub-bituminous blending was prevented from growing beyond 2010 levels, notwithstanding the trend through 2010. Under these conditions, Texas is still projected to meet its 2012 SO_2 assurance level using other cost-effective emission reduction strategies, including greater dispatch from lower-emitting generators, while still maintaining 2010 lignite blending levels. The sensitivity analysis revealed that Texas can still achieve its assurance level with other emission reductions available at the same marginal cost shared by all Group 2 states under the rule. Therefore, this analysis shows that the Texas SO_2 assurance level under CSAPR is robust across a wide spectrum of lignite and sub-bituminous blending levels at Texas units.

Texas is still projected in this sensitivity scenario to emit less SO_2 than its assurance level in both 2012 and 2014, even with its EGUs continuing to consume in the future the level of lignite reported to EIA in 2010. This sensitivity analysis therefore shows that Texas can sustain the operation of lignite mines and the provision of lignite coal to Texas EGUs while still cost-effectively meeting the Transport Rule's emission reduction requirements. Also, coal-switching is only one of many ways by which Texas can comply; EPA data show that more than half of Texas coal capacity will be scrubbed by 2012 and analysis shows that those units can increase their generation. Finally, natural gas-fired units benefiting from substantially expanding Texas natural gas supplies and low near-term prices can also increase their generation to help Texas cost-effectively meet its 2012 SO_2 budget.

b. Please provide the sensitivity analysis, relevant portions of the Response to Comments Document (including the Feasibility Section), and the IPM model files (including any relevant IPM Documentation, the Texas Lignite coal supply curves, and relevant IPM summary files and actual files), along with any other relevant information or records.

Response: See CD

4. The final rule notes that EPA received public comments expressing concern with the assumption that coal-switching from lignite to sub-bituminous is a cost-effective or feasible emission reduction strategy at Texas electric generating units (EGUs). The Agency states that it considered these comments and made adjustments in its model so that it assumes coal-switching is not a compliance option at the specific units where commenters identified technical barriers to subbituminous coal consumption. Accordingly, EPA asserts that the rule's emission budgets are based on modeling that does not assume any infeasible coal-switching from lignite to subbituminous.

a. Please identify those technical barriers to coal-switching that EPA determined justified no or reduced coal-switching assumptions in its analysis.

Response: EPA received some comments from specific unit owners and/or operators that identified physical engineering barriers preventing those units from obtaining or consuming certain types of coal. For example, a San Miguel facility commented on their inability to receive subbituminous deliveries due to rail access. Therefore EPA ensured that they did not receive such deliveries in their 2012 or 2014 policy modeling and that the unit continued to consume lignite coal. EPA also reviewed its base case coal assumptions for the blending facilities based on comments from TCEQ.

b. Please identify any technical barriers that EPA determined did not justify relief from coal-switching assumptions in its analysis.

Response: Because of its low heating value, the rail transport cost for lignite is relatively high and lignite plants are therefore typically located close to local lignite mines, so called "mine mouth" plants – often trucking or conveying coal to the plant. Switching from lignite to a subbituminous that comes from more distant sources may therefore entail some improvement to the rail spur and coal receiving system at some plants. These transport and coal handling requirements may already be in place at many lignite plants. Aside from these fundamental requirements, the more important modifications that may be required to facilitate a successful switch to subbituminous is the minor upgrading of current boiler cleaning systems to modern "water cannons" and "intelligent sootblowing" systems to cope with various issues that might arise due to the slagging potential or higher "ash reflectivity" of subbituminous coal. These modifications are minor and EPA believes that a switch from lignite to 100% subbituminous coal or to a blend with subbituminous is a technically feasible compliance option that can be accomplished at most lignite plants within the time frames available under the Transport Rule.

c. **Please explain the Agency's rationale and/or standards for evaluating potential technical barriers to coal-switching.**

Response: Based on comments EPA received, the agency developed a procedure to capture limitations that prevent unrestricted switching from one type to another type of coal without incurring additional investment costs. The procedure consisted of the following steps: (1) Determining a level of coal consumption indicative of an existing capability to burn 100% subbituminous coal. (2) Developing cost adders, heat rate penalties, and decision rules that would apply to units that don't meet this threshold.

Existing units not meeting the 90% subbituminous coal criteria incur a fuel cost adder and heat rate penalty for combusting more than a pre-specified percent of subbituminous. The cost adder is designed to reflect material handling and boiler modification costs. The heat rate penalty reflects the impact of the higher moisture content subbituminous coal on the unit's heat rate. The procedure applies only to units that are currently designated to burn both bituminous and subbituminous coal in the base case. Historical fuel usage data is used to infer whether units have already made investments allowing them to burn unrestricted amounts of subbituminous coal.

Commenters had expressed specific concern about the technical feasibility of switching to 100% subbituminous coal use in power plants that were originally designed for 100% lignite and are currently burning either 100% lignite or a blend of lignite and subbituminous. EPA carefully considered these comments and has confirmed its IPM modeling assumption that units designed for 100% lignite can readily switch to 100% subbituminous, or to a blend, by making relatively minor physical modifications that can be accomplished within the time frame available for compliance with the Transport Rule.

The primary reason that large pulverized coal boilers designed for a lower grade coal (lignite) can readily burn a higher grade coal (subbituminous) without major modifications is that in almost all respects such units are already "over designed" as regards the capabilities needed to successfully burn the higher grade coal. This fact is most apparent in comparing boiler furnace sizes: the plan area and height of a furnace designed for low-slagging lignite are at least as large as needed for subbituminous, and the dimensions of a high-slagging lignite furnace may be as much as 50% larger than needed for subbituminous. Similarly, the lower heating value of lower rank lignite requires that a lignite unit's coal handling systems, pulverizers, boiler draft fans, air emission controls, and ash handling systems already have significantly greater capacity than needed for subbituminous. Lignite units that are currently blending a significant share of subbituminous have likely already made the important but relatively minor improvements in coal handling and dust suppression systems needed to safely accommodate the friability and dusting associated with subbituminous coal.

d. Please identify which public comments resulted in EPA's review of technical barriers at specific facilities.

Response: Factors limiting changes in near term coal use were considered technically plausible in 2012. Consequently, EPA incorporated such limitations in 2012 in cases where the affected units were explicitly identified, where sufficient documentation and an adequate explanation of the governing factors were provided, where EPA was not aware of data contradicting the claim, and where the inclusion of the limitation might affect modeling results. In cases where comments identified specific units that could not change from a specific coal due to short term constraints and generally met the conditions outlined above, the unit's coal assignment in 2012 would be limited to the coal stipulated in the comment.

e. Please provide a list of all facilities for which technical barriers were evaluated, the technical barriers EPA reviewed for such facilities, and a list of any facilities for which EPA did not evaluate technical barriers to coal-switching.

Response: Coal choice was restricted in the first model run year (2012) in the modeling horizon in situations where sufficient information was provided to EPA indicating that short-term factors (like coal contracts and boiler engineering considerations) limited a unit's choice to a particular assigned coal. More specifically, EPA examined the engineering feasibility of such an increase in subbitumious coal use at blending facilities. Six Texas facilities-- Pirkey, San Miguel, Sandow No4, Sandow Station, and Twin Oaks Power One-- had not demonstrated that ability in recent data and burned only lignite coal. EPA verified in its model that these lignite only burning facilities remained lignite only in its model – both in base case and policy case. There were additional EGUs in Texas for which no additional information about coal-switching was received.

f. Please provide all technical analysis and similar records related to the evaluation of technical barriers to coal-switching.
Response: See CD.

National Emission Standards for Hazardous Air Pollutants From Coal and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units, 76 Fed. Reg. 24,976 (May 3, 2011).

5. **For each of the proposed emission limitations for existing units that utilize coal as a fuel (broken down by subcategory), specify the best performing 12 percent of existing sources that EPA used to establish such limitations. For each unit so specified, state:**

- **The pollution control technologies currently in use at such unit;**
- **The rank of coal used at the unit, the sulfur and chlorine content of such coal, and the coal region from which such coal is produced;**
- **The type of coal technology used (conventional, CFB, IGCC).**

Response: The requested information on proposed emission limits for existing and new units is in the spreadsheets found on the accompanying CD. These spreadsheets also include answers to question 7 below. We do not have readily available information on the sulfur and chlorine content of all of the coals or on the coal region from which such coal is produced.

6. **Specify all existing units that will be subject to the proposed Air Toxics Rule that currently meet all of the proposed emission limitations for existing units. For each such unit, state:**

- **The pollution control technologies currently in use at such unit;**
- **The rank of coal used at the unit, the sulfur and chlorine content of such coal, and the coal region from which such coal is produced;**
- **The type of coal technology used (conventional, CFB, IGCC).**

Response: Because we are not currently collecting data to demonstrate conclusively which units would meet the proposed standards, we do not have data to definitively answer your request. The spreadsheet (a8 ExhibitAbilityToAchieve.xls on the accompanying CD) provides information about the electric utility steam generating units (EGUs) for which we have data -- either data that the EGUs acquired over the past five years or new data that they gathered as part of the 2010 information collection request (ICR) -- indicating that the EGU has exhibited the ability to achieve the level of all of the proposed emission limits. Information in this spreadsheet was excerpted from the MACT Floor Analysis spreadsheets which we are producing in response to question 5 and which are found on the accompanying CD). These spreadsheets also include information to answer question 8 below. We do not have readily available information on the sulfur and chlorine content of all of the coals or on the coal region from which such coal is produced.

7. **For each of the proposed limitations for new units (broken down by subcategory), specify the best controlled similar source that EPA used to establish such limitations. For each unit so specified, state:**

   - **The pollution control technologies currently in use at such unit;**
   - **The rank of coal used at the unit, the sulfur and chlorine content of such coal, and the coal region from which such coal is produced;**
   - **The type of coal technology used (conventional, CFB, IGCC).**

   See the response to question 5 above.

8. **Specify all existing units that will be subject to the proposed Air Toxics Rule that currently meet all of the proposed emission limitations for new units. For each unit so specified, state:**

   - **The pollution control technology currently in use at such unit;**
   - **The rank of coal used at the unit, the sulfur and chlorine content of such coal, and the coal region from which such coal is produced;**
   - **The type of coal technology used (conventional, CFB, IGCC).**

   Response: As noted above, we do not have data to conclusively answer this question. However we have included information on units that provided testing information that indicated no one unit had exhibited the ability to achieve the level of all of the proposed emission limits for new sources. We do not have readily available information on the sulfur and chlorine content of all of the coals or on the coal region from which such coal is produced.

9. The preamble to the proposed rule claims that more than half of all existing coal-fired plants will be able to meet all of the MACT standards in 2015. *See* 76 Fed. Reg. at 25054. Please identify the existing sources that can meet all of the proposed MACT standards in 2015 without installing additional control technology.

Response: The preamble states: "Much of the power sector already has controls in place that remove significant amounts of acid gases. Today over 50 percent of the power generation fleet has scrubbing technology installed and the industry is already working on installations to bring that number to nearly two-thirds of the fleet by 2015." (76 Fed. Reg. at 25054/3)

Scrubbers are currently installed on 59% of existing coal steam capacity greater than 25 MW. The EGUs with existing scrubber controls are included on the attached CD.

10. **The preamble to the proposed rule claims that many existing units will be able to meet the acid gas MACT standard using dry sorbent injection rather than installing scrubbers at nearly ten times the cost. *See* 76 Fed. Reg. at 25054. Please identify the existing sources that can meet the proposed acid gas standard as well as all of the MACT standards using this technology without a scrubber burning bituminous coal.**

Response: Dry Sorbent Injection (DSI) is an acid gas removal technology that is capable of achieving HCl reductions, but does not achieve significant reductions of other HAPS. The following units were projected to burn at least some bituminous coal, and were also projected to install DSI for acid gas control in the modeling done in support of the proposed rule.

Plant Name	ORIS Code	Unit ID	State Name	Capacity (MW)
Alma	4140	B4	Wisconsin	51
Alma	4140	B5	Wisconsin	77
Bridgeport Station	568	BHB3	Connecticut	371
Carbon	3644	2	Utah	105
Dean H Mitchell	996	4	Indiana	124
Dean H Mitchell	996	5	Indiana	124
Dean H Mitchell	996	6	Indiana	124
Dean H Mitchell	996	11	Indiana	109
E C Gaston	26	2	Alabama	255
E C Gaston	26	3	Alabama	253
Eagle Valley	991	3	Indiana	43
Eagle Valley	991	4	Indiana	56
Eagle Valley	991	5	Indiana	62
Eagle Valley	991	6	Indiana	99
Eastlake	2837	1	Ohio	131

Eastlake	2837	2	Ohio	131
Eastlake	2837	3	Ohio	131
Eastlake	2837	4	Ohio	239
Fair Station	1218	2	Iowa	41
Gadsden	7	1	Alabama	64
Gadsden	7	2	Alabama	66
Gorgas	8	6	Alabama	108
Gorgas	8	7	Alabama	109
Harding Street	990	50	Indiana	109
Harding Street	990	60	Indiana	109
J C Weadock	1720	7	Michigan	149
J C Weadock	1720	8	Michigan	149
J H Campbell	1710	1	Michigan	259
J H Campbell	1710	2	Michigan	352
J R Whiting	1723	1	Michigan	102
J R Whiting	1723	2	Michigan	102
J R Whiting	1723	3	Michigan	124
Jack Watson	2049	4	Mississippi	229
Kraft	733	1	Georgia	48
Kraft	733	2	Georgia	52
Kraft	733	3	Georgia	102
KUCC	56163	4	Utah	64
Martin Drake	492	5	Colorado	46
Martin Drake	492	6	Colorado	77
McIntosh	6124	1	Georgia	156
North Valmy	8224	1	Nevada	253
Presque Isle	1769	5	Michigan	88
Presque Isle	1769	6	Michigan	88
River Rouge	1740	2	Michigan	240
River Rouge	1740	3	Michigan	271
Shawnee	1379	2	Kentucky	133
Shawnee	1379	3	Kentucky	133
Shawnee	1379	4	Kentucky	133
Shawnee	1379	5	Kentucky	133
Shawnee	1379	6	Kentucky	133
Shawnee	1379	7	Kentucky	133
Shawnee	1379	8	Kentucky	133
Shawnee	1379	9	Kentucky	133
Sibley	2094	3	Missouri	400
St Clair	1743	1	Michigan	150
St Clair	1743	2	Michigan	153

St Clair	1743	3	Michigan	159
St Clair	1743	4	Michigan	150
St Clair	1743	6	Michigan	311
Tanners Creek	988	U2	Indiana	144
Tanners Creek	988	U3	Indiana	199
Tanners Creek	988	U4	Indiana	498
Wabash River	1010	2	Indiana	42
Wabash River	1010	4	Indiana	42
Wabash River	1010	6	Indiana	317
Whitewater Valley	1040	1	Indiana	35
Whitewater Valley	1040	2	Indiana	63
Yates	728	Y2BR	Georgia	105
Yates	728	Y3BR	Georgia	112
Yates	728	Y4BR	Georgia	134
Yates	728	Y5BR	Georgia	136

11. We note that downwind nonattainment areas used to support the Agency's decision in the final transport rule are based on older air quality data and do not reflect the most recent ozone and PM 2.5 air quality data. How many of the downwind nonattainment areas would be in attainment based on the 2008 to 2010 ozone air quality data and the most recent PM2.5 air quality data? How many of those areas would be in attainment based on the projected continued reductions from existing mobile and stationary source regulations over the next ten years?

Response: It is neither meaningful nor appropriate to compare the most recent air quality design values to the predicted future year 2012 and 2014 design values from CSAPR. In particular, it is inappropriate to compare current design values to EPA's no-CAIR 2012 future year modeling results. As explained in the response to question 1b, EPA did not examine the most recent air quality data as part of the CSAPR final rule modeling in order to ensure we made appropriate comparisons of the base case to projected air quality. The recent air quality data are impacted by several factors. Among them are the emissions reductions from CAIR, the relatively low recent observed ozone and $PM_{2.5}$ concentrations that were at least partially due to non-conducive meteorology (particularly in 2009), and the atypical suppression of emissions due to the sharp economic recession.

Nonetheless, based on 2008-2010 design values for the CSAPR projected 2012 nonattainment areas, the Baltimore area remains nonattainment for the 1997 ozone NAAQS, and the Liberty/Clairton area (within Alleghany County, Pa.) remains nonattainment for 1997 annual and 2006 24-hour PM2.5 NAAQS. The rest of the predicted nonattainment and/or maintenance receptors have recent data that is consistent with attainment of the 1997 ozone and 1997 and 2006 PM2.5 NAAQS.

The CSAPR model projections predict that Houston will have a remaining ozone nonattainment problem and Liberty/Clairton will have a remaining 24-hr PM2.5 nonattainment problem after the CSAPR is fully implemented in 2014. We did not model future years beyond 2014.

12. When does EPA expect to release the most recent air quality data for ozone?

Response: The most recent ozone design values for the 2008-2010 period were updated on January 11, 2012 (spreadsheet attached) and are publicly available at: http://www.epa.gov/airtrends/values.html

Senator CARPER. Thank you, Ms. McCarthy.

Before we get started with questions, I want to ask unanimous consent to place into the record two letters to me from the Institute of Clean Air Companies and the American Federation of Labor that State that labor availability will in no way constrain industry from complying with the proposed Transport Rule or Air Toxics Rule.

I also ask unanimous consent to place into the record a letter to EPA Administrator Lisa Jackson from Ms. Angela Davis, mother from Pennsylvania. She writes in support of the Air Toxics Rule and tells her terrible story of losing her 17 year old son Cameron to asthma.

If there is no objection, those will be made a part of the record.

[The referenced documents follow:]

Testimony of Angela Davis, Pennsylvania Mother

Angela Davis
1340 Farrington Road
Philadelphia, PA 19151

May 24, 2011

Administrator Lisa P. Jackson
Environmental Protection Agency
Washington, DC

Dear Administrator Jackson,

I am writing to submit my comments in support of EPA's proposal to clean up hazardous air pollutants from coal-fired power plants.

I am not a scientist nor an environmental expert. I am a mom, and I am writing to you in that capacity – one mother to another.

I am the mother of two children, a son Cameron and a daughter Jaimise. My son Cameron died on August 11, 2009 from a severe asthma attack. He was only 17 years old. I would not wish our family's pain or loss on anyone, and I am committed to doing all I can to raise awareness of the seriousness of asthma in the hopes that it might save another family the anguish we have suffered. It is for this reason that I support the EPA's efforts to clean up pollution, including mercury from coal-fired power plants.

Cameron's asthma had many triggers, including seasonal allergies, food allergies, and secondhand smoke. We worked hard as a family to eliminate these irritants to the greatest extent possible. Despite this, Cameron still had severe asthma attacks, necessitating several trips to the hospital each year. I believe very strongly that we should do all we can to reduce air pollution to protect our country's children, especially our vulnerable asthmatics, because these are things that families themselves cannot eliminate or control. Was air pollution responsible for Cameron's fatal asthma attack? I will never know. But the science is clear that air pollution *is* an asthma trigger. And my family's experience makes it clear that in some cases asthma *is* a life-threatening disease.

Although Cameron was only 17 when he died, he had a keen awareness of the seriousness of his lung disease. In fact, on more than one occasion, including just the day before he died, he confided in his sister than he didn't think he would live long because of his disease, saying "I just want to have fun and hang out with my friends. I don't think I'll be here long."

Asthma is a terrible, life-altering and yes, sometimes life-threatening disease. As a mother, I urge you to do all you can to reduce air pollution to ensure that families like ours and kids like Cameron have a fighting chance at controlling and beating their asthma. Thank you very much.

Sincerely,

Angela Davis

Senator CARPER. Ms. McCarthy, again, thank you for your testimony and for your service. I just want to start off by saying you have the opportunity here, not only Senator Cornyn's introduction for his Commissioner from Texas, but also to make some additional comments. Anything that you want to say just in response to some of Senator Cornyn's comments?

Ms. MCCARTHY. I would appreciate the opportunity and again, Senator, thank you for your leadership on these issues.

We have looked extensively and we have met with the company and we have spoken on the Texas issues and their concerns related to the Transport Rule. Let me point out just a few things. One is that the process that we used, the public process we used related to the Transport Rule thoroughly addressed both the legal requirements under the Act to look at the air pollutants that Texas is contributing to their downwind neighbors. We also did extensive modeling to show what the most cost-effective emissions could be achieved in Texas commensurate with what we believe to be the significant contribution to downwind States.

We are very confident that we not only met our legal obligation, but we also met the spirit of the law. We actually identified and sought comments on including Texas for the variety of pollutants that we were looking at. We actually received comments from both TCEQ, as well as the regulated community that talked in detail——

Senator CARPER. Comments from what? What was the acronym you used?

Ms. MCCARTHY. TCEQ. That is the Texas——

Senator CARPER. Council on Environmental Quality?

Ms. MCCARTHY. I am sorry.

Mr. SHAW. Commission on Environmental Quality.

Ms. MCCARTHY. Commission on Environmental Quality, TCEQ. Thank you very much.

Senator CARPER. Thank you.

Ms. MCCARTHY. That was their Chairman, Bryan Shaw.

Senator CARPER. Oh, OK.

Ms. MCCARTHY. And we firmly believe that we have met not only our legal obligation, but we are basically—the State and the regulated community provided great comments, and we know they understand and we will consider those comments in the final.

Senator CARPER. All right, thanks. Thanks for saying that. Could you take a moment to discuss with us how the Transport Rule, that is, the one replacing the Clean Air InterState Rule, tries to ensure that we are all better neighbors when it comes to air pollution?

Ms. MCCARTHY. Yes. I believe that—I don't cover this too much—you are more than familiar with the Clean Air InterState Rule, but it was a rule that intended to address the clean neighbor provisions in the Clean Air Act, in other words, that downwind States shouldn't have to suffer the air pollution from upwind States that are causing them to be out of air quality attainment, have bad air quality, or to continue to achieve that air quality through maintenance operations.

The Clean Air InterState Rule and the Clean Air Mercury Rule were found by the courts to be failing in terms of meeting the obligations of the Clean Air Act. The courts told us that they would remand it back to the agency, but we needed to be expeditious in terms of replacing those rules with rules that would meet the test of the Clean Air Act and the courts.

Senator CARPER. When can we see a final Transport Rule from EPA? I am hoping it is going to be soon.

Ms. MCCARTHY. Next week.

Senator CARPER. Next week. All right. That is pretty soon.

Ms. MCCARTHY. That is soon.

Senator CARPER. Monday? Probably not Monday.

Ms. MCCARTHY. Actually, I will go off over the weekend and will contemplate it, Senator, but it will be middle of the week next week.

Senator CARPER. Thank you.

Ms. MCCARTHY. And thank you for your patience.

Senator CARPER. Sure. A couple of my colleagues talked to you about how important energy costs are in driving economic development or job creation in certain States. As Governor, I worked for 8 years on economic development and job creation. I loved it and still do. I describe myself as a recovering Governor.

And there are any number of factors that companies consider when they are deciding whether to create jobs, put up shop in a particular area of a State, grow jobs or not grow jobs. They look at schools, they look at quality of schools; they look at access to decisionmakers; they look at look at regulations, whether or not the regulations use common sense; they look at access to transportation; they look at crime. They look at all kinds of stuff. They also look at energy costs, and some of them look at a lot of energy costs, and a lot of them look at health care costs, given how much health care costs are.

And, for me, one of the things that drives me crazy is that we have to compete with States that have lower—for jobs, we have to compete with other States for jobs where they burn dirty fuel, they put out a lot of air pollution, they get cheap, in some cases, coal-created electricity. It is cheap for them and they send the pollution over to us, and then we have to take special safeguards that drive up our energy costs to compensate for the cheap energy costs that our neighbors have. And, on top of that, we end up with more air pollution in our State from their State and it drives up our health care costs. That is just not fair. That is just not fair. Do you have any comment on that?

Ms. MCCARTHY. Senator, I would agree with you. The Clean Air Act actually intended that when national ambient air quality standards were changed, that this upwind issue, this interState transport of pollution would be addressed. It simply hasn't been effectively addressed. It has caused an economic disparity, where some States that are the receivers of this pollution have to spend much more money to take a look at eking out pollution reductions that in upwind States would be much cheaper to produce for the American public.

And it is a level playing field issue, it is a good neighbor issue, it is a fairness and equity issue, and it is time that we took action and moved these rules forward that will provide everybody equal opportunity for clean air. I have worked in States, as you have lived in, where I believe that we could shut the entire State down and still not produce the clean air that our citizens are looking for. That has to change.

Senator CARPER. Thank you. In 1998, the agency, EPA, completed a report to Congress on the health impact of air toxic emissions from utilities and whether utilities should be regulated under the air toxics framework in the Clean Air Act. Could you take maybe a minute, that is about what I have left, and describe this report and the results? I am thinking the report was due sometime like in 1993. Maybe you can clarify that for us, if you would, please.

Ms. MCCARTHY. Yes. There were two reports that were required in the 1990 Clean Air Act; one had to do with looking at all of the health and science around the issues of mercury: Is it a pollutant? Is it a pollutant that is posing significant risk to public health and the environment? And the other was specifically looking at the utilities as whether or not they are a major contributor and should be regulated under the Clean Air Act.

And those studies were completed in the end of 1997 and 1998; they underpinned the decision of the EPA that mercury is a toxic constituent; it is a pollutant that threatens, in particular, the health of our children; that it needed to be addressed. It also verified that utilities are the major stationary contributor toward the emissions of mercury in our atmosphere.

And this decision led to an appropriate necessary decision that said that utility mercury emissions and emissions of other hazardous air pollutants should be regulated under the provisions in which we are now moving forward to regulate it. And without these there is no Federal standard to control toxic emissions from this Country's largest stationary source of emissions without this rule moving forward.

Senator CARPER. All right, thank you. Thanks very much for those responses.

Senator Sessions.

Senator SESSIONS. Thank you.

You do have a high responsibility, Ms. McCarthy, and I understand that, but you would acknowledge that, for example, with regard to mercury, President Bush's regulations would drop the mercury emissions 70 percent. Now EPA wants to go to 90 percent. Do you know whether or not that extra 20 percent will cost as much as the first 70? Don't we have an extra cost when you reduce the emissions closer and closer to zero?

Ms. MCCARTHY. Senator, I appreciate the question, and EPA looks very closely at both the costs and the benefits. The benefits and cost ratio for the Mercury Air Toxics Rule is going to be very significantly leaning toward many more benefits as opposed to cost.

Senator SESSIONS. Well, we have a number of challenges. On how we achieve those we can disagree. I know the Chairman shares a belief that nuclear power can be one of our clean energy sources. Natural gas is cleaner. But both of those sources—cleaner than coal. Both of those sources are under environmental attack and it is hard to move forward with them in a way that would economically make sense for America, it seems to me.

What is the compliance deadline for the Transport Rule and the Utility MACT? Are those deadlines mandated by courts, are they your deadlines, and is there any opportunity to seek compliance or delays in order to reasonably transition?

Ms. McCarthy. The statutory deadline for the rules related to MACT, which is our Toxics Standards, are a 3-year window for compliance. States usually, and often, give a 1-year extra window, which we would encourage in this rule, and we are encouraging. That is a 4-year window in order to comply with the rules from the date of the rule becoming effective.

Senator Sessions. And when would those likely be?

Ms. McCarthy. We are intending to complete the rule in November of this year, which means the compliance window would be November 2014 or 2015, depending upon whether the State gives that extra year.

Senator Sessions. I have learned that some of the EPA proposed Transport Rule was based on incorrect data and assumptions. Are you aware of any of those problems and are you committed to ensuring that the data you actually base a decision on is accurate?

Ms. McCarthy. We are certainly openly and we will be reviewing all of the comments and will consider those in the final. EPA has no interest in basing its decisions on inaccurate or incomplete data and we believe that we will have the data sufficient to make this decision.

Senator Sessions. With regard to ozone, we have made some real progress in ozone reduction; the standards have gone from 125 parts per billion to 75 today. The first drop was to 85, and then 85 to 75. And now I understand you are considering ozone standards as low as 60 parts per billion. But one of the things that is troubling about this to me is the alteration of the normal standard of evaluation of ozone, the 5-year review process.

In other words, the last reduction went from 85 to 75. That is a 13 or so percent reduction. The previous one was from 125 to 85, a 33 percent. But as you get that number lower, there is a lot of naturally occurring ozone and it is harder to get each percentage below, I think you would recognize. So EPA's reconsideration of the 2008 ozone determination is occurring outside the normal 5-year window, or at least inside it; it is about 2 years or 3 years instead of the 5-years.

How do you justify that? Don't you think that a rational policy would be a gradual, sustained, reasonable reduction of ozone?

Ms. McCarthy. Senator, we are moving forward the 5-year review of ozone, but when Administrator Jackson came into office, we were facing litigation requiring the prior administration's decision to make a determination that 75 ppb was the appropriate level for ozone. That was outside of the range of science-based information that the Clean Air Science Advisory Committee recommended to the agency at that time. The Administrator decided that rather than litigate, she would work with the litigants to put that litigation on hold; she would revisit the science. She didn't believe that the decision that the Bush administration was actually commensurate with the science at the time it was made; it was in conflict with the recommendations of the Clean Air Science Advisory Committee, and she was appropriate, rather than to defend that standard and to move forward with it, to reconsider that, and that decision will be made at the end of July.

Senator SESSIONS. It is a very significant matter, and numbers I am seeing are that it costs as much as $90 billion. And we have to ask ourselves whether the path we are on, a steady reduction, closer and closer to situations in which certain days naturally occurring in the summer in my State get close to 60 parts per billion, I am told, naturally. So I don't know exactly what that figure is and the appropriate number is, but I do believe that you are accelerating that beyond what was expected and it is going to have a great cost and is causing some concern.

Mr. Chairman, I think Senator Barrasso will be back shortly, and I thank you for the opportunity to——

Senator CARPER. Should we wait for him? What do you think?

Senator SESSIONS [continuing]. to ask these questions.

Senator CARPER. All right. You bet. Thanks.

Senator Sessions raised questions, justifiably so, about the cost of implementation of these regulations and one of the things that you may recall that Senator Alexander and I worked on for years is legislation that would step down over time emissions of sulfur dioxide, nitrogen oxide, and mercury; and our goal for mercury was to reduce emissions by as much as 90 percent. I think we asked for and got a GAO study that showed mercury reductions can be obtained at that level for as low as, I think, $0.10 a month for families who use electricity, and I would ask unanimous consent to submit that EPA study for the record.

Senator SESSIONS. I would be glad to see that. Thank you.

Senator CARPER. Sure.

[The referenced document follows:]

United States Government Accountability Office

GAO

Report to the Chairman, Subcommittee on Clean Air and Nuclear Safety, Committee on Environment and Public Works, U.S. Senate

October 2009

CLEAN AIR ACT

Mercury Control Technologies at Coal-Fired Power Plants Have Achieved Substantial Emissions Reductions

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GAO-10-47

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CLEAN AIR ACT

Mercury Control Technologies at Coal-Fired Power Plants Have Achieved Substantial Emissions Reductions

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Highlights

Highlights of GAO-10-47, a report to the Chairman, Subcommittee on Clean Air and Nuclear Safety, Committee on Environment and Public Works, U.S. Senate

Why GAO Did This Study

The 491 U.S. coal-fired power plants are the largest unregulated industrial source of mercury emissions nationwide, annually emitting about 48 tons of mercury—a toxic element that poses health threats, including neurological disorders in children. In 2000, the Environmental Protection Agency (EPA) determined that mercury emissions from these sources should be regulated, but the agency has not set a maximum achievable control technology (MACT) standard, as the Clean Air Act requires. Some power plants, however, must reduce mercury emissions to comply with state regulations or consent decrees.

After managing a long-term mercury control research and development program, the Department of Energy (DOE) reported in 2008 that systems that inject sorbents—powdery substances to which mercury binds—into the exhaust from boilers of coal-fired power plants were ready for commercial deployment. Tests of sorbent injection systems, the most mature mercury control technology, were conducted on a variety of coal types and boiler configurations—that is, on boilers using different air pollution control devices. In this context, GAO was asked to examine (1) reductions achieved by mercury control technologies and the extent of their use at power plants, (2) the cost of mercury control technologies, and (3) key issues EPA faces in regulating mercury emissions from power plants. GAO obtained data from power plants operating sorbent injection systems. EPA and DOE provided technical comments, which we incorporated as appropriate.

View GAO-10-47 or key components. For more information, contact John B. Stephenson at (202) 512-3841 or stephensonj@gao.gov.

What GAO Found

Commercial deployments and 50 DOE and industry tests of sorbent injection systems have achieved, on average, 90 percent reductions in mercury emissions. These systems are being used on 25 boilers at 14 coal-fired plants, enabling them to meet state or other mercury emission requirements—generally 80 percent to 90 percent reductions. The effectiveness of sorbent injection is largely affected by coal type and boiler configuration. Importantly, the substantial mercury reductions using these systems commercially and in tests were achieved with all three main types of coal and on boiler configurations that exist at nearly three-fourths of U.S. coal-fired power plants. While sorbent injection has been shown to be widely effective, DOE tests suggest that other strategies, such as blending coals or using other technologies, may be needed to achieve substantial reductions at some plants. Finally, some plants already achieve substantial mercury reductions with existing controls designed for other pollutants.

The cost of the mercury control technologies in use at power plants has varied, depending in large part on decisions regarding compliance with other pollution reduction requirements. The costs of purchasing and installing sorbent injection systems and monitoring equipment have averaged about $3.6 million for the 14 coal-fired boilers operating sorbent systems alone to meet state requirements. This cost is a fraction of the cost of other pollution control devices. When plants also installed a fabric filter device primarily to assist the sorbent injection system in mercury reduction, the average cost of $16 million is still relatively low compared with that of other air pollution control devices. Annual operating costs of sorbent injection systems, which often consist almost entirely of the cost of the sorbent itself, have been, on average, about $675,000. In addition, some plants have incurred other costs, primarily due to lost sales of a coal combustion byproduct—fly ash—that plants have sold for commercial use. The carbon in sorbents can render fly ash unusable for certain purposes. Advances in sorbent technologies that have reduced sorbent costs at some plants offer the potential to preserve the market value of fly ash.

EPA's decisions on key regulatory issues will have implications for the effectiveness of its mercury emissions standard. In particular, the data EPA decides to use will impact (1) the emissions reductions it starts with in developing its regulation, (2) whether it will establish varying standards for the three main coal types, and (3) how the standard will take into account a full range of operating conditions at the plants. These issues can affect the stringency of the MACT standard EPA proposes. For example, if EPA uses data from its 1999 power plant survey as the basis for its mercury standard, the standard could be less stringent than what has been broadly demonstrated in recent commercial deployments and DOE tests of sorbent injection systems at power plants. On July 2, 2009, EPA announced that it would seek approval from the Office of Management and Budget to conduct an information collection request to update existing emissions data, among other things, from power plants.

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Abbreviations

BTU	British thermal units
CEMS	continuous emissions monitoring systems
DOE	Department of Energy
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
MACT	maximum achievable control technology
OMB	Office of Management and Budget

GAO
Accountability * Integrity * Reliability
United States Government Accountability Office
Washington, DC 20548

October 8, 2009

The Honorable Thomas R. Carper
Chairman
Subcommittee on Clean Air
and Nuclear Safety
Committee on Environment
and Public Works
United States Senate

Dear Mr. Chairman:

Mercury is a toxic element that poses human health threats—including neurological disorders in children that impair their cognitive abilities. Coal-fired power plants, the nation's largest electricity producers, represent the largest unregulated industrial source of mercury emissions in the United States.[1] In 2000, the Environmental Protection Agency (EPA) determined that it was "appropriate and necessary" to regulate mercury emissions from coal-fired power plants under section 112 of the Clean Air Act. Subsequently, in 2005, EPA chose to promulgate a cap-and-trade program,[2] rather than establish a maximum achievable control technology (MACT) standard to control mercury emissions as required under section 112. However, the cap-and-trade program was vacated by the D.C. Circuit Court of Appeals in February 2008 before EPA could implement it.

EPA must now develop a MACT standard to regulate mercury emissions from coal-fired power plants. As prescribed by the Clean Air Act, the MACT standard shall require that mercury emissions from all coal-fired boilers be reduced to the average amount emitted by the best performing

[1]EPA's 1999 data, the agency's most recent available data on mercury emissions, show that the 491 U.S. coal-fired power plants annually emit 48 tons of mercury into the air. These emissions are unregulated at the federal level and largely unregulated at the state level.

[2]EPA's cap-and-trade program, known as the Clean Air Mercury Rule, was established under Clean Air Act section 111 and set a cap on mercury emissions of 38 tons for 2010 and a second phase cap of 15 tons for 2018. The rule included a model cap-and-trade program that states could adopt to achieve and maintain their mercury emissions budgets. States could join the trading program by adopting the model trading rule in state regulations, or by adopting regulations that mirrored the necessary components of the model trading rule. States could also opt out of the trading program entirely as long as they imposed controls on plants sufficient to meet the mercury budget set for the state by the federal rule.

12 percent of coal-fired boilers.[3] While developing MACT standards for hazardous air pollutants can take up to 3 years, EPA may be required to promulgate its standard sooner depending on the outcome of a pending lawsuit. Specifically, EPA has been sued by several environmental groups requesting that the EPA Administrator promulgate a MACT standard to regulate mercury emissions for coal-fired power plants by a date no later than December 2010.

The Department of Energy's (DOE) National Energy Technology Laboratory has worked with EPA and the Electric Power Research Institute (EPRI),[4] among others, during the past 10 years on a comprehensive mercury control technology test program. Mercury is emitted in such low concentrations that its removal and measurement are particularly difficult, and it is emitted in several forms, some of which are harder to capture than others.[5] The DOE program has focused largely on testing sorbent injection systems[6] on all coal types and at a variety of boiler configurations at operating power plants.[7] This regimen of testing was important because the type of coal burned and the variety of air pollution control devices for other pollutants already installed at power plants can impact the effectiveness of sorbent injection systems. For example, some power plants already achieve mercury reductions as a "co-benefit" of using devices designed to reduce other pollutants, such as sulfur dioxide, nitrogen oxides, and particulate matter.

According to a 2008 report in which DOE described its mercury technology testing program, "DOE successfully brought mercury control technologies to the point of commercial-deployment readiness." Nonetheless, the report stated that while the results achieved during

[3]According to EPA, its MACT is to also cover the other hazardous air pollutants listed in the Clean Air Act as well as emissions from oil-fired power plants. For categories with fewer than 30 sources, the MACT standard must be set, at least, at the average level achieved by the top five performing units.

[4]EPRI is an independent non-profit company funded by electricity producers that conducts research and development in the electricity sector.

[5]Mercury can be emitted in oxidized, elemental, or particulate-bound form.

[6]Sorbent injection systems inject sorbents—powdery substances, typically activated carbon, to which mercury binds—into the exhaust from boilers before it is emitted from the stack.

[7]In this report, the term "boiler configuration" refers to a coal-fired boiler's suite of air pollution control devices.

DOE's field tests met or exceeded program goals, the only way to truly know the effectiveness—and associated costs—of mercury control technologies is through their continuous operation in commercial applications at a variety of configurations. At least 18 states have laws or regulations requiring mercury emissions reductions at coal-fired power plants.[8] The compliance time frames for the state requirements vary. As of August 2009, five states—Connecticut, Delaware, Illinois, Massachusetts, and New Jersey—require compliance with mercury emission limits. In this context, you asked us to examine (1) what mercury reductions have been achieved by existing mercury control technologies and the extent to which they are being used at coal-fired power plants; (2) the costs associated with mercury control technologies currently in use; and (3) key issues EPA faces in developing a new regulation for mercury emissions from coal-fired power plants.

To respond to these objectives, we identified power plants with coal-fired boilers that are currently operating sorbent injection systems—the most mature, mercury-specific control technology—to reduce mercury emissions. Using a structured interview tool, we interviewed plant managers and engineers at the 14 coal-fired power plants operating sorbent injection systems to reduce mercury emissions. These individuals provided data on the effectiveness of sorbent injection systems at reducing mercury emissions and the costs of doing so.[9] We also obtained information on the engineering challenges plant officials have encountered in installing and operating sorbent injection systems and actions taken to mitigate those challenges.[10] In addition, we examined DOE National

[8]Two of the states expect mercury emissions reductions from required installations of multipollutant control technologies; the other sixteen have specific mercury emissions reduction targets. These 18 states are those that had mercury emissions reduction requirements in place before the Clean Air Mercury Rule was promulgated or which promulgated state-specific provisions in addition to the provisions required by the rule and have not specifically repealed those provisions as of August 2009. GAO did not confirm whether each state is actively enforcing or planning to enforce these rules. Provisions of some state rules may rely on provisions of the Clean Air Mercury Rule, which have been vacated.

[9]We interviewed managers at plants with 24 of the 25 boilers using sorbent injection systems. As of August 2009, data for one boiler were not provided. Mercury emissions data for one boiler were being reviewed by the state clean air agency and were not provided in time for inclusion in this report.

[10]We visited six plants using sorbent injection systems, and we interviewed plant managers at six other plants that reported meeting state mercury emissions requirements with existing pollution control devices for other pollutants.

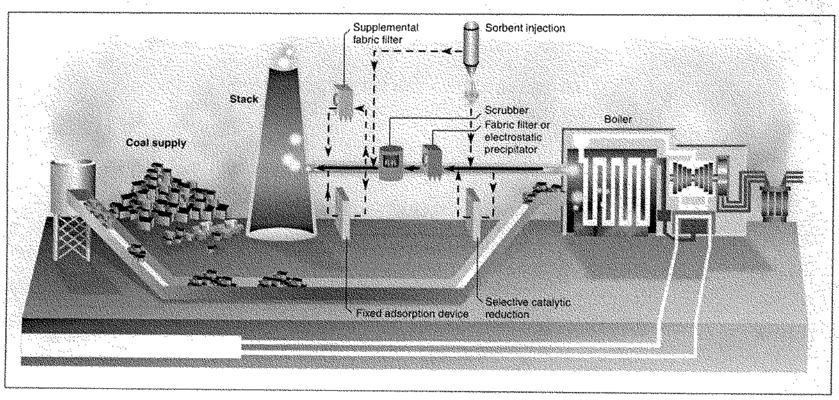
Energy Technology Lab, EPRI, and academic reports on the effectiveness and costs of sorbent injection systems over time and reviewed literature from recent technical conferences that addressed strategies to overcome challenges that some plants have experienced with sorbent injection systems. We also reviewed EPA's requirements for establishing MACT standards under the Clean Air Act and recent court cases with implications for how EPA establishes such standards. Finally, we met with EPA officials in the Office of Air and Radiation regarding the agency's plans for regulating mercury at power plants. Appendix I provides a more detailed description of our scope and methodology. We conducted this performance audit from November 2008 through September 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Mercury enters the environment in various ways, such as through volcanic activity, coal combustion, and chemical manufacturing. As a toxic element, mercury poses ecological threats when it enters water bodies, where small aquatic organisms convert it into its highly toxic form—methylmercury. This form of mercury may then migrate up the food chain as predator species consume the smaller organisms. Fish contaminated with methylmercury may pose health threats to people who rely on fish as part of their diet. Mercury can harm fetuses and cause neurological disorders in children, resulting in, among other things, impaired cognitive abilities. The Food and Drug Administration and EPA recommend that expectant or nursing mothers and young children avoid eating swordfish, king mackerel, shark, and tilefish and limit consumption of other potentially contaminated fish. These agencies also recommend checking local advisories about recreationally caught freshwater and saltwater fish. In recent years, most states have issued advisories informing the public that concentrations of mercury have been found in local fish at levels of public health concern.

Coal-fired power plants burn at least one of three primary coal types—bituminous, subbituminous, and lignite—and some plants burn a blend of these coals. Of all coal burned by power plants in the United States in 2004, DOE estimates that about 46 percent was bituminous, 46 percent was subbituminous, and 8 percent was lignite. The amount of mercury in coal and the relative ease of its removal depend on a number of factors, including the geographic location where it was mined and the chemical variation within and among coal types.[11] In addition to mercury, coal combustion releases other harmful air pollutants, including sulfur dioxide and nitrogen oxides. EPA regulates these pollutants under its program intended to control acid rain and its new source performance standards program. Figure 1 shows various pollution controls that may be used at coal-fired power plants: selective catalytic reduction to control nitrogen oxides, wet or dry scrubbers to reduce sulfur dioxide, fabric filters and hot-side or cold-side electrostatic precipitators to control particulate matter, and sorbent injection to reduce mercury emissions.

Figure 1: Sample Layout of Air Pollution Controls, Including Sorbent Injection to Control Mercury, at a Coal-Fired Power Plant



Source: GAO analysis of Electric Power Research Institute data.

[11]Coal combustion releases mercury in oxidized, elemental, or particulate-bound form. Oxidized mercury is more prevalent in the flue gas from bituminous coal combustion, and it is relatively easy to capture using some sulfur dioxide controls, such as wet scrubbers. Elemental mercury, more prevalent in the flue gas from combustion of lignite and subbituminous coal, is more difficult to capture with existing pollution controls. Particulate-bound mercury is relatively easy to capture in particulate matter control devices.

From 2000 to 2009, DOE's National Energy Technology Lab conducted field tests at operating power plants with different boiler configurations to develop mercury-specific control technologies capable of achieving high mercury emission reductions at the diverse fleet of U.S. coal-fired power plants.[12] As a result, DOE now has comprehensive information on the effectiveness of sorbent injection systems using all coal types at a wide variety of boiler configurations. Most of these tests were designed to achieve mercury reductions of 50 to 70 percent while decreasing costs—which consist primarily of the cost of the sorbent. Thus, the results from the DOE test program may understate the mercury reductions that can be achieved by sorbent injection systems to some extent. For example, while a number of short-term tests achieved mercury reductions in excess of 90 percent, the amount of sorbent injection that achieved the reductions was often decreased during long-term tests to determine the minimum cost of achieving, on average, 70 percent mercury emissions reductions.

Beginning in 2007—near the end of the research program—DOE field tests aimed to achieve reductions of 90 percent or greater mercury at low costs. However, DOE reported that federal funding for the DOE tests was eliminated before the final phase of planned tests was completed. Under its mercury testing program, DOE initially tested the effectiveness of untreated carbon sorbents, and then DOE tested the effectiveness of chemically treated sorbents. In addition, DOE assessed solutions to impacts on plant devices, structures, or operations that may result from operating these systems—called "balance-of-plant impacts." We note that DOE, EPRI, and others have also helped develop and test other technologies, including oxidation catalysts and precombustion mercury removal, to reduce mercury emissions that may become commercially available in the future. We provide information on some of these emerging technologies in appendix II.

[12]DOE's research program also tested different types of boilers (such as T-fired, wall-fired and cyclone); DOE officials said the pollution control devices were the more important parameter in mercury emissions reductions.

Substantial Mercury Reductions Have Been Achieved Using Sorbent Injection Technology at 14 Plants and in Many DOE Tests

Power plants using sorbent injection systems—either commercially deployed or tested by DOE and industry—have achieved substantial mercury reductions with the three main types of coal and on boiler configurations that exist at nearly three-fourths of U.S. coal-fired power plants. Some plants, however, may require alternative strategies to achieve significant mercury emissions reductions. Nonetheless, some plants already achieve substantial mercury emissions reductions with existing control devices for other pollutants.

Sorbent Injection Systems Have Achieved Substantial Mercury Emissions Reductions at Power Plants

The managers of 14 coal-fired power plants reported to us they currently operate sorbent injection systems on 25 boilers to meet the mercury emissions reduction requirements of five states and several consent decrees and construction permits. Data from power plants show that these boilers have achieved, on average, reductions in mercury emissions of about 90 percent.[13] Of note, all 25 boilers currently operating sorbent injection systems nationwide have met or surpassed their relevant regulatory mercury requirements, according to plant managers.[14] Following are a few examples:

- A 164 megawatt[15] bituminous-fired boiler, built in the 1960s and operating a cold-side electrostatic precipitator and wet scrubber, was reported as exceeding its 90 percent reduction requirement—achieving more than a 95 percent mercury emission reduction using chemically treated carbon sorbent.

[13]This number reflects data reported by officials with 9 boilers that were required to achieve 90 percent mercury emission reduction—which 7 surpassed—and 10 boilers that were required to achieve reductions between 80 percent and 89 percent. We do not have mercury emissions reduction data for 5 of the 24 sorbent injection systems because the power company running these systems is not required to measure emissions under its regulatory framework. Data for another boiler are being reviewed by the state clean air agency.

[14]Data from commercial applications of sorbent injection systems show that mercury reductions have been achieved over periods ranging from 3 months to more than a year. Most data we examined reflected mercury emissions as of the fourth quarter of 2008. Since that time, the power plants have continued to use sorbent injection systems—in some cases, these systems have been in continuous use for nearly 2 years.

[15]A megawatt is a unit for measuring the electric generation capacity of a power plant. One megawatt of capacity operating for one full day produces 24 megawatt-hours—or 24,000 kilowatt-hours—of electricity.

- A 400 megawatt subbituminous-fired boiler, built in the 1960s and operating a cold-side electrostatic precipitator and a fabric filter, was reported as achieving a 99 percent mercury reduction using untreated carbon sorbent, exceeding its 90 percent reduction regulatory requirement.
- A recently constructed 600 megawatt subbituminous-fired boiler operating a fabric filter, dry scrubber, and selective catalytic reduction system was reported as achieving an 85 percent mercury emission reduction using chemically treated carbon sorbent, exceeding its 83 percent reduction regulatory requirement.

While mercury emissions reductions achieved with sorbent injection on a particular boiler configuration do not guarantee similar results at other boilers with the same configuration,[16] the reductions achieved in deployments and tests provide important information for plant managers who must make decisions about pollution controls to reduce mercury emissions as more states' mercury regulations become effective and as EPA develops a national mercury regulation.[17] Further, in 2008, DOE reported that the high performance observed during many of its field tests at power plants with a variety of boiler configurations has given coal-fired power plant operators the confidence to begin deploying these technologies. The sorbent injection systems currently used at power plants to reduce mercury emissions are operating on boiler configurations that are used at 57 percent of U.S. coal-fired power boilers.[18] Further, when the results of 50 tests of sorbent injection systems at power plants conducted primarily as part of DOE's or EPRI's mercury control research and

[16]As we reported in 2005, the results achieved at a particular power plant may not necessarily serve as a reliable indicator of the performance of the same control devices at all plants. For example, some data show that the extent of mercury reduction achieved by sorbent injection at facilities using electrostatic precipitators depends largely on the location of these devices at the plant. The location of an electrostatic precipitator affects the temperatures of the flue gas entering the device, allowing more mercury to be captured at cooler temperatures.

[17]For example, see EPRI's 2006 *Mercury Control Technology Selection Guide*, which summarized tests by DOE and other organizations to provide the coal-fired power industry with a process to select the most promising mercury control technologies. EPRI assessed the applicability of technologies to various coal types and power plant configurations and developed decision trees to facilitate decision making.

[18]We used EPA's 2006 National Electric Energy Data System database for calculating the percentage of coal-fired boilers with particular configuration types. We excluded coal-fired boilers under 25 megawatts from our analysis because the Clean Air Act does not apply to smaller units such as these.

development programs are factored in, mercury reductions of at least 90 percent have been achieved at boiler configurations used at nearly three-fourths of coal-fired power boilers nationally.[19] Some boiler configurations tested in the DOE program that are not yet included in commercial deployments follow:

- A 360 megawatt subbituminous-fired boiler with a fabric filter and a dry scrubber using a chemically treated carbon sorbent achieved a 93 percent mercury reduction.
- A 220 megawatt boiler burning lignite, equipped with a cold-side electrostatic precipitator, increased mercury reduction from 58 percent to 90 percent by changing from a combination of untreated carbon sorbent and a boiler additive to a chemically treated carbon sorbent.
- A 565 megawatt subbituminous-fired boiler with a fabric filter achieved mercury reductions ranging from 95 percent to 98 percent by varying the amount of chemically treated carbon sorbent injected into the system.[20]

As these examples of commercially deployed and tested injection systems show, power plants are using chemically treated sorbents and sorbent enhancement additives, as well as untreated sorbents. Chemically treated sorbents and additives can help convert the more difficult-to-capture mercury common in lignite and subbituminous coals to a more easily captured form, which helped DOE and industry achieve high mercury reduction across all coal types.[21] The DOE test program initially used untreated sorbents. On the basis of these initial tests, we reported in 2005 that sorbent injection systems showed promising results but that they were not effective when used at boilers burning lignite and subbituminous

[19]We identified 56 field tests conducted by DOE during its mercury control technology testing program. Of these tests, we analyzed mercury reduction data of 41 tests conducted at power plants. The majority of these tests were long-term tests (30 days or more). Our analysis does not include mercury reduction data associated with the other 15 tests either because they reflected mercury reduction associated with mercury oxidation catalysts—an emerging mercury control technology—or because test result data were not reported. We also analyzed results of 9 tests conducted by industry, primarily by EPRI.

[20]The rate of sorbent injection varied between 1.0 pounds per million actual cubic feet and 3.0 pounds per million actual cubic feet.

[21]DOE injected sorbents that were treated with halogens such as chlorine or bromine, which help convert mercury from an elemental form into an oxidized form.

coals.[22] Since then, DOE's shift to testing chemically treated sorbents and enhancement additives showed that using chemically treated sorbents and enhancement additives could achieve substantial mercury reductions for coal types that had not achieved these results in earlier tests with untreated sorbents. For example, injecting untreated sorbents reduced mercury emissions by an average of 55 percent during a 2003 DOE test at a subbituminous-fired boiler. Recent DOE tests using chemically treated sorbents and enhancement additives, however, have resulted in average mercury reductions of 90 percent for boilers using subbituminous coals.[23] Similarly, recent tests on boilers using lignite reduced mercury emissions by about 80 percent, on average.

The examples of substantial mercury reductions highlighted above also show that sorbent injection can be successful with both types of air pollution control devices that power plants use to reduce emissions of particulate matter—electrostatic precipitators and fabric filters. In some commercial deployments, fabric filters were installed to assist with mercury control. Plant officials told us, for example, that they chose to install fabric filters to assist with mercury control for 10 of the sorbent injection systems currently deployed—but that some of the devices were installed primarily to comply with other air pollution control requirements. One plant manager, for example, said that the fabric filter installed at his plant has helped the sorbent injection system achieve higher levels of mercury emission reductions but that the driving force behind the fabric filter installation was compliance with particulate matter emission limits. Further, as another plant manager noted, fabric filters may provide additional benefits by limiting emissions of acid gases and trace metals, as well as by preserving fly ash—fine powder resulting from coal combustion—for sale for reuse.[24] Fabric filters, which are more effective at mercury emission reduction than electrostatic precipitators, are increasingly being installed to reduce emissions of particulate matter and other pollutants, but currently less than 20 percent of boilers have them.

[22]GAO, *Clean Air Act: Emerging Mercury Control Technologies Have Shown Promising Results, but Data on Long-Term Performance Are Limited*, GAO-05-612 (Washington, D.C.: May 31, 2005).

[23]On subbituminous coal units, eight long-term tests were conducted using chemically treated sorbents. The average mercury emission reduction was 90 percent, with mercury reductions ranging from 81 percent to 93 percent.

[24]Properties of fly ash vary significantly with coal composition and plant-operating conditions. Some power plants sell fly ash for use in Portland cement and to meet other construction needs.

The successful deployments of sorbent injection technologies at power plants occurred around the time DOE concluded, on the basis of its tests, that these technologies were ready for commercial deployment. As a result, funding for the DOE testing program has been eliminated.[25] As many states' compliance dates for mercury emission reduction near,[26] the Institute of Clean Air Companies reported that power plants had 121 sorbent injection systems on order as of February 2009.[27] (App. III provides data on state regulations requiring mercury emission reductions.)

Some Plants May Require Alternative Strategies to Achieve Significant Mercury Reductions

While sorbent injection technology has been shown to be effective with all coal types and on boiler configurations that currently exist at more than three-fourths of U.S. coal-fired power plants, DOE tests show that some plants may not be able to achieve mercury reductions of 90 percent or more with sorbent injection systems alone. Following are a few reasons why:

- Sulfur trioxide—which can form under certain operating conditions or from using high sulfur bituminous coal—may limit mercury reduction because it interferes with the process of mercury binding to carbon sorbents.
- Hot-side electrostatic precipitators reduce the effectiveness of sorbent injection systems. Installed on 6 percent of boilers nationwide, these particulate matter control devices operate at very high temperatures, which reduces the ability of mercury to bind to sorbents and be collected in the devices.
- Lignite, used by roughly 3 percent of boilers nationwide,[28] has relatively high levels of elemental mercury—the most difficult form to capture.

[25]The DOE mercury testing program has not received new funding since fiscal year 2008.

[26]Illinois, Maryland, Minnesota, Montana, New Mexico, New York, and Wisconsin require compliance by the end of 2010. Arizona, Colorado, New Hampshire, Oregon, and Utah require compliance in 2012 or later. Georgia and North Carolina require installation between 2008 and 2018 of other pollution control devices that capture sulfur dioxide, nitrogen oxides, and mercury as a side benefit. North Carolina requires the submission of specific mercury reduction plans for certain plants by 2013.

[27]The Institute of Clean Air Companies is the trade association of companies that supply air pollution control and monitoring technology.

[28]As noted earlier, the lignite burned by all coal-fired power plants represents 8 percent of all coal burned in the United States.

Lignite is found primarily in North Dakota and the Gulf Coast (the latter is called Texas lignite). Mercury reduction using chemically treated sorbents and sorbent enhancement additives on North Dakota lignite has averaged about 75 percent—less than reductions using bituminous and subbituminous coals. Less is known about Texas lignite because few tests have been performed using it. However, a recent test at a plant burning Texas lignite achieved an 82 percent mercury reduction.

Boilers that may not be able to achieve 90 percent emissions reductions with sorbent injection alone, and some promising solutions to the challenges they pose, are discussed in appendix IV. Further, EPRI is continuing research on mercury controls at power plants that should help to address these challenges. In some cases, however, plants may need to pursue a strategy other than sorbent injection to achieve high mercury reductions. For example, officials at one plant decided to install a sulfur dioxide scrubber—designed to reduce both mercury and sulfur dioxide—after sorbent injection was found to be ineffective. This approach may become more typical as power plants comply with the Clean Air Interstate Rule and court-ordered revisions to it,[20] which EPA is currently developing, and as some plants add air pollution control technologies required under consent decrees.

Along these lines, EPA air strategies group officials told us that many power plants will be installing devices—fabric filters, scrubbers, and selective catalytic reduction systems—that are typically associated with high levels of mercury reduction, which will likely reduce the number of plants requiring alternative strategies for mercury control. Finally, mercury controls have been tested on about 90 percent of the boiler configurations at coal-fired power plants. The remaining 10 percent include several with devices that are often associated with high levels of mercury emission reductions, such as selective catalytic reduction devices for nitrogen oxides control and wet scrubbers for sulfur dioxide control.

[20]The Clean Air Interstate Rule is a regional air pollution reduction program covering 28 eastern states and the District of Columbia. Developed by EPA and promulgated in May 2005, the rule controls emissions from power plants through caps on sulfur dioxide and nitrogen oxides pollution. A D.C. Circuit Court of Appeals December 23, 2008, ruling leaves this rule and its trading programs in place until EPA issues a new rule to replace it. EPA informed the Court that development and finalization of a replacement rule could take about 2 years.

A Number of Plants Already Achieve Substantial Mercury Reductions with Existing Controls for Other Pollutants

Importantly, mercury control technologies will not have to be installed on a number of coal-fired boilers to meet mercury emission reduction requirements because these boilers already achieve high mercury reductions from their existing pollution control devices.[30] EPA 1999 data, the most recent available, indicated that about one-fourth of the industry achieved mercury reductions of 90 percent or more as a co-benefit of other pollution control devices.[31] We found that of the 36 boilers currently subject to mercury regulation, 11 are relying on existing pollution controls to meet their mercury reduction requirements.[32] One plant manager told us his plant achieves 95 percent mercury reduction as a result of existing devices, specifically with a fabric filter for particulate matter control, a scrubber for sulfur dioxide control, and a selective catalytic reduction system for nitrogen oxides control. Other plants may also be able to achieve high mercury reduction with their existing pollution control devices. For example, according to EPA data, a bituminous-fired boiler with a fabric filter may reduce mercury emissions by more than 90 percent. As discussed above, it is likely that many power plants will be installing devices that are typically associated with high levels of mercury reduction; thus the number of plants that may not require sorbent injection systems to meet regulatory requirements is likely to increase.

[30]Nationwide, mercury reductions achieved as a co-benefit of other pollution control devices reduced mercury emissions from about 75 tons (inlet coal) to approximately 48 tons. Mercury reductions achieved as a co-benefit range from zero to nearly 100 percent, depending on control device configuration and coal type. For example, a boiler using bituminous coal and having a fabric filter can achieve mercury reductions in excess of 90 percent. In contrast, a boiler using subbituminous coal and having only a cold-side electrostatic precipitator might achieve little, if any, co-benefit mercury reduction.

[31]This estimate is based on data from EPA's 1999 information collection request, which EPA air toxics program officials believe to be representative of the current coal-fired power industry.

[32]Two plants with four boilers will face increasingly stringent limits in the next 3 to 4 years. One plant manager, facing a mercury reduction requirement that will increase from 80 percent to 90 percent, told us that the plant is currently installing a sorbent injection system in anticipation of the more stringent standard. The other plant manager, facing a mercury reduction requirement that will increase from 85 percent to 95 percent, told us that his plant will likely need to install a sorbent injection system in the future to supplement the co-benefit mercury capture the plant currently achieves with existing pollution controls.

Mercury Control Technologies Are Often Relatively Inexpensive, but Costs Depend Largely on How Plants Comply with Requirements for Reducing Other Pollutants

The cost to meet current regulatory requirements for mercury reductions has varied depending in large part on decisions regarding compliance with other pollution reduction requirements. For example, while sorbent injection systems alone have been installed on most boilers that must meet mercury reduction requirements—at a fraction of the cost of other pollution control devices—fabric filters have also been installed on some boilers to assist in mercury capture or to comply with particulate matter requirements, according to plant officials we interviewed.

The costs of purchasing and installing sorbent injection systems and monitoring equipment have averaged about $3.6 million for the 14 coal-fired boilers that use sorbent injection systems alone to reduce mercury emissions.[33] For these boilers, the cost ranged from $1.2 million to $6.2 million.[34] By comparison, on the basis of EPA estimates, the average cost to purchase and install a wet scrubber for sulfur dioxide control, absent monitoring system costs, is $86.4 million per boiler, ranging from $32.6 million to $137.1 million.[35] EPA's estimate of the cost to purchase and install a selective catalytic reduction device to control nitrogen oxides ranges from $12.7 million to $127.1 million, or an average of $66.1 million.

Capital costs can increase significantly if fabric filters are also purchased to assist in mercury emission reductions or as part of broader emission reduction requirements. For example, plants installed fabric filters at another 10 boilers for these purposes. On the five boilers where plant officials reported also installing a fabric filter specifically designed to assist the sorbent injection system in mercury emission reductions, the average reported capital cost for both the sorbent injection system and fabric filter was $15.8 million per boiler—the costs ranged from $12.7 million to $24.5 million. Importantly, some of these boilers have uncommon configurations[36]—ones that, as discussed earlier, DOE tests

[33]Cost data are reported in 2008 dollars.

[34]The total cost to purchase and install a sorbent injection system reflects the costs of (1) sorbent injection equipment, (2) an associated mercury emissions monitoring system, and (3) associated engineering and consulting services.

[35]EPA's 2006 cost estimates are reported in 2008 dollars.

[36]Three of the five boilers with fabric filters designed specifically to assist in mercury reduction, for instance, have hot-side electrostatic precipitators—a relatively rare particulate matter control device that inhibits high mercury removal when sorbent injection systems are used without fabric filters.

showed would need additional control devices to achieve high mercury reductions.[37]

For the five boilers where plant officials reported installing fabric filters along with sorbent injection systems largely to comply with requirements to control other forms of air pollution, the average reported capital cost for the two technologies was $105.9 million per boiler, ranging from $38.2 million to $156.2 million per boiler.[38] For these boilers, the capital costs result from requirements to control other pollutants, and we did not determine what portion of these costs would appropriately be allocated to the cost of reducing mercury emissions. Decisions to purchase such fabric filters will likely be driven by the broader regulatory landscape affecting plants in the near future, such as requirements for particulate matter and sulfur dioxide reductions, as well as EPA's upcoming MACT standard to regulate mercury emissions from coal-fired power plants. Information on detailed average costs to purchase and install sorbent injection systems and monitoring equipment, with and without fabric filters, is provided in appendix V.

Regarding operating costs, plant managers said that annual operating costs associated with sorbent injection systems consist almost entirely of the cost of the sorbent itself. In operating sorbent injection systems, sorbent is injected continuously into the boiler exhaust gas to bind to mercury passing through the gas. The rate of injection is related to, among other things, the level of mercury emissions reduction required to meet regulatory requirements and the amount of mercury in the coal used. For the 18 boilers with sorbent injection systems for which power plants provided sorbent cost data, the average annualized cost of sorbent was $674,000—ranging from $76,500 to $2.4 million.

Plant engineers often adjust the injection rate of the sorbent to capture more or less mercury—the more sorbent in the exhaust gas, the higher the likelihood that more mercury will bind to it. Some plant managers told us that they have recently been able to decrease their sorbent injection rates,

[37]The costs reported by officials of coal-fired power plants that installed sorbent injection systems and, in some cases, fabric filters may not necessarily serve as reliable indicators of the costs of the same control devices at all plants.

[38]The average cost of the sorbent injection system for these boilers was $2.9 million and for the monitoring systems, $500,000. The average cost for the fabric filters was $84 million and for the engineering studies, $11 million.

thereby reducing costs, while still complying with relevant requirements. Specifically, a recently constructed plant burning subbituminous coal successfully used sorbent enhancement additives to considerably reduce its rate of sorbent injection—resulting in significant savings in operating costs when compared with its original expectations. Plant managers at other plants reported that they have injected sorbent at relatively higher rates because of regulatory requirements that mandate a specific injection rate. In one state, for example, plants are required to operate their sorbent injection systems at an injection rate of 5 pounds per million actual cubic feet.[39] Among the 19 boilers for which plant managers provided operating cost data, the average injection rate was 4 pounds per million actual cubic feet; rates ranged from 0.5 to 11.0 pounds per million actual cubic feet.

For those plants that installed a sorbent injection system alone to meet mercury emissions requirements—at an average cost of $3.6 million—the cost to purchase, install, and operate sorbent injection and monitoring systems represents 0.12 cents per kilowatt hour, or a potential 97 cent increase in the average residential consumer's monthly electricity bill. How, when, and to what extent consumers' electric bills will reflect the capital and operating costs power companies incur for mercury controls depends in large measure on market conditions and the regulatory framework in which the plants operate. Power companies in the United States are generally divided into two broad categories: (1) those that operate in traditionally regulated jurisdictions where cost-based rate setting still applies (rate-regulated) and (2) those that operate in jurisdictions where companies compete to sell electricity at prices that are largely determined by supply and demand (deregulated). Rate-regulated power companies are generally allowed by regulators to set rates that will recover allowable costs, including a return on invested capital.[40] Minnesota, for example, passed a law in 2006 allowing power companies to seek regulatory approval for recovering the costs of state-required reductions in mercury emissions in advance of the regulatory schedule for rate increase requests. One power company in the state submitted a plan for the installation of sorbent injection systems to reduce mercury

[39]Pounds per million actual cubic feet is the standard metric for measuring the rate at which sorbent is injected into a boiler's exhaust gas.

[40]Under traditional cost-based rate regulations, utility companies submit to regulators the costs they seek to cover through the rates they charge their customers. Regulators examine the power companies' requests and decide what costs are allowable under the relevant rules.

emissions at two of its plants at a cost of $4.4 million and $4.5 million, respectively, estimating a rate increase of 6 to 10 cents per month for customers of both plants.[41]

For power companies operating in competitive markets where wholesale electricity prices are not regulated, prices are largely determined by supply and demand. Generally speaking, market pricing does not guarantee full cost recovery to suppliers, especially in the short run. Of the 25 boilers using sorbent injection systems to comply with a requirement to control mercury emissions, 21 are in jurisdictions where full cost recovery is not guaranteed through regulated rates.

In addition to the costs discussed above, some plant managers told us they have incurred costs associated with balance-of-plant impacts. The issue of particular concern relates to fly ash—fine particulate ash resulting from coal combustion that some power plants sell for commercial uses, including concrete production, or donate for such uses as backfill. According to DOE, about 30 percent of the fly ash generated by coal-fired power plants was sold in 2005; 216 plants sold some portion of their fly ash. Most sorbents increase the carbon content of fly ash, which may render it unsuitable for some commercial uses.[42] Specifically, some plant managers told us that they have lost income because of lost fly ash sales due to its carbon content and incurred additional costs to store fly ash that was previously either sold or donated for re-use. For the eight boilers with installed sorbent injection systems to meet mercury emissions requirements for which plants reported actual or estimated fly-ash-related costs, the average net cost reported by plants was $1.1 million per year.[43]

[41]The rate increase request will be submitted in conjunction with requests for rate increases for the utility's other plants.

[42]Technologies to mitigate balance-of-plant costs associated with fly ash are available. For example, one plant installed a polishing fabric filter using TOXECON™ system, which preserves the plant's ability to sell its fly ash. Another plant had previously installed an ash reduction device that removes excess carbon in fly ash and enables the plant to sell the vast majority of its fly ash when operating its sorbent injection system.

[43]DOE's research program also examined the potential costs plants may incur to dispose of fly ash if the carbon and mercury content renders it unsuitable for commercial uses. See Andrew P. Jones et al., *DOE/NETL's Phase II Mercury Control Technology Field Testing Program: Updated Economic Analysis of Activated Carbon Injection*, prepared at the request of DOE, May 2007.

Advances in sorbent technologies that have reduced costs at some plants also offer the potential to preserve the market value of fly ash. For example, at least one manufacturer offers a concrete-friendly sorbent to help preserve fly ash sales—thus reducing potential fly ash storage and disposal costs. Additionally, a recently constructed plant burning subbituminous coal reported that it had successfully used sorbent enhancement additives to reduce its rate of sorbent injection from 2 pounds to less than one-half pound per million actual cubic feet—resulting in significant savings in operating costs and enabling it to preserve the quality of its fly ash for reuse. Other potential advances include refining sorbents through milling and changing the sorbent injection sites. Specifically, in testing, milling sorbents has, for some configurations, improved their efficiency in reducing mercury emissions—that is, reduced the amount of sorbent needed—and also helped minimize negative impact on fly ash re-use. Also, in testing, some vendors have found that injecting sorbents on the hot side of air preheaters can decrease the amount of sorbent needed to achieve desired levels of mercury control.[11]

In addition, some plant managers reported balance-of-plant impacts associated with sorbent injection systems, such as ductwork corrosion and small fires in the particulate matter control devices. The managers told us these issues were generally minor and have been resolved. For example, two plants experienced corrosion in the ductwork following the installation of their sorbent injection systems. One plant manager resolved the problem by purchasing replacement parts at a cost of $4,500. The other plant manager told us that the corrosion problem remains unresolved but that it is primarily a minor engineering challenge that does not impact plant operations. Four plant managers reported fires in the particulate matter control devices; plant engineers have generally solved this problem by emptying the ash from the collection devices more frequently. Overall, despite minor balance-of-plant impacts, most plant managers said that the sorbent injection systems at their plants are more effective than they had originally expected.

[11]An air preheater is a device designed to preheat the combustion air used in a fuel-burning furnace for the purpose of increasing the thermal efficiency of the furnace.

Decisions EPA Faces on Key Regulatory Issues Will Have Implications for the Effectiveness of Its Mercury Emission Standard for Coal-Fired Power Plants and the Availability of Monitoring Data

EPA's decisions on key regulatory issues will impact the overall stringency of its MACT standard regulating mercury emissions. Specifically, the data EPA decides to use will affect (1) the mercury emission reductions calculated for "best performers," from which a proposed emission limit is derived; (2) whether EPA will establish varying standards for the three coal types; and (3) how EPA's standard will take into account varying operating conditions. Each of these issues will affect the stringency of the MACT standard the agency proposes. In addition, the format of the standard—whether it limits the mercury emissions as a function of the amount of mercury per trillion British thermal units (BTU) of heat input (an input standard) or on the basis of the amount of mercury per megawatt hour of electricity produced (an output standard)—may affect the stringency of the MACT standard the agency proposes. Finally, the court's decision to vacate the Clean Air Mercury Rule, which required most coal-fired power plants to conduct continuous emissions monitoring for mercury beginning in 2009, has delayed for a number of years the continuous emissions monitoring that would have started in 2009 at most coal-fired power plants.

Current Data from Commercial Deployments and DOE Tests Could Be Used in Determining Whether to Support a More Stringent Standard for Mercury Emissions from Power Plants Than Was Last Proposed by EPA

Obtaining data on mercury emissions and identifying the "best performers"—defined as the 12 percent of coal-fired power plant boilers with the lowest mercury emissions[45]—is a critical initial step in the development of a MACT standard regulating mercury emissions. EPA may set one standard for all power plants, or it may establish subcategories to distinguish among classes, types, and sizes of plants. For example, in its 2004 proposed mercury MACT standard,[46] EPA established subcategories for the types of coal most commonly used by power plants. Once the average mercury emissions of the best performers are established for power plants—or for subcategories of power plants—EPA accounts for variability in the emissions of the best performers in its MACT standards. EPA's method for accounting for variability has generally resulted in MACT standards that are less stringent than the average emission reductions achieved by the best performers.

[45]This is how section 112 of the Clean Air Act, as amended, defines best performers for the largest categories of sources when establishing MACT standards.

[46]Prior to finalizing the Clean Air Mercury Rule, EPA also proposed a MACT standard regulating mercury emissions from coal-fired power plants. EPA chose not to finalize the MACT rule.

To identify the best performers, EPA typically collects emissions data from a sample of plants representative of the U.S. coal-fired power industry through a process known as an information collection request. Before a federal agency can collect data from 10 or more nongovernmental parties, such as power plants, it must obtain approval from the Office of Management and Budget (OMB) for the information collection request. According to EPA officials, this data collection process typically takes from 8 months to 1 year. Although EPA has discretion in choosing the data it will use to identify best performers,[47] on July 2, 2009, EPA published a draft information collection request in the *Federal Register* providing a 60-day public comment period on the draft questionnaire to industry prior to submitting this information collection request to OMB for review and approval. EPA's schedule for issuing a proposed rule and a final rule has not yet been established; the agency is currently defending a lawsuit that may establish such a schedule.[48]

Our analysis of EPA's 1999 data, as well as more current data from deployments and DOE tests, shows that newer data may have several implications for the stringency of the standard. First, the average emissions reductions of the best performers, from which the standard is derived, may be greater using more current data than the reductions derived from EPA's 1999 data. Our analysis of EPA's 1999 data shows an average mercury emission reduction of nearly 91 percent for the best performers.[49] In contrast, using more current commercial deployment and DOE test data, as well as data on co-benefit mercury reductions collected in 1999, an average mercury emission reduction of nearly 96 percent for best performers is demonstrated. The 1999 data do not reflect the significant and widespread mercury reductions achieved by sorbent injection systems. Further, EPA's 2004 proposed MACT standards for mercury were substantially less stringent than the 1999 average emission

[47]EPA officials told us, for instance, that the agency could decide to use data from its 1999 information collection request or data from commercial deployments and DOE tests.

[48]Under the Clean Air Act Amendments of 1990, EPA had 10 years from the enactment of the amendments, or 2 years from the listing of electric steam-generating units as sources of hazardous air pollutants subject to regulation, whichever was later, to promulgate a MACT standard. Because EPA did not list electric steam-generating units until 2000, it originally had 2 years, or until 2002, to promulgate a MACT standard. Because EPA missed this promulgation date, a mandatory duty lawsuit was filed against the agency that will result in a court-approved schedule.

[49]Our analysis of EPA's data includes the three primary coal types: bituminous, subbituminous, and lignite.

reduction of the best performers because of variability in mercury emissions among the top performers, as discussed later in more detail.

Second, more current information that reflects mercury control deployments and DOE tests may make the rationale EPA used in the past to create MACT standards for different subcategories less compelling to the agency now. In 2004, using 1999 data, EPA proposed separate MACT standards for each type of coal used at power plants. The agency explained that mercury emissions reductions from boilers using lignite and subbituminous coal was substantially less than from those using bituminous coal. Specifically, the 1999 data EPA used for its 2004 proposed MACT standards showed that best performers achieved average emission reductions of 97 percent for bituminous, 71 percent for subbituminous, and 45 percent for lignite. In contrast, more current data show that sorbent injection systems have achieved average mercury emissions reductions of more than 90 percent with bituminous and subbituminous coal types and nearly this amount with lignite.

Finally, using more current emissions data in setting the MACT standard for regulating mercury may mean that accounting for variability in emissions will not have as significant an effect as it did in the 2004 proposed MACT—when it led to a less stringent MACT standard—because more current data may already reflect variability. In its 2004 proposed MACT, EPA explained that its 1999 data, obtained from the average of short-term tests (three samples taken over a 1- to 2-day period), did not necessarily reveal the range of emissions that would be found over extended periods of time or under a full range of operating conditions they could reasonably anticipate. EPA thus extrapolated longer-term variability data from the short-term data, and on the basis of these calculations, proposed MACT standards equivalent to a 76 percent reduction in mercury emissions for bituminous coal, a 25 percent reduction for lignite, and a 5 percent reduction for subbituminous coal—20 to 66 percentage points lower than the average of what the best performers achieved for each coal type.

However, current data may eliminate the need for such extrapolation. Data from commercial applications of sorbent injection systems, DOE field tests, and co-benefit mercury reductions show that mercury emissions reductions well in excess of 90 percent have been achieved over periods ranging from more than 30 days in field tests to more than a year in commercial applications. Mercury emissions measured over these periods may more accurately reflect the variability in mercury emissions that plants would encounter over the range of operating conditions.[50] Along these lines, at least 15 states with mercury emission limits require long-term averaging—ranging from 1 month to 1 year—to account for variability. According to the manager of a power plant operating a sorbent injection system, long-term averaging of mercury emissions takes into account the "dramatic swings" in mercury emissions from coal that may occur. He told us that while mercury emissions can vary on a day-to-day basis, this plant has achieved 94 percent mercury reduction, on average, over the last year.[51] Similarly, another manager of a power plant operating a sorbent injection system told us the amount of mercury in the coal used at the plant "varies widely, even from the same mine." Nonetheless, the plant manager reported that this plant achieves its required 85 percent mercury reduction because the state allows averaging mercury emissions on a monthly basis to take into account the natural variability of mercury in the coal.

The Type of Standard EPA Chooses May Also Affect the Stringency of the Regulation

In 2004, EPA's proposed mercury MACT included two types of standards to limit mercury emissions: (1) an output-based standard for new coal-fired power plants and (2) a choice between an input- or output-based standard for existing plants. Input-based standards establish emission limits on the basis of pounds of mercury per trillion BTUs of heat input; output-based standards, on the other hand, often establish emission limits

[50]According to officials with one industry group, many coal-fired power plants use coal from numerous mines, and the mercury content in coal from these different sources can vary dramatically. These officials said that variability in mercury emissions resulting from the use of coal from different sources should be considered when setting a MACT standard. Officials with several coal-fired power plants told us that requiring compliance over long time periods—such as monthly, quarterly, or annually—is one way to ensure that such variability is accounted for.

[51]The requirement for this plant, which the plant manager reported it has met, is for a 90 percent reduction averaged over a 3-month period.

on the basis of pounds of mercury per megawatt hour of electricity produced. These standards are referred to as emission limits.[52]

Input-based limits can have some advantages for coal-fired power plants. For example, input-based limits can provide more flexibility to older, less efficient plants because they allow boilers to burn as much coal as needed to produce a given amount of electricity, as long as the amount of mercury per trillion BTUs does not exceed the level specified by the standard.[53] However, input-based limits may allow some power plants to emit more mercury per megawatt hour than output-based limits. Under an output-based standard, mercury emissions cannot exceed a specific level per megawatt-hour of electricity produced—efficient boilers that use less coal will be able to produce more electricity than inefficient boilers under an output-based standard. Moreover, under an output-based limit, less efficient boilers may have to, for example, increase boiler efficiency or switch to a lower mercury coal. Thus, output-based limits provide a regulatory incentive to enhance both operating efficiency and mercury emission reductions. If all else was held equal, less mercury would be emitted nationwide under an output-based standard.

We found that at least 16 states have established a format for regulating mercury emissions from coal-fired power plants. Eight states allow plants to meet either an emission limit or a percent reduction, three require an emission limit, four require percent reductions, and one state requires plants to achieve whatever mercury emissions reductions—percent

[52]For the purposes of setting a standard, emissions limits can be correlated to percent reductions. For example, EPA's 2004 proposed standards for bituminous, lignite, and subbituminous coal (2, 9.2, and 5.8 pounds per trillion BTUs, respectively) are equivalent with mercury emissions reductions of 76, 25, and 5 percent, respectively, based on nationwide averages of the mercury content in coal. During EPA's 2004 MACT development process, state and local agency stakeholders, as well as environmental stakeholders, generally supported output-based emission limits; industry stakeholders generally supported having a choice between an emission limit and a percent reduction. EPA must now decide in what format it will set its mercury MACT standard(s).

[53]The main types of coal burned, in decreasing order of rank, are bituminous, subbituminous, and lignite. Rank is the coal classification system based on factors such as the heating value of the coal. High-rank coal generally has relatively high heating values (i.e., heat per unit of mass when burned) compared with low-rank coal, which has relatively low heating values.

reduction or emission limit—are greater.[54] On the basis of our review of these varying regulatory formats, we conclude that to be meaningful, a standard specifying a percent reduction should be correlated to an emission limit. When used alone, percent reduction standards may reduce the actual mercury emissions reductions achieved. For example, in one state, mercury reductions are measured against the "historical" amount of mercury in coal, rather than the amount of mercury in coal being currently used by power plants in the state. If plants are required to reduce mercury by, for example, 90 percent compared to historical coal data, but coal used in the past had higher levels of mercury than the plants have been using more recently, then actual mercury emission reductions would be less than 90 percent. In addition, percent reduction requirements do not provide an incentive for plants burning high mercury coal to switch coals or pursue more effective mercury control strategies because it is easier to achieve a percent reduction requirement with higher mercury coal than with lower mercury coals.

Similarly, a combination standard that gives regulated entities the option to choose either a specified emission limit or a percent reduction might reduce the actual mercury emission reductions achieved. For example, a plant burning coal with a mercury content of 15 pounds per trillion BTUs that may choose between meeting an emission limit of 0.7 pounds of mercury per trillion BTUs or a 90 percent reduction could achieve the percent reduction while emitting twice the mercury that would be allowed under the specified emission limit. As discussed earlier, for the purposes of setting a standard, a required emission limit that provides a consistent benchmark for plants to meet can be correlated to a percent reduction. For example, according to EPA's Utility Air Toxic MACT working group, a 90 percent mercury reduction based on national averages of mercury in coal generally equates to a national average emission limit of approximately 0.7 pounds per trillion BTUs.[55] For bituminous coal, a 90

[54]Colorado, Connecticut, Delaware, Illinois, Massachusetts, New Jersey, Oregon, and Utah allow either an emission limit or a percent reduction; Montana, New Mexico, and New York require an emission limit; Maryland, Minnesota, New Hampshire, and Wisconsin require percent reductions (Wisconsin mercury emission standard changes to require meeting either a limit or a percent reduction in 2015); and Arizona requires the more stringent option—whichever is more stringent, a percent reduction or emission limit.

[55]Presentation on "Recommendations on the Utility Air Toxics MACT, Final Working Group Report, October 2002." The Working Group on the Utility MACT was formed under the Clean Air Act Advisory Committee, Subcommittee for Permits/New Source Reviews/Toxics.

percent reduction equates to a limit of 0.8 pounds per trillion BTUs; for subbituminous coal, a 90 percent reduction equates to a limit of 0.6 pounds per trillion BTUs; and for lignite, a 90 percent reduction equates to a limit of 1.2 pounds per trillion BTUs.

Continuous Monitoring of Mercury Emissions at Most Power Plants Has Been Delayed

EPA's now-vacated Clean Air Mercury Rule required most coal-fired power plants to conduct continuous emissions monitoring for mercury—and a small percentage of plants with low mercury emissions to conduct periodic testing—beginning in 2009. State and federal government and nongovernmental organization stakeholders told us they support reinstating the monitoring requirements of the Clean Air Mercury Rule. In fact, in a June 2, 2008, letter to EPA, the National Association of Clean Air Agencies requested that EPA reinstate the mercury monitoring provisions that were vacated in February 2008 because, among other things, they are important to state agencies with mercury reduction requirements and power plants complying with them.[56] This association also said the need for federal continuous emissions monitoring requirements is especially important in states that cannot adopt air quality regulations more stringent than those of the federal government. However, EPA officials told us the agency has not determined how to reinstate continuous emissions monitoring requirements for mercury at coal-fired power plants outside of the MACT rulemaking process.

Under the Clean Air Mercury Rule, the selected monitoring methodology for each power plant was to be approved by EPA through a certification process. For its part, EPA was to develop performance specifications—protocols for quality control and assurance—for continuous emissions monitoring systems (CEMS). However, when the Clean Air Mercury Rule was vacated in February 2008, EPA delayed development of these performance specifications. EPA has taken steps recently to develop performance specifications for mercury CEMS under a May 6, 2009, proposed rule limiting mercury emissions from facilities that produce Portland cement.[57] As part of this proposed rule, EPA also proposed performance specifications that describe performance evaluations that must be conducted to ensure the continued accuracy of the CEMS

[56]The National Association of Clean Air Agencies represents air pollution control agencies in 53 states and territories and over 165 major metropolitan areas across the United States.

[57]Portland cement is the most common type of cement in general use around the world. It is a basic ingredient of concrete, mortar, stucco and most non-specialty grout.

emissions data. In the proposed rule, EPA stated that the performance specifications for mercury CEMS used to monitor emissions from Portland cement facilities could also apply to other sources. Further, an EPA Sector Policies and Programs Division official told us that if EPA chooses—as it did in its 2004 proposed MACT—to require continuous monitoring for mercury emissions in its final rule regulating hazardous air pollutants from coal-fired power plants, the performance specifications will already be in place for continuous emissions monitoring systems' use when the Portland cement MACT is finalized.

Effective continuous emissions monitoring can assist facilities and regulators ensure compliance with regulations and can also help facilities identify ways to better understand the efficiency of their processes and operations. For example, using CEMS, plant managers told us they can routinely make adjustments in the amount of sorbent needed to meet regulatory requirements, potentially reducing costs. Nevertheless, monitoring mercury emissions is more complex than monitoring other pollutants, such as nitrogen oxides and sulfur dioxide, which are measured in parts per million—mercury is emitted at lower levels of concentration than other pollutants and is measured in parts per billion. Consequently, mercury CEMS may require more time to install than CEMS for other pollutants, and according to plant engineers using them, getting these relatively complex monitoring systems up and running properly involves a steeper learning curve.

In our work, we found that mercury CEMS were installed on 16 boilers at power plants and used for monitoring operations and compliance reporting.[58] Plant managers reported that their mercury CEMS were online from 62 percent to 99 percent of the time. The system that was online 62 percent of the time was not used for compliance purposes but rather to monitor the effectiveness of different sorbent injection rates on mercury emissions. Excluding this case, CEMS were online about 90 percent of the time, on average. When these systems were offline, it was mainly because of failed system integrity checks or for routine parts replacement. Some plant engineers told us that they believed CEMS were several years away from commercial readiness to accurately measure mercury emissions but that they had purchased and installed the CEMS in anticipation of the requirement that was part of the now-vacated Clean Air Mercury Rule.

[58]At least 15 states have enacted mercury emission standards that include a continuous emission or other long-term monitoring requirement

Others using CEMS said that these systems are accurate at measuring mercury emissions and can be used to determine compliance with a stringent regulation.

EPA, EPRI, the National Institute of Standards and Technology, and others are working collaboratively to approve protocols for quality assurance and control for mercury CEMS that will ensure the continued accuracy of the emissions data at the precise levels of many state rules. These organizations are in the final phase of their collaborative effort, and in July 2009 they provided interim procedures to states that require use of mercury CEMS and other groups that use these systems.

Concluding Observations

Data from commercially deployed sorbent injection systems show that substantial mercury emissions reductions have been achieved at a relatively low cost. Importantly, these results, along with test results from DOE's comprehensive research and development program, suggest that similar reductions can likely be achieved at most coal-fired power plants in the United States. Other strategies, including blending coal and using other technologies, exist for the small number of plants with configuration types that were not able to achieve significant mercury emissions reductions with sorbent injection alone.

Whether power plants will install sorbent injection systems or pursue multipollutant control strategies will likely be driven by the broader regulatory context in which they operate, such as requirements for sulfur dioxide and nitrogen oxides reductions in addition to mercury, and the associated costs to comply with all pollution reduction requirements. Nonetheless, for many plants, sorbent injection systems appear to be a cost-effective technology for reducing mercury emissions. For other plants, sorbent injection may represent a relatively inexpensive bridging technology—that is, one that is available for immediate use to reduce only mercury emissions but that may be phased out—over time—with the addition of multipollutant controls, which are more costly. Moreover, some plants achieve substantial mercury emissions reductions without mercury-specific controls because their existing controls for other air pollutants also effectively reduce mercury emissions. In fact, while many power plants currently subject to mercury regulation have installed sorbent injection systems to achieve required reductions, about one-third of them are relying on existing pollution control devices to meet the requirements.

As EPA proceeds with its rulemaking process to regulate hazardous air pollutants from coal-fired power plants, including mercury, it may find that current data from commercially deployed sorbent injection systems and plants that achieve high co-benefit mercury reductions would support a more stringent mercury emission standard than was last proposed in 2004. More significant mercury emissions reductions are actually being achieved by the current best performers than was the case in 1999 when such information was last collected—and similar results can likely be achieved by most plants across the country at relatively low cost.

Agency Comments and Our Evaluation

We provided a draft of this report to the Administrator, EPA, and the Secretary, DOE, for review and comment. EPA and DOE provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to interested congressional committees; the Administrator, the Environmental Protection Agency; the Secretary, Department of Energy; and other interested parties. The report is also available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or stephensonj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix VI.

Sincerely yours,

John B. Stephenson
Director, Natural Resources
and Environment

Appendix I: Objectives, Scope, and Methodology

This appendix details the methods we used to examine (1) the mercury reductions that have been achieved by existing mercury control technologies and the extent to which they are being used at coal-fired power plants, (2) the costs associated with mercury control technologies currently in use, and (3) key issues the Environmental Protection Agency (EPA) faces in developing a new regulation for mercury emissions from coal-fired power plants.

For the first two objectives, we identified coal-fired power plants subject to regulatory requirements to reduce mercury emissions by contacting clean air agencies in all 50 states. In so doing, we identified those states that had established laws or regulations—or had coal-fired power plants subject to consent decrees or construction permits—requiring reductions in mercury emissions. In states where laws or regulations are in effect, we asked clean air agency officials to identify which coal-fired power plants are meeting the requirements—either through "co-benefit" mercury removal achieved by plants' existing air pollution control equipment or by operating sorbent injection systems. State clean air agency officials identified 14 coal-fired power plants that are currently operating sorbent injection systems to meet regulatory requirements to reduce mercury emissions.[1] For these plants, we developed a structured interview instrument to obtain information on the effectiveness of sorbent injection systems in reducing mercury emissions and the associated costs of the systems and the monitoring equipment.[2] We designed the instrument to also obtain information on the engineering challenges, if any, that plant officials experienced when operating the systems and the steps taken to mitigate such challenges. Staff involved in the evaluation and development of mercury control technologies within EPA's Office of Research and

[1]Representatives of one plant that is operating a sorbent injection system to meet its state's mercury reduction requirements did not participate in the structured interview, stating they could not participate until a compliance report had been completed and submitted to the state clean air agency.

[2]We obtained data on the capital and operating costs incurred to purchase, install, and operate sorbent injection systems and determined their potential impact on utility rates. To account for differences in timing, we adjusted these costs for inflation to represent 2008 dollars. We then used, by boiler, the reported operating costs, total electrical output, and capital costs to determine a levelized cost per kilowatt hour. The levelized cost is an assessment of the anticipated costs of a sorbent injection system over its lifetime, including capital costs and operations and maintenance costs. We assumed a 20-year lifetime and a return on capital of 10 percent. We then compared these costs with DOE data on 2008 average utility rates by state to determine the potential impact on utility rates, should the plants we interviewed pass on 100 percent of the costs to consumers.

Development and DOE's Office of Fossil Energy reviewed and commented on the instrument. We conducted the structured interview with representatives of 13 of the 14 coal-fired power plants and conducted site visits at 6 of them. We conducted structured interviews with officials at the following plants:

- B.L. England, New Jersey
- Brayton Point, Massachusetts
- Bridgeport Harbor, Connecticut
- Crawford, Illinois
- Fisk, Illinois
- Indian River Generating Station, Delaware
- Mercer Generating Station, New Jersey
- Presque Isle, Michigan
- TS Power Plant, Nevada
- Vermillion Power Station, Illinois
- Walter Scott Jr. Energy Center, Iowa
- Waukegan, Illinois
- Weston, Wisconsin

Furthermore, state clean air agency officials identified six coal-fired power plants that are aiming to meet mercury emission reduction requirements through operation of existing air pollution control equipment. From officials with these six plants, we obtained information on the effectiveness of the existing controls in reducing mercury emissions, as well as the reliability and costs of mercury emissions monitoring equipment. We spoke with officials at the following plants:

- AES Thames, Connecticut
- Carney's Point, New Jersey
- Deepwater, New Jersey

- EdgeMoor, Delaware
- Logan, New Jersey
- Salem Harbor, Massachusetts

In addition to examining the effectiveness of commercially deployed sorbent injection systems, we examined field test results of sorbent injection systems—installed at operating power plants—conducted by DOE and the Electric Power Research Institute (EPRI) over the past 10 years as part of DOE's comprehensive mercury control technology test program. We relied primarily on data from the second and third phases of the DOE field testing program. The second phase of the DOE program focused heavily on chemically treated sorbents, which helped many boiler configurations achieve much higher mercury emission reductions than the same boiler configurations achieved under phase one tests, when untreated sorbents were used. The third phase of the DOE program focused on finding solutions to "balance-of-plant" impacts. To determine the percentage of coal-fired boilers nationwide that have air pollution control device configurations that are the same as those at power plants with commercially deployed sorbent injection systems or where field tests occurred, we used a draft version of EPA's National Electricity and Energy Data System database that contains boiler level data, as of 2006, on coal type used, pollution control devices installed, and generating capacity.[3]

We conducted a reliability review of the data we received from coal-fired power plants, EPA, and DOE. Through our review, we determined that the data were sufficiently reliable for our purposes. Our assessment consisted of interviews with officials about the data systems and elements of data. We also corroborated the data with other sources, where possible. For example, we verified the information in structured interviews by obtaining compliance reports from state clean air agencies, where possible. Finally, we reviewed literature presented at the 2008 MEGA Symposium and the 2009 Energy and Environment Conference on (1) strategies to overcome challenges that some plants have experienced with sorbent injection systems, such as sulfur trioxide interference, and (2) on emerging mercury control technologies, such as oxidation catalysts.

[3]We excluded boilers with generating capacity of less than 25 megawatts from our analysis because they would not be subject to a MACT regulation under the Clean Air Act.

For the third objective, we examined EPA's requirements for establishing MACT standards under the Clean Air Act and recent court cases with implications for how EPA establishes such standards.[4] We interviewed EPA officials in the Clean Air Markets Division and Sector Policies and Programs Division regarding the agency's plans for regulating mercury at power plants. To examine EPA's process for identifying best performers, we obtained and analyzed EPA data on mercury emissions reductions from the agency's 1999 information collection request. Using these data, we followed the steps EPA described in its proposed 2004 MACT rulemaking to calculate the average mercury emissions reductions achieved by the best performing 12 percent of boilers—the threshold for calculating a minimum MACT emissions standard under the Clean Air Act. We then used newer data—the data we obtained from commercially deployed sorbent injection systems and DOE and industry tests—and followed the same steps to calculate the average mercury emissions reductions achieved by the best performing 12 percent of these boilers.

In addition, we examined EPA's steps to resolve technical monitoring challenges, including how the agency develops quality control and assurance procedures for continuous emissions monitoring systems. We also obtained data from coal-fired power plants—operating 16 continuous emissions monitoring systems—on the reliability of the systems, including data on the number of times the systems were offline, the outcome of periodic system integrity checks, and the extent to which plant engineers believed the systems to accurately measure mercury emissions. We interviewed EPA's technical experts in the Clean Air Markets Division.

We conducted this performance audit from November 2008 through September 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

[4]We examined the following cases: *National Lime Association v. EPA*, 233 F.3d 625 (D.C. Cir. 2000); *Cement Kiln Recycling Coal. v. EPA*, 255 F.3d 855 (D.C. Cir. 2001); *Sierra Club v. EPA*, 479 F.3d 875 (D.C. Cir. 2007); *Natural Resources Defense Council v. EPA*, 489 F.3d 1250 (D.C. Cir. 2007); *Natural Resources Defense Council v. EPA*, 489 F.3d 1364 (D.C. Cir. 2007).

Appendix II: Emerging Technologies That May Reduce Mercury Emissions from Coal-Fired Power Plants

In addition to sorbent injection systems, DOE, EPRI, and others have developed and tested other technologies to reduce mercury emissions that show promise and may become commercially available in the future. These technologies are being developed to potentially lower the cost of mercury removal for some plants and enable others—those for which sorbent injection may be ineffective—to achieve significant mercury emission reductions. Such technologies include oxidation catalysts, which help convert elemental mercury into oxidized mercury that can be captured in particulate control devices; the MerCAP™ process, which involves installing metal plates with sorbents on them in the exhaust gas (instead of injecting sorbents); and low-temperature mercury capture, which involves lowering the temperature of the exhaust gas to enable mercury to bind more effectively to the unburned carbon in fly ash. Finally, novel technologies are being developed by entities such as the Western Research Institute.[1] The technologies the Western Research Institute is working on include those designed to remove mercury directly from coal before it is burned. Innovative techniques for mercury control could eventually replace or augment the more mature technologies discussed in this report, according to DOE.

Oxidation catalysts. Oxidation catalysts are powdered chemicals injected into either the boiler or the boiler's exhaust gas to help change elemental mercury into oxidized mercury—a form that is easier to capture in pollution control devices for sulfur dioxide and particulate matter. According to recent research, oxidation of elemental mercury, which is then collected in particulate matter control devices or absorbed across a wet scrubber system, has the potential to be a reliable and cost-effective mercury control strategy for some coal-fired power plants, especially those that must comply with sulfur dioxide emission requirements. According to DOE, examples of oxidation catalysts tested at operating power plants include the following:

- URS Corporation tested oxidation catalysts at a plant that fires a blend of Texas lignite and subbituminous coals. Tests completed in April 2005 showed that oxidation catalysts enabled the wet scrubber to achieve mercury reductions ranging from 76 percent to 87 percent, compared with only 36 percent reduction under baseline conditions.

[1]The Western Research Institute is a not-for-profit research organization involved in advanced energy systems, environmental technologies, and highway materials research.

- URS has also begun testing oxidation catalysts at a boiler firing low-sulfur eastern bituminous coal that is equipped with a cold-side electrostatic precipitator. According to DOE, the project represents the next logical advancement of the catalytic oxidation technology, and it will answer technical questions such how much catalyst is required to achieve high mercury oxidation percentages, what is the catalyst life, and what is the efficiency of mercury capture in wet scrubber systems using oxidation catalysts.

MerCAP™: Developed by EPRI, MerCAP is a process in which metal plates laced with carbon sorbents are positioned in a boiler's exhaust gas stream to adsorb mercury. During two 6-month tests, MerCAP was used at a boiler equipped with a dry scrubber and a fabric filter and at another boiler equipped with a wet scrubber. After more than 250 days of continuous operation at one plant, mercury reduction averaged 30 percent to 35 percent across acid-treated MerCAP plates and 10 to 30 percent across the untreated plates. At the other plant, MerCAP achieved 15 percent mercury reduction when a water wash system for the plates was installed, which helped prevent limestone slurry from the wet scrubber system from inhibiting mercury reduction. MerCAP™ is still in the research and development phase, and although these mercury reduction amounts appear relatively low, when engineers altered the spacing between the metal plates, mercury emission reductions increased to about 60 percent in some cases.

Low-temperature mercury capture process: The low temperature mercury capture process helps reduce mercury emissions by cooling the exhaust gas temperature to about 220° Fahrenheit, which promotes mercury adsorption to the unburned carbon inherent in fly ash. This process may have the ability to reduce mercury emissions by over 90 percent, as was recently shown by one company performing a limited scale test.

Pilot testing of novel mercury control technology: The Western Research Institute is developing and evaluating the removal of mercury from coal prior to combustion. The institute developed a two-step process that involves first evaporating moisture in the coal and then heating the coal with inert gas. Pre-combustion mercury removal technology has been successful in removing 75 percent of mercury from subbituminous coal and 60 percent of mercury from lignite coal, but the technology has encountered difficulty when used with bituminous coal. By removing up to 75 percent of mercury before combustion, less mercury remains in the exhaust gas for removal by pollution control devices. In addition, pre-combustion technology has other benefits: (1) removing the moisture from the coal increases the heat content of the coal for combustion purposes, which may reduce the amount of coal burned by the plant and increase efficiency by about 3 percent; (2) this process also helps to remove other trace metals; (3) the water that is removed from the coal during pre-combustion treatment can be recovered and re-used in plant operations. According to DOE, Western Research Institute testing has also shown that, for some coals, the amount of time the coal is exposed to heat affects the amount of mercury removed. For example, an increase of 8 minutes of "residence time" resulted in the removal of nearly 80 percent of mercury before combustion.[2]

DOE in-house development of novel control technologies: DOE recently patented three techniques that are now licensed and in commercial demonstration. First, the thief carbon process—which involves extracting carbon from the boiler and using it as sorbent to inject into the exhaust gas for mercury capture—may be a cost-effective alternative to sorbent injection systems for mercury removal from boilers' exhaust gas. Thief carbon sorbents, for instance, range from $90 to $200 per ton according to DOE—less than 10 percent of the typical cost of sorbents used in sorbent injection systems. According to the Western Research Institute, which tested the thief carbon process at an operating power plant, mercury emission reductions were comparable to those achieved by commercially available sorbents. Second, DOE patented the photochemical oxidation process. This process introduces an ultraviolet light into the exhaust gas to help convert mercury to an oxidized form for collection in other pollution control devices.[3] Finally, DOE researchers have invented a new sorbent that works at elevated temperatures. The new sorbent, which is palladium-based, removes mercury at temperatures above 500° Fahrenheit and, according to DOE, may improve the overall energy efficiency of the combustion process.[4]

[2]During testing, the percentage of mercury removed from coal varied from 50 percent to almost 90 percent, depending on the amount of time the coal was exposed to heat and inert gas, according to DOE.

[3]Researchers at DOE's National Energy Technology Laboratory received the 2005 Award for Excellence in Technology Transfer from the Federal Laboratory Consortium for the photochemical oxidation method.

[4]Researchers at DOE's National Energy Technology Laboratory received the 2008 Award for Excellence in Technology Transfer for developing the palladium-based sorbent.

Appendix III: Summary of State Regulations Requiring Reductions in Mercury Emissions from Coal-Fired Power Plants

Table 1 summarizes data about state regulations that require reductions in mercury emissions from coal-fired power plants, including compliance date, percent reduction required, and emission limit. This table represents the best available data on state regulations, which appear to be independent of rules that were adopted in accordance with the vacated Clean Air Mercury Rule as of August 2009. For states with percent reduction and emission limit provisions, plants generally may choose the format with which they will comply.

Table 1: Summary of Key Provisions of State Regulations Requiring Mercury Emission Reductions Applicable to Existing or All Coal-Fired Power Plants

State	Compliance date	Percent reduction	Emission limit	Continuous emission or other long-term monitoring requirement (some state requirements may rely on vacated portions of federal rule)
Arizona[a]	December 31, 2013	90	0.0087 pounds/gigawatt-hour	X
Colorado[a]	July 1, 2014[b]	80	0.0174 pounds/gigawatt-hour	X
	January 1, 2018	90	0.0087 pounds/gigawatt-hour	
Connecticut[a]	July 1, 2008	90	0.60 pounds/trillion BTUs	
Delaware[c]	January 1, 2009	80	1.0 pounds/trillion BTUs	X
	January 1, 2013	90	0.60 pounds/trillion BTUs	
Georgia	Each plant shall install certain types of air pollution control devices, at varying times, according to a legislatively prescribed schedule.			
Illinois[a, d]	July 1, 2009	90	0.0080 pounds/gigawatt-hour	X
Maryland	January 1, 2010	80	No emission limit required	X
	January 1, 2013	90	No emission limit required	
Massachusetts	January 1, 2008	85	0.0075 pounds/gigawatt-hour	X
	October 1, 2012	95	0.0025 pounds/gigawatt-hour	
Minnesota[a]	December 31, 2010[e]	90	No emission limit required	X
	December 31, 2014[f]	90	No emission limit required	
Montana[a]	January 1, 2010	No percent reduction required	0.90 pounds/trillion BTUs[g]	X
New Hampshire[a]	July 1, 2013	80	No emission limit required	X
New Mexico	January 1, 2010/ January 1, 2018	No percent reduction required	Each plant has its own emission limit (in two phases)	X
New Jersey	December 15, 2007	90	3 milligrams/megawatt-hour	

State	Compliance date	Percent reduction	Emission limit	Continuous emission or other long-term monitoring requirement (some state requirements may rely on vacated portions of federal rule)
New York	January 1, 2010[h]	No percent reduction required	0.60 pounds/trillion BTUs	X
North Carolina[i]	December 31, 2013	No percent reduction required	No emission limit required	X
Oregon[a]	July 1, 2012	90	0.60 pounds/trillion BTUs	X
Utah[a]	December 31, 2012	90	0.65 pounds/trillion BTUs	X
Wisconsin	January 1, 2010[j]	40	No emission limit required	X
	January 1, 2015[k]	90	0.0080 pounds/gigawatt-hour	

Source: GAO analysis of state clean air agency data.

[a]Alternate standards may be applied under certain circumstances.

[b]Two plants in Colorado must comply with an 80 percent mercury emission reduction requirement beginning on January 1, 2012.

[c]Requirement applies to large plants. Plants are also subject to mass emission caps beginning in 2009 and becoming more stringent in 2013.

[d]Through 2013, requirement applies to systems of plants and additional minimum requirements apply on a plant-by-plant basis; after 2013, requirement applies to all plants on a plant-by-plant basis.

[e]This compliance date applies to coal-fired boilers equipped with dry scrubbers for air emissions control.

[f]This compliance date applies to coal-fired boilers equipped with wet scrubbers for air emissions conrol.

[g]The Montana regulation established a separate standard for coal-fired boilers using lignite of 1.5 pounds per gigawatt-hour.

[h]Between 2010 and 2015, 13 coal-fired power plants must reach a specific mercury emission limit prescribed by law. If a plant is not on that list, it must achieve an emission limit of 0.60 pounds per trillion BTUs. Beginning in 2015, all plants must achieve an emission limit of 0.60 pounds per trillion BTUs.

[i]North Carolina requires installation of technology that captures sulfur dioxide, nitrogen oxides, and mercury.

[j]Applies to four major utilities.

[k]Applies to large coal-fired power plants. Plants can take an additional six years to achieve 90% reduction if they choose additional nitrogen oxide and sulfur dioxide controls. Small coal-fired power plants must reduce their mercury emissions to that achieved by the Best Available Control Technology by January 1, 2015.

Appendix IV: Potential Solutions for Plants Unable to Achieve High Mercury Emissions Reductions Using Sorbent Injection Systems Alone

DOE tests show that some plants may not be able to achieve mercury emissions reductions of 90 percent or more with sorbent injections alone. Specifically, the tests identified three factors that can impact the effectiveness of sorbent injection systems: sulfur trioxide interference, using hot-side precipitators, and using lignite. These factors are discussed below, along with some promising solutions to the challenges they pose.

Sulfur trioxide interference. High levels of sulfur trioxide gas may limit mercury emission reductions by preventing some mercury from binding to carbon sorbents. Using an alkali injection system in conjunction with sorbent injection can effectively lessen sulfur trioxide interference. Depending on the cause of the sulfur trioxide interference—which can stem from using a flue gas conditioning system, a selective catalytic reduction system, or high-sulfur bituminous coal—additional strategies may be available to ensure high mercury reductions:

- Flue gas conditioning systems, used on 13 percent of boilers nationwide, improve the performance of electrostatic precipitators by injecting a conditioning agent, typically sulfur trioxide, into the flue gas to make the gas more conducive to capture in electrostatic precipitators. Mercury control technology vendors are working to develop alternative conditioning agents to improve the performance of electrostatic precipitators without jeopardizing mercury emission reductions using sorbent injection.
- Selective catalytic reduction systems, common control devices for nitrogen oxides, are used by about 20 percent of boilers nationwide. Although selective catalytic reduction systems often improve mercury capture, in some instances these devices may lead to sulfur trioxide interference when sulfur in the coal is converted to sulfur trioxide gas. Newer selective catalytic reduction systems often have improved catalytic controls, which can minimize the conversion of sulfur to sulfur trioxide gas.
- High-sulfur bituminous coal—defined as having a sulfur content of at least 1.7 percent sulfur by weight—may also lead to sulfur trioxide interference in some cases. As many as 20 percent of boilers nationwide may use high-sulfur coal, according to 2005 DOE data; however, the number of coal boilers using high-sulfur bituminous coal is likely to decline as more stringent sulfur dioxide regulations take effect. Plants can consider using alkali-based sorbents, such as Trona, which adsorb sulfur trioxide gas before it can interfere with the performance of sorbent injection systems. Plants that burn high-sulfur coal can also consider blending their fuel to

include some portion of low-sulfur coal. In addition, according to EPA, power companies are likely to install scrubbers for controlling sulfur dioxide at plants burning high-sulfur coal (for those boilers that do not already have them). Scrubbers also reduce mercury emissions as a co-benefit, so many such plants may use them instead of sorbent injection systems to achieve mercury emissions reductions.

Hot-side electrostatic precipitators. Installed on 6 percent of boilers nationwide, these particulate matter control devices operate at very high temperatures, which reduces the amount of mercury binding to sorbents for collection in particulate matter control devices. However, at least two promising techniques for increasing mercury capture have been identified in tests and commercial deployments at configuration types with hot-side electrostatic precipitators. First, during DOE testing 70 percent mercury emission reductions were achieved with specialized heat-resistant sorbents. Moreover, one of the 25 boilers currently using a sorbent injection system has a hot-side electrostatic precipitator and uses a heat-resistant sorbent. Although plant officials are not currently measuring mercury emissions for this boiler, the plant will soon be required to achieve mercury emission reductions equivalent to 90 percent.[1] Second, in another DOE test, three 90 megawatt boilers—each with a hot-side electrostatic precipitator—achieved more than 90 percent mercury emission reductions by installing a shared fabric filter in addition to a sorbent injection system, a system called TOXECON™. According to plant officials, these three units, which are using this system to comply with a consent decree, achieved 94 percent mercury emission reductions during the third quarter of 2008, the most recent compliance reporting period during which the boiler was operating under normal conditions.

Lignite. North Dakota and Texas lignite, the fuel source for roughly 3 percent of boilers nationwide, have relatively high levels of elemental mercury—the most difficult form to capture. Four long-term DOE tests were conducted at coal units burning North Dakota lignite using chemically treated sorbents. Mercury emission reductions averaged 75 percent across the tests. The best result was achieved at a 450 megawatt boiler with a fabric filter and a dry scrubber—mercury reductions of 92 percent were achieved when chemically treated sorbents were used. In addition, two long-term tests were conducted at plants burning Texas lignite with a 30 percent blend of subbituminous coal. With coal blending,

[1]Plant officials did not provide us with mercury emission reduction data for this boiler.

these boilers achieved average mercury emission reductions of 82 percent. Specifically, one boiler, with an electrostatic precipitator and a wet scrubber, achieved mercury reductions in excess of 90 percent when burning the blended fuel. The second boiler achieved 74 percent reductions in long-term testing. However, 90 percent was achieved in short-term tests using a higher sorbent injection rate. Although DOE conducted no tests on plants burning purely Texas lignite, one power company is currently conducting sorbent injection tests at a plant burning 100 percent Texas lignite and is achieving promising results. In the most recent round of testing, this boiler achieved mercury emission reduction of 82 percent using untreated carbon and a boiler additive in conjunction with the existing electrostatic precipitator and wet scrubber.

Appendix V: Average Costs to Purchase and Install Sorbent Injection Systems and Monitoring Equipment, with and without Fabric Filters, per Boiler

Table 2 summarizes information on average costs to purchase and install sorbent injection systems and monitoring equipment, with and without fabric filters. This table includes cost data for boilers with sorbent injection systems and fabric filters installed specifically for mercury emissions control. This table does not include cost data for the 5 boilers with sorbent injection systems and fabric filters that were installed largely to comply with requirements to control other forms of air pollution.[1]

Table 2: Detailed Average Costs to Purchase and Install Sorbent Injection Systems and Monitoring Equipment, with and without Fabric Filters, per Boiler

2008 dollars

Mercury control technology type	Number of boilers using technology type[a]	Cost of sorbent injection system	Cost of mercury emissions monitoring system	Cost of consulting and engineering	Cost of fabric filter	Total
Sorbent injection system alone	14	$2,723,000[b]	$560,000[b]	$382,000[b]	[c]	**$3,594,000[d]**
Sorbent injection system with fabric filter to assist in mercury removal	5	$1,335,000[e]	$120,000[f]	$1,444,000[g]	$19,010,000[h]	**$15,786,000[i]**

Source: GAO analysis of data from power plants operating sorbent injection systems.

[a]We identified 25 boilers using sorbent injection systems to reduce mercury emissions, for which power companies provided cost data on 24. Cost data for 19 of the 24 are provided in the table. We did not report costs in this table for the remaining 5 because much of the cost incurred for fabric filters in these cases is not related to mercury removal. See footnote.

[b]Of the 14 boilers that installed a sorbent injection system alone, cost data for only 12 boilers were provided in this category.

[c]Not applicable.

[d]Numbers do not add to total. Total capital cost data were provided for 14 boilers, but for only 12 in the other cost categories.

[e]Cost data were provided for two boilers in this category. The costs of the sorbent injection systems for the two boilers were $1,071,000 and $1,599,000.

[f]Cost data were provided for two boilers in this category. The costs of the monitoring systems for the two boilers were $107,000 and $160,000.

[g]Cost data were provided for three boilers in this category and were the same for all three boilers.

[h]Cost data were provided for two boilers in this category. The costs of the fabric filters were $15,255,000 and $22,765,000.

[i]Numbers do not add to total. Total capital cost data were provided for five boilers with fabric filters.

[1]For the five boilers where plant officials reported installing fabric filters along with sorbent injection systems largely to comply with requirements to control other forms of air pollution, the average reported capital cost for the two technologies was $105.9 million per boiler, ranging from $38.2 million to $156.2 million per boiler.[1] For these boilers, the capital costs result from requirements to control other pollutants, and we did not determine what portion of these costs would appropriately be allocated to the cost of reducing mercury emissions.

Appendix VI: GAO Contact and Staff Acknowledgments

GAO Contact

John B. Stephenson, (202) 512-3841 or stephensonj@gao.gov

Staff Acknowledgments

In addition to the contact named above, Christine Fishkin, Assistant Director; Nathan Anderson; Mark Braza; Antoinette Capaccio; Nancy Crothers; Michael Derr; Philip Farah; Mick Ray; and Katy Trenholme made key contributions to this report.

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Senator CARPER. All right, Senator Lautenberg.

Senator LAUTENBERG. Thanks, Mr. Chairman. We have this debate going on here about whether or not things that will improve health are affordable, and I mentioned before the Wall Street Journal article, a letter to the editor written by eight companies, including Public Service Electric & Gas, Calpine Corporation, National Grid USA, Exelon, Austin Energy Texas Company, that says we are OK with EPA's new air quality regulation; and it goes on to suggest that plants are retiring old plants because of EPA's regulations fails to recognize that the lower power prices and depressed demand are the primary retirement drivers.

Contrary to the complaints by the claims that EPA's agenda will have negative economic consequences, our companies, they say, experience complying with air quality regulation demonstrates that regulations can yield important economic benefits, including job creation, while maintaining reliability. How do we ignore that evidence, I can't quite comprehend.

Now, people in my State of New Jersey are suffering because a coal-fired plant just across the river in Pennsylvania is pumping dangerous levels of sulfur dioxide into the air. It is the Portland Generating Station in Pennsylvania, located just across the Delaware River from New Jersey, and is the primary source of sulfur dioxide pollution in several New Jersey counties. In fact, the Portland Generating Station in Pennsylvania emits more sulfur pollution than all of the power plants in New Jersey combined.

So we have this problem. Emissions from the plants are causing some New Jersey counties to exceed Federal limits for sulfur dioxide that causes serious breathing problems for children, the elderly, and people with asthma. EPA has proposed reducing sulfur pollution from the plants by more than 80 percent.

Ms. McCarthy, when will EPA finalize the rule and offer some relief to those people in New Jersey who are breathing that polluted air?

Ms. MCCARTHY. First of all, Senator, I hope you are proud of your State of New Jersey; they did a wonderful job on the petition and the data that they presented. We have been working closely with them. As you know, we have proposed some control strategies, a Federal implementation plan to address these pollutants from that particular facility. We have finished the comment period, we have finished the hearings, and we will be issuing that final decision this summer.

Senator LAUTENBERG. This summer?

Ms. MCCARTHY. Actually, end of summer, potentially September. But we are moving forward. We want it to be defensible and we think you have made a very strong case.

Senator LAUTENBERG. Terrific. Earlier this week OMB released a report that found EPA rules had cost polluters roughly $25 billion, while providing as much as $550 billion in public benefits over the last decade. Should we expect this pattern of modest cost to polluters, large benefits to the public to continue if EPA follows through on the rulemakings you have had in the works?

Ms. MCCARTHY. Senator, EPA has had 40 years of history in doing exactly what you suggest, which is to find the most cost-effective ways to achieve the greatest amount of public health benefit.

What the OMB study showed is that we are still on track, as we have been for 40 years. We are going to maintain that track record. And the Clean Air Transport Rule that you are talking about today is exactly the same rule with high benefits, low costs. The Mercury Rule is the same. So we are proud of these and they will continue in the course that we have set for the Clean Air Act.

Senator LAUTENBERG. On balance, the benefits far exceed the costs.

Ms. MCCARTHY. They do, on a balance of 30 to 1, sir.

Senator LAUTENBERG. The Clean Air Act requires EPA to issue air toxic rules that force polluting facilities to operate as cleanly as other companies in their industry that have already invested in pollution controls. What message might it send the companies that invested in technology to reduce the pollution decades ago if we are going to delay those rules yet again?

Ms. MCCARTHY. I think the major concern and what you are hearing from the Clean Energy Group is that for those who have invested in clean energy, we are not allowing them to run their units as they are available to run and, instead, basically investing in the dirty ones by allowing them to make more profits while the cleaner ones sit by. I think we need to recognize the public health costs of that pollution and that cost should be reflected in the way in which we meet our energy obligations in this Country.

Senator LAUTENBERG. A former high-ranking EPA official who left the agency during the Bush administration told the New York Times that a decade-long delay in air toxic rules says, "costs thousands of lives." Now, you recently put an end to that delay by proposing limits on the largest sources of air toxics, but polluting industries continue to lobby to prevent these long-overdue rules. What would be the impact of further delaying or weakening these rules in terms of illness and loss of life? What might we expect?

Ms. MCCARTHY. The Mercury Air Toxics Rule alone would reduce premature deaths by 17,000 every year. The Transport Rule has equal size benefits, and actually even more. We are talking about lives lost, work days lost. We are talking about exacerbated asthma levels. We are talking about hospital and emergency room visits. Those are real costs to American workers, to American families, and to our children?

Senator LAUTENBERG. Thank you very much, Ms. McCarthy.

I have to say, Mr. Chairman, that the Massachusetts accent lends charm to the facts that we are hearing, so well delivered. Thank you, Ms. McCarthy.

Ms. MCCARTHY. Thanks, Senator.

Senator CARPER. I knew it wasn't Mississippi, that's for sure.

Maybe we will go another 2 minutes or so, and then we will go to our newt panel.

Recently, American Electric Power, AEP, stated that they are retiring, I believe, some 6,000 megawatts in the next couple of years, and all these retirements are due to recent clean air regulations proposed under your watch. However, didn't AEP agree to retrofit or retire most of the megawatts in question under consent decrees with former President Bush's EPA? And is it your understanding that AEP's retirement announcement includes facilities listed in past consent decrees?

Ms. McCARTHY. Many of the facilities that they indicated would be retiring as a result of our rules have already been under consent agreements. In fact, 20 of them were already under consent agreements to retire or upgrade with proper pollution control equipment.

In addition, as we all know, announcements have been made that retirements are in the offing for some of these smaller, inefficient; they simply can't compete in the market. So what AEP was doing was confusing information by attributing market conditions and their failure to comply with earlier required reductions with the impacts of these rules.

Senator CARPER. All right, thank you. Another question is in testimony from an earlier hearing, a company mentioned that they had several coal-fired units that are currently not being scrubbed and, therefore, may have to close down or switch to natural gas, if possible, due to the air toxics regulations. Many of the sites in question were installed over 50 years ago, over a half century ago. How efficient are these coal-fired plants today if they are running on 50-year-old technology?

Ms. McCARTHY. I would say, Senator, first, that these rules seek the most cost-effective ways to make these reductions. Our coal-fired power plants now are, on average, over 50 years old. What we see is that those units are at least, the average, 20 percent efficient than the units that are constructed today, and many of them are nearly 40 percent less efficient. They are simply not competitive if they have to compete on a level playing field. But those are market decisions. Our decisions don't drive those retirements. Our decisions drive the installation of cost-effective, available pollution control equipments that save lives.

Senator CARPER. Good. A third question, in the 1970 and 1990 Clean Air Act amendments, Congress delayed air control requirements for older coal plants because apparently we thought that most of the old plants would still retire. The thought of investing in new technologies at a plant that wouldn't be around much longer didn't really seem logical at the time. But looking back, did many of these coal plants actually retire? And what would you guess is the average age of our coal fleet, any idea?

Ms. McCARTHY. We did not see the retirements that the Clean Air Act expected. We now have a coal fleet that, on average, is over 50 years old. We see them being more inefficient than current technologies and we see the availability of equipment that can be installed that will help them reduce the pollution that was expected under the Clean Air Act. So I would say that what we are seeing now, though, is, with the change in the market that inexpensive natural gas has brought to the table, that you are seeing a change in the position of those, the marketability of those units and the electricity they generate. So many retirements are expected just simply as a result of inexpensive natural gas, but that gives us the opportunity at this point, frankly, to have an ability to bring cost-effective reductions to the table.

However, I would also add that it will not reduce, and we don't predict a significant number of retirements attributable to these rules. We are talking about 10 gigawatts of coal retirement. There are 300 gigawatts of coal retirement in the system today and there is 1,000 gigawatts of electricity generation today.

So we are talking about a small amount of retirements attributable to this rule and the installation of pollution control equipment in the vast majority of those larger units that are necessary and functioning and competitive, and that is going to produce the results that we are looking for that will have such significant public health benefits without increasing significantly electricity costs.

Senator CARPER. OK. Thanks so much.

Senator Merkley, welcome. Good to see you.

Senator MERKLEY. Thank you very much, Mr. Chair. Good to be here.

Thank you for your testimony. I wanted to ask for EPA's perspective on coal plants that have agreed to a negotiated shutdown but are now making or needing to make new investments in pollution control technologies. Specifically, we have a plant in Boardman, Oregon that has negotiated to shut down all coal firing by 2020. But if they upgrade all their pollution controls to meet the requirements, then they feel like they need to keep the plant open longer in order to be able to recoup the investment in those technologies.

Does EPA have any flexibility on specific pollution reduction targets if it can also take into consideration a State-negotiated and federally enforceable shutdown, especially if that produces a better picture in terms of total emissions reduction?

Ms. MCCARTHY. Senator, we are more than happy to sit down with the folks who have negotiated the settlement and with Boardman themselves. We think that the agreement that was reached is quite remarkable. I think that you should be very proud of them, their attitude in working with all of the concerned citizens, as well as our regional EPA offices, and coming up with this agreement, and we are more than happy to look at what flexibilities are available to us on a one-on-one basis to take a look at how we can accommodate this agreement and ensure that they have certainty moving forward.

Senator MERKLEY. Thank you. I think that would be very helpful. Thank you.

Thank you, Mr. Chair.

Senator CARPER. You are welcome.

Senator BARRASSO.

Senator BARRASSO. Thank you, Mr. Chairman.

Ms. McCarthy, Senator Cornyn was here, had a couple of questions. In the Clean Air Transport Rule proposal, EPA excluded Texas from the SOx trading program, but now sources say that Texas will be included in the final rule. All EPA did in the proposal was, in a single sentence, asked for comment on possibly including Texas. No specific program elements, such as emission budgets, were provided for public review and comment, as they were for every other State included in the trading program. So obviously we have serious concerns that this violates the Administrative Procedure Act. Is your position otherwise?

Ms. MCCARTHY. My position is that Texas was in the CAIR program, it had requirements and, as you know, the Transport Rule is replacing the Clean Air InterState Rule. We did provide sufficient notice that we had concerns about the significant contribution of Texas. As you indicated, we sought comment on that issue, which we are required to do under the law.

We will take a look at the comments we received, but I will tell you that in our record, when that is released with the Transport Rule as it is released next week, you will see that the regulated community, as well as the State, did not miss that sentence; they actually understood the implications. They provided significant comment and we will make our decision on the basis of that comment and sound data that we have available to understand the significant contribution that the State of Texas might make to their downwind States.

Senator BARRASSO. This EPA appears to be rushing to issue as many new rules and regulations as it possibly can, and it seems to be making critical mistakes in the analysis that can have huge impacts on the recovery of our economy. For example, the Texas Commission on Environmental Quality points to a number of careless errors in an analysis EPA did provide in support of its Clean Air Transport Rule, hypothetical assumption about future Texas emissions. At a plant EPA predicted to have an increase of more than 15,000 tons per year in SOx, there actually is an enforceable cap on emissions that reduces the emissions by more than 27,000 tons per year.

In light of these and other discrepancies, how is it that the EPA's last minute addition of Texas is not just arbitrary and capricious when EPA attempts to base a regulatory program not on what is actually happening, but on flawed data and mistake-ridden predictions about future emission levels that don't exist?

Ms. MCCARTHY. Senator, I would say that we do not believe that we are rushing to judgment or we will produce a rule that is based on inaccurate data. We are not rushing; it has been 20 years delay in terms of bringing this rule in addressing the issues associated with interState pollution. We are not rushing to judgment. We will take a look at the data that is available to us and we will make a sound decision, and that decision will be based on quality data and sound analysis.

Senator BARRASSO. So do you dispute the Texas Commission on Environmental Quality's pointing out the careless errors in the analysis that the EPA provided in support of your rule in terms of assumptions that were made?

Ms. MCCARTHY. I do believe that every rule is a challenge in terms of getting every number right, and we take that challenge very seriously. There was an error that was pointed out to us very early in the process on one computation that had to do with a small amount of information that had no impact in terms of the outcome of the decisionmaking for the regulated community. We took public responsibility for that. We put a notice out; we correct that very early in the process. I do not believe that there are substantive data problems in either the proposal, and we certainly, though, will look at the comments we have received, and if TCEQ and others point out issues, we will look at those thoroughly and address them in the final rule.

Senator BARRASSO. Well, thank you for admitting that there was an error in that, and I know that Texas is going to go on to continue to address this with you, as will I.

You have often referenced EPA's report of the benefits and costs of the Clean Air Act from 1990 to 2020 as justification for saying that today's EPA regulations will provide trillions in benefits. In congressional testimony before the House Energy and Commerce Committee on March 24th, you stated, EPA can't monetize all of the benefits from recent Clean Air Act regulations. To the extent we can, however, you said, study indicates that the Clean Air Act will provide $2 trillion in benefits in 2020, over $30 in benefits for every dollar spent.

The EPA relies upon their own cost-benefit analysis of the Clean Air Act when they cite this up to $2 trillion in annual economic benefits by 2020. Are you saying that in the absence of air quality regulations, that gross domestic product in 2020 would then only be $18 trillion because of the $2 trillion that you are taking under account?

Ms. MCCARTHY. Actually, EPA doesn't believe that gross domestic product is an appropriate measure of the economic success of the rules that we are doing and the cost-benefits. The only thing I would tell you, Senator, is that the study that I was quoting on cost effectiveness of our rules and the kind of benefits we bring to the American public versus cost was actually a study that was first envisioned by the legislature.

It was heavily peer-reviewed by a body that the legislature asked us to create that has expert panels. It went through rigorous peer review process. So when you say it was an EPA cost-benefit study, everything that underpinned that rule went through scientific rigorous review by professionals in the field and it is done in accordance with the best economic practices. So while we filled the data in, it was done absolutely with everybody's view and peer review, and we believe it is one of the most credible analytical reports that you will see today in terms of the cost-benefits of any rulemaking.

Senator BARRASSO. Clearly, the Country is very concerned about the economy, 9.1 percent unemployment, getting that under control, getting people back to work, and we need to understand the true costs and benefits of the regulations coming out of your agency, but other agencies as well. So could you please explain why the total benefits in EPA's study are based on public surveys of how much people are willing to pay to avoid slightly greater health risks and not more focused on economic considerations such as the GDP and employment, which I think is key to getting people back to work?

Ms. MCCARTHY. I think that the idea of using GDP as a measure of economic success is fine in the economic world, but we actually put a value on human life. There needs to be people out there working in jobs, getting to their jobs, sending their kids to school. What we have done in the IRAs, in the analysis of the Mercury and Air Toxics Rule is done a specific cost-benefit analysis that is not based on a survey or projections of what someone might want to pay, but actual economic analysis of the costs and benefits associated with this rule; and when we do that we see costs of $10.9 billion in 2015, as opposed to benefits of $59 billion to $140 billion. That is a credible cost-benefit analysis.

Senator BARRASSO. Mr. Chair, my time has expired. I have some additional questions that perhaps I could submit those for the record and get a written response.

Senator CARPER. OK. Sounds great.

Senator BARRASSO. Thank you, Mr. Chairman.

Senator CARPER. Thanks so much.

I think that's it. Senator Merkley, anything else?

Senator MERKLEY. Thank you, Mr. Chair. Since I used only about 30 seconds of my time, I would like to do one followup here, which is just to observe that recently a bipartisan delegation of Senators took a trip to China, 10 of us led by the majority leader, and what I was tremendously struck by was that virtually every conversation we had with a diplomat had some element of the health impact of the air in China on his or her family. We had one diplomat talking about the fact that——

Senator CARPER. Chinese diplomats?

Senator MERKLEY. American diplomats.

Senator CARPER. OK.

Senator MERKLEY. American diplomats saying that they could only keep their family in the country for 2 years because of the advice of their physicians about the impact on the long-term health of their family. We had another diplomat saying that the children were all affected by China cough, which apparently is the term now used by the persistent cough, as if you were a smoker.

And it took me by back, in a way, to being in Southern California, in LA, before the full impact to clean up the air in LA, where your eyes stung and your lungs were irritated, and I just want to say that I think Americans understand that there is just an enormous value to our quality of life to take pollutants out of the air, and thus the widespread support for clean air. It does have value and we appreciate having an agency that is recognizing that the environment and the economy are not at war together; they can be in partnership to make a better America for all.

Senator CARPER. Thanks for that statement.

Ms. McCarthy, you are now excused. Thank you so much. Our colleagues have 2 weeks to ask some additional questions, and if someone does I would just ask that you respond promptly. But, again, we appreciate your presence, your testimony, your responses, and your service. We look forward to seeing you soon. Thank you.

Ms. MCCARTHY. Thank you.

Senator CARPER. As our next panel comes to the witness table, I would observe I think we know, we realize we need electricity in this Country. Quality of life, if we didn't have it, frankly, it wouldn't be very good. And we generate electricity from a lot of different sources. Close to 50 percent of our electricity comes from coal, another 20 percent comes from nuclear. I would like to personally see that go up a little bit. We generate a fair amount of electricity from natural gas-fired power plants and I think we are going to see that continue to rise. Some comes from hydro. My hope is we will be generating some electricity off the East Coast here, including off Rehoboth Beach in a couple of years, about 12 miles out. But we all realize that we need electricity.

We also need to be fair in the way that we generate that electricity, so that States that are generating electricity for their own use, for their own people, for their own businesses don't disadvantage other States that happen to be downwind from them. And that is what we are trying to get out and trying to do it in a way that is cost-effective and uses some common sense.

Someone who is pretty good at using common sense is our lead off witness here, and his name is Collin O'Mara. He has been our Secretary of Natural Resources and Environmental Protection for the State of Delaware, starting, I think, he was nominated by Jack Markell, Governor, when Jack was, I think, about 29 years old. I kid with him back home; if I had half his energy, I would be both president and vice president. This guy is a dynamo and just a great server to the people of Delaware. He is also currently the Chairman of the Ozone Transport Commission and is instrumental in making Delaware a leader in the global clean energy economy.

We have Bryan Shaw. Bryan has been introduced also by John Cornyn, but he is the Chairman of the Texas Commission on Environmental Quality. Welcome, sir. Very nice to see you, Dr. Shaw.

Sue Tierney, Managing Principal of the Analysis Group, Incorporated. Ms. Tierney, great to see you. Thank you for coming.

Barbara Walz, who is the Senior Vice President for Policy and Environment, Tri-State Generation and Transmission Incorporated. Welcome.

And Mr. David Carpenter, who is the Director of the Institute of Health and Environment at the State University of New York at Albany.

Our oldest son, Christopher, is going to go to work for a company that actually makes, part of their business model is to take the concept of the cleanest, most affordable form of energy is the energy we never use, a company called Honeywell. Actually, a big part of their business model is based on that and our son is going to be going to work next Monday, a week from Monday in that part of the business and is going to be living and working out of Albany, so you will have a new neighbor there, a new Carper to join the Carpenters. Welcome, Dr. Carpenter.

Secretary, I want to welcome you and thank you for your time. Your testimony will be made part of the record and we will ask you to use about 5 minutes to do that. I understand you are under the gun to get to your next engagement back in Delaware, so we will try to be mindful of your time. Please proceed.

STATEMENT OF COLLIN P. O'MARA, SECRETARY, DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL FOR THE STATE OF DELAWARE

Mr. O'Mara. Chairman Carper, Ranking Member Barrasso, thank you very much for the opportunity to be with you today. Before I testify to the broader transport challenges, I would first like to address the Utilities Toxics Rule just briefly.

We believe the toxics rule proposed by EPA on May 3d to set emissions standards for hazardous air pollution from coal and oil electrical utility steam generating units will produce significant and cost-effective public health benefits. We also believe this is well overdue. The proposed emission standard is much superior to the existing CAMR trading approach.

Since 2009, Delaware has actually already required that every coal-fired unit in the State, you control its mercury emissions by at least 90 percent. We develop our standards in consultation with industry. Our experience has demonstrates that controlling toxic metals like mercury on a unit-by-unit basis is both cost-effective and technologically feasible. While there are several coal units in Delaware that are scheduled for shutdown, existing units ranging from 90 megawatts to 400 megawatts in size were all able to achieve these reductions in a cost-effective and timely manner. We adopted this approach because we do not believe it is proper to allow emissions trading or averaging of neurotoxins when cost-effective and site-specific reductions are possible.

A strong complimentary Transport Rule would make the incremental lift necessary to meet the goals and requirements of the Toxics Rule much smaller. For example, acid gas emissions are eliminated with any level of scrubbing technology for sulfur dioxide, so we can actually achieve multi-pollutant reductions at the same time if we do these policies in tandem.

Regarding the Transport Rule itself, as Senator Carper said earlier, Delaware's air quality challenge is caused by both local emissions and emissions from upwind sources. In Delaware, as much as 90 percent, that is 90 percent of our non-attainment problem comes from out-of-State sources; and, as a result, we face significant public health consequences, including higher than average rates of respiratory illness, lung disease, and asthma.

Primarily due to this pollution transported into our State, all of Delaware is currently designated as non-attainment, or out of compliance with the 8-hour ozone National Ambient Air Quality Standards, the NAAQS. Our most populace county, New Castle County, up north, is designated non-attainment for particulate matter as well.

Up to now, Delaware has been able to offset the inadequate mitigation of transport by requiring additional control of its local sources above and beyond most States. Delaware has adopted numerous measures to meet the legal requirements of the Clean Air Act, including multi-pollutant regulations, transportation conformity, multiple rounds of control technology reviews, plus a myriad of other regional measures like paint regulations, gas cans, and other consumer products. And these have resulted in significant mitigation of Delaware's local emissions and improvements in air quality.

However, as we put together our plans to meet the new 75 parts per billions or lower standards, there are virtually no cost-effective pollution reduction options remaining for the State. In fact, our modeling shows, as you said earlier, that we could eliminate all stationary sources in the State of Delaware and still not achieve attainment under the likely new standard.

For this reason, it is absolutely imperative that we find ways to reduce pollution from upwind sources that continue to impair air quality in Delaware and much of the ozone transport region. While ozone transport regions, as Senator Cardin said, of adopting most of the stringent and costly standards in the Nation and significantly reduced emissions, highly cost-effective emission reductions in upwind States continue to be possible even after the implementation of some reductions through the NOx and CAIR. Delaware and other downwind States have been a force to adopt more costly control measures to a large extent because of the Federal failure to fully mitigate transport.

This inequity in regulatory requirements has significant consequences and has contributed to relatively higher regional energy costs for OTR States compared to our counterparts, while EGUs and upwind States remain able to offer lower cost electricity which is generated by virtually unregulated units. This imbalance allows the upwind States to enjoy a competitive advantage for economic development while the downwind States are suffering more and more every day. This is particularly true in the recruitment and retention of manufacturing firms, which are heavily dependent on energy pricing. The downwind States are forced to deal with the consequences, both economically and environmentally, of irresponsible activities upwind.

In addition, these new upwind industries themselves are actually contributing to the problem even more because they are subject to less stringent standards, which means more direct and indirect emissions will then come our way. This is a double whammy, so to speak, for the OTR States because they face both a competitive disadvantage economically from the increased energy costs in our States compared to the other States, as well as greater public health costs and environmental costs due to the lack of regulatory equity. We must address this growing inequity through this new Transport Rule; it is a matter of fundamental fairness.

For Delaware to have any chance of shedding its status as the tailpipe of the Nation and reducing local pollution levels to comply with the new NAAQS, as required by the Clean Air Act legally, we will need a strong Federal commitment to achieving significant reductions through a much more comprehensive and timely approach than any of the rules that have been proposed or adopted to date. This is a regional challenge and, as such, requires a truly regional solution. We propose a handful of steps that will significantly improve air quality, and we would be happy to discuss those during the question session.

I thank you for this opportunity to testify before you. I thank you, Senator Carper, for your incredible leadership on air quality issues and look forward to working with you to make sure to make sure that all Delawareans can breathe deeply and have good public health outcomes. Thank you, sir.

[The prepared statement of Mr. O'Mara follows:]

TESTIMONY OF COLLIN O'MARA BEFORE THE U.S. SENATE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS SUBCOMMITTEE ON CLEAN AIR AND NUCLEAR SAFETY ON REVIEW OF EPA REGULATIONS REPLACING THE CLEAN AIR INTERSTATE RULE (CAIR) AND THE CLEAN AIR MERCURY RULE (CAMR)

Chairman Carper, Ranking Member Barrasso, and Members of the Subcommittee, my name is Collin O'Mara and I serve as Delaware's Secretary of the Environment and Energy. I also serve as the Chairman of the Ozone Transport Commission (OTC). On behalf of Delaware Governor Jack Markell, I would like to thank you for the opportunity to discuss the Environmental Protection Agency's efforts to replace the vacated Clean Air Mercury Rule (CAMR) and the remanded Clean Air Interstate Rule (CAIR).

Clean Air Mercury Rule

Before I testify on the broader transport challenges, I would like to briefly address the utilities toxic rule. Since 2009, Delaware has required that every coal-fired unit control its mercury emissions by 90 percent. Our experience has demonstrated that controlling toxic metals like mercury is both cost-effective and technologically feasible. Our requirements were developed in consultation with industry and all in-state sources are meeting the standard on a unit by unit basis. While several coal units in Delaware are scheduled for shutdown, existing units ranging from 90 MW to 400 MW in size all were able to achieve these reductions in a cost-effective and timely manner. We adopted this approach because we do not believe that it is proper to allow emissions trading or averaging of neurotoxins when cost-effective and site specific reductions are possible. In addition, acid gas emissions are eliminated with any level of scrubbing technology for sulfur dioxide (SO_2), providing an added benefit. This rule will produce significant and cost-effective public health benefits and we believe it is long overdue.

Clean Air Interstate Rule (CAIR)

Like other States along the East Coast, Delaware's air quality challenges are caused by both local emissions and the transport of emissions from upwind sources to downwind areas. In Delaware, as much as ninety percent of our non-attainment problem comes from out-of-state sources and we face significant public health consequences as a result (areas throughout the entire Ozone Transport Region (OTR) face similar challenges). Primarily due to this pollution transported into our state, all of Delaware is currently designated as nonattainment, or out of compliance, with regard to the 8-hour Ozone National Ambient Air Quality Standards (NAAQS), and our most populated county, New Castle County, is designated nonattainment for the particulate matter ($PM_{2.5}$) NAAQS.

This is not to suggest that Delaware's air quality has not significantly improved over the past twenty years. Since the adoption of the 1990 Clean Air Act Amendments, Delaware has benefitted from significant reductions in local emissions and limited improvements from upwind sources. In fact, Delaware's air quality currently meets all of the NAAQS except for the 2008 75 parts per billion (ppb) ozone standard, which EPA has determined is not protective of public health and will finalize next month its proposed rule to set a new ozone NAAQS at a level between 60 and 70 ppb. Also, a new $PM_{2.5}$ standard is anticipated to be proposed later this year. The full mitigation of upwind transport is paramount as we move forward to address these new health based air quality standards. In order to explain why this is, I will discuss some of the more significant steps that the EPA has taken to partially mitigate transport, identify where we are now relative to the mitigation of transport, and suggest concepts that should be embraced as we move forward.

Steps that Partially Mitigated Transport

One of the first steps that the EPA took to mitigate transport was the NOx SIP Call. EPA reported that after the NOx SIP Call was implemented in 2004 NOx emissions from the power industry in the eastern U.S. decreased by about 50%. This reduction in transport, plus a large reduction in local emissions attributable to Delaware's unique and OTC based initiatives was enough to enable Delaware and most other OTC states to attain the 0.12 part per million (ppm) 1-hour ozone NAAQS in 2005. While this may sound good, and it was, Delaware was soon designated non-attainment for the 1997 0.08 ppm ozone and the 15 ug/m3 particulate matter standards.

EPA's next major effort to partially mitigate transport was the adoption of CAIR. CAIR was a step forward in that it helped with both our ozone and PM problems because it addressed both NOx and SO_2 emissions. However, the EPA CAIR rule had two major problems – it would not require reductions on a schedule needed necessary to help with our ozone plans and it would again only partially mitigate transport. Both of these issues proved significant.

Regarding the timing of the reductions, under the CAA, air quality is judged against a standard based on three years of data. Compliance was required with the 0.08 ppm standards in 2009—based upon 2007, 2008, and 2009 monitoring data. EPA proposed CAIR with a first phase of reductions to take effect beginning 2010. Obviously this was not helpful to non-attainment states with 2009 attainment dates, like Delaware. EPA did finalize CAIR so that the first round of reduction occurred in 2009, which enabled states like Delaware to rely on the reductions in our attainment plans. But, because reductions did not occur in 2007 or 2008, our monitors did not reach attainment for the 2007-2009 period and an extension to our attainment date was needed.

As Delaware began putting its attainment plans together for the 1997 standards, it became clear, based upon analysis of air quality modeling and data from our ambient monitoring network, that transport would remain a significant problem even after implementation of both the NOx SIP Call and CAIR. In addition, while CAIR did help reduce regional NOx and SO_2 emissions, CAIR's trading scheme was projected to create a local problem in Delaware—EPA models predicted that under CAIR emissions in Delaware would actually increase. In response, Delaware was not able to adopt CAIR. Instead, Delaware was forced to develop its own multi-pollutant regulation that required BACT level controls for NOx, SO_2 and mercury from each of its power plants and peaking units and filed a Section 126 petition with the EPA.

Local measures, plus the partial mitigation of transport from CAIR, enabled Delaware's air quality to meet the 0.08 ppm ozone and the 15 ug/m3 PM standards in 2011. However, Delaware continues to have significant air quality problems—EPA's 0.08 ppm ozone standard is not sufficiently protective of public health and a lower 75 ppb standard was adopted, which is now itself being reconsidered at a 60 to 70 ppb level because it is also not sufficiently protective of public health.

Where We Are Today

Today, the vast majority of Delaware's air quality problems are caused by transported emissions, as much as ninety percent. In the past, Delaware has been able to offset the partial mitigation of transport by requiring additional control of its sources. Measures including Delaware's multi-pollutant regulation, transportation conformity, multiple rounds of control technology reviews, plus a myriad of other regional measures, like regulating paints, gas cans and other consumer products, have resulted in significant mitigation of Delaware's local emission on its air quality. In addition, Delaware has facilitated the fuel switching of numerous coal units to natural gas, hundreds of millions of dollars of controls on the largest coal unit in the state, and the shutdown of three older coal units. As we put our plans together to meet the 75 ppb or lower standard, there are very few cost-effective pollution reduction options remaining for Delaware to further reduce emissions from stationary sources. In fact, our modeling shows that Delaware could eliminate all pollution from in-state stationary sources and still not achieve attainment.

At the same time, pollution from upwind sources continues to impair air quality in Delaware and much of the OTR, specifically contributing to unhealthy concentrations of ozone and fine particulate matter. Any new standard must address this fundamental unfairness within the current regulatory regime. While OTR states have adopted some of the most stringent standards in the nation and significantly reduced in-state emissions as required to achieve attainment, cost-effective emission reductions in upwind states continue to be possible even after the implementation of the NOx SIP Call and CAIR. The unwillingness to require greater emission reductions upwind has forced Delaware to adopt more costly control measures which to a large extent were necessary only because the EPA failed to fully mitigate transport. This inequity in regulatory requirements has contributed to relatively higher regional energy costs, while EGUs in upwind states remain able to offer lower-cost electricity generated by virtually unregulated units. This imbalance allows upwind states to enjoy a competitive advantage for economic development, particularly in the recruitment and retention of manufacturing firms, while the downwind states are forced to deal with the consequences economically and environmentally. This is a double-whammy, so to speak, for the OTR states in that they face both a competitive disadvantage economically from increased energy costs as well as greater public health and environmental impacts due to the lack of regulatory equity. We must address this growing inequity as a matter of fundamental fairness.

As part of this conversation, it is critical to note that the public health costs from not requiring air quality improvements upwind are both significant and quantifiable. A National Academy of Science 2009 report stated that the health costs caused by air pollution from 406 coal fired plants in 2005 were more than $62 billion annually. More specifically in Delaware, a report developed as part of the Integrated Resource Planning docket by the local electrical utility, demonstrated that the movement towards lower-emission fossil fuel generation and additional energy efficiency measures and deployment of renewable resources could provide up to $4.3 billion of health benefits to the state annually. Greater regulatory consistency with a focus on transport will produce significant public health benefits regionally and nationally.

EPA's most recent rule to mitigate transport is the CAIR replacement, the Clean Air Transport Rule. This rule was proposed last year, and is projected to be finalized next month. Like CAIR, the transport rule is an improvement, mainly in the regulation of SO_2 in that it sets specific emission caps for each state that requires each covered state to substantially reduce their SO_2 emissions. Unfortunately, the proposed rule was, by design, not intended to fully mitigate transport, and is no better than CAIR relative to ozone. This is because it is only targeted to reduce ozone levels to the old 1997 0.08 ppm level. The transport proposal, by design, did not require reductions to fully mitigate transport, nor even to mitigate emission relative to the current, but still inadequate, 2008 75 ppb NAAQS. Since we know that EPA's CAIR replacement will not sufficiently mitigate transport, we must pursue other means to achieve NOx reductions which are critical remedy the unhealthy ozone levels experienced in Delaware. EPA has signaled that they agree with this finding and explained in the transport rule proposal that it plans to issue a second transport rule to require the additional needed regional reductions in NOx emissions. Delaware needs Transport Rule 2 to approach transport inequities more comprehensively that previous efforts with the goal of fully mitigating the impact of upwind states on those downwind.

A better approach to reducing transport

The new health based ozone and $PM_{2.5}$ standards and the EPA regulations that replace CAMR and CAIR, especially Transport Rule 2, are all critical to Delaware. The impact of local emission on Delaware's air quality has already been aggressively mitigated, while the transport of ozone, PM, and their precursors from sources in upwind states have only been mitigated partially. Transport is by far the predominate cause of Delaware's ozone and $PM_{2.5}$ problems and must be fully mitigated through substantial, cost-effective, emission reductions in upwind states to achieve local air quality standards. To achieve air quality attainment in Delaware and other OTR states, we propose that there are a few concepts that should be embraced:

- Fundamental Economic Fairness: Delaware and other OTR states have been implementing significant emission controls for more than 35 years. Additional reductions are difficult to identify and implement, and are very costly. By comparison, many heavily polluting units in upwind states remain uncontrolled, despite their significant impact on Delaware's air quality. The upwind emission reductions are also much more cost effective, as demonstrated by NOx credits in Delaware recently trading for more than $10,000 per ton whereas upwind controls are possible at one quarter of this cost.

- Broader non-attainment areas: One way to ensure transport is mitigated is for the EPA to establish broad non-attainment area boundaries. This would reinforce the science-based and wide-accepted fact that ozone non-attainment is a regional, rather than a local, problem." We strongly encourage that all counties that are contributing to this regional problem, and thus are necessary to solve it, be included in any new rules. This change would give more states a vested interest in solving this regional problem. We must also level the playing field by setting the consistent baseline of control requirements of Subpart 2 of Title I, Part D of the CAA within the region, which include New Source Review (NSR), vehicle Inspection and Maintenance, and highly cost effective Reasonably Available Control Technology (RACT) requirements. This improvement would effectively compliment national and regional rules that address regional transport, like the EPA transport rule (Delaware made this request through its ozone attainment and boundary recommendation filed in 2009).

- Performance Standards: Sole reliance on a regional cap-and-trade program to mitigate transport will not likely address some of the most impactful emission contributions that afflict the various non-attainment areas. Some minimum performance standards are necessary to ensure that improvements are made throughout the entire non-attainment region, rather than driving investment in only a few areas. EPA performance standards should include multi-pollutant measures where possible, which have been demonstrated to be both technologically feasible and cost-effective in Delaware. In addition, both daily and annual limits should be pursued to reduce unhealthy ozone concentrations. For example, peaking units that have very low annual emissions, but high daily emissions must be controlled.

- Opportunities beyond EGUs: EPA measures to mitigate transport to date have been limited to electric generating units (EGUs). In addition to the power industry, EPA should include other source categories, particularly NOx and VOC emission sources that can be controlled with RACT measures. These should include a wide range of industrial, commercial, and residential sources (both stationary point sources and stationary non-point/area sources). Collectively, those RACT controls have provided the OTR states significant and cost-effective NOx and VOC reductions and have contributed significantly to the OTR's success in improving ambient air quality.

- Alignment of timelines: EPA measures to fully mitigate transport must be implemented according to timelines that ensure the benefits of these transport rules will be sufficiently used in the states' SIP planning and attainment efforts.

- Focus on transportation sector opportunities: EPA has made great strides in recent years to improve vehicle fleet fuel economy as a means towards reducing air emissions. In addition, fifteen states, including Delaware, have adopted low-emission vehicle standards. Additional focus on fuel economy, deployment of alternative fuel vehicles, and adoption of cleaner petroleum fuels, all present significant opportunities to reduce air pollution.

In summary, Delaware and the other OTR states face significant air quality challenges, most of which are caused by factors outside of their jurisdiction. The current EPA approach is inadequate to mitigate the impact of these upwind emissions on downwind states and must be strengthened. Current regulatory deficiencies have required Delaware to impose emission requirements on its in-state sources that far exceed those required for sources in upwind states, despite their adverse impact on our air quality. We are at a point where little more can be done in Delaware, even though we are facing new air quality standards that we must to achieve under the CAA, and more importantly, are obligated to achieve to protect public health. Yet Delaware does not have the authority to regulate the emissions that are causing these problems because they are outside of the boundaries of the State of Delaware or related to the transportation sector. For Delaware to have any chance of shedding its label as the "tailpipe of the nation" and reducing local ozone levels to comply with a new ozone NAAQS as required by CAA, we will need a strong Federal commitment to achieving significant regional NOx reductions through a much more comprehensive and timely approach than any rules that have been proposed or adopted to date. This is a regional challenge and as such requires a true regional solution.

I thank you for the opportunity to discuss potential solutions to Delaware's significant air quality challenges. I have also enclosed copies of our 126 petition, Delaware's attainment and boundary recommendation, and Delaware's comments on Transport Rule 1 for the record. I look forward to your questions.

Senator CARPER. Thanks so much for your leadership. It is great to be your partner. Thank you.

Dr. Shaw, welcome. We are delighted to see you. What part of Texas are you from?

Mr. SHAW. I live in Austin at this time. I grew up in West Texas, though.

STATEMENT OF CHAIRMAN BRYAN W. SHAW, PH.D., TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Mr. SHAW. Thank you, Chairman Carper and Ranking Member Barrasso. I think he stepped out, but thank you for the opportunity to address this Committee and to address not only what are some very important issues from the standpoint of the particular actions in place today that we are discussing, but also to shine some light on a larger issue of some issues or some actions that EPA has taken that have been focused largely on Texas, but have implications broadly.

EPA has tended to move away from following clearly the direction that the Federal Clean Air Act and direction from Congress would require in making certain that the relationship between State and Federal Government, that is, the State regulatory agencies and the Federal EPA, follows what is envisioned by the Clean Air Act and also to adhere to the directives that this Congress has directed through the Clean Air Act, the Clean Water Act, and others. And specifically I want to address what has happened with regard to the Clean Air Transport Rule and looking at the issues there.

One, I want to say that my State, fortunately, is not one that contributes to those challenges in the northeast. We certainly do, and I certainly do support the fact that the Clean Air Act requires States to address through the rulemaking process to address inter-State transport, and that failing States' ability to avoid impact on those non-attainment areas outside of their State, that it would be appropriate for this action to take place through the action such as the Clean Air Transport Rule.

However, the problems that I want to discuss largely today discuss with the errors in the methodology that was used, the errors in the data that were used to come to the conclusions, and the unintended impacts that these will foretell.

I started talking about some of the EPA actions and their impact on Texas. I want to briefly discuss that in light of what happened with the Flexible Permit Program in Texas. EPA has denied that permitting program after about 13 years of existence, and in that process EPA failed to follow the Clean Air Act requirements and, in fact, they were forced by a lawsuit to make a decision. They are supposed to make decisions within 18 months of a SIP approval or SIP submittal, and did not do that until 13 years later, when forced to do so. And in their Clean Air Federal Register notice having to designate why the Flexible Permit Program failed to meet Federal requirements, they were forced to address what those deficiencies were. We followed up and addressed and expressed that those deficiencies were unfounded.

We also agreed to an expedited rulemaking process to clarify and ensure that not only did we meet those requirements, but that we would continue to meet them going forward; and, unfortunately, EPA changed their view of the relationship between State and Federal Government and indicated that they were not interested in pursuing that further, that even though they no longer were arguing verbally that it didn't meet Federal requirements, they then generated another requirement that they failed to provide notice for and, more importantly, indicated that they don't like or don't want the Flexible Permit Program going forward, which I think signaled a dramatic change in the State-Federal relations, which impacts these other regulations as well.

We have seen similar failure to allow meaningful public input through the greenhouse gas tailoring rule, whereby EPA unilaterally changed the definition in the tailoring rule such that States no longer had the opportunity to address their State implementation plans for greenhouse gases, but, instead, EPA dictated that greenhouse gases would be regulated January 2011.

With regard to how that applies to the Clean Air Transport Rule and the MACT Standards, EPA has again avoided public participation, meaningful public participation, and I think the key there is the definition. While EPA asserts that they did indeed ask for comment on inclusion of Texas a Group 2 State, having failed to include information about the adequacy of SO2 budgets, the new unit set-asides, and the variability limits, those key components to what a regulation would mean, brings into serious question how meaningful that input was, on top of the fact that there were several errors associated with the data collection and the analysis that suggests that there are other potential errors and that the benefits and requirements they highlight are unlikely to occur.

Not only do they have that, but if you do look at the data they have, EPA's own data suggests and indicate that Texas would not have an impact from PM 2.5 because of the existing levels of emissions. In fact, only if you follow through with their scenario of what could and might happen if the cost of high sulfur coal decreases and low sulfur coal increases, and Texas somehow able to change the infrastructure necessary, go through the rigorous permitting process, which is very demanding and a great daunting task, that somehow we might increase our SO2 emissions. There were other discussions earlier that there are emissions reductions that are in place that EPA failed to take into account. So there is great concern that not only are those benefits not there, but that the data to lead to those conclusions were wrong and based on a faulty scenario.

As you look at the EPA's efforts to include the ozone deployment of the Clean Air Transport Rule as well, the only State that is tied to Texas is New Orleans, Baton Rouge, Louisiana, and the data shows that Texas does not exceed the levels—I will finish up, sir—and also that area is no longer non-attainment. So it appears that there is no justification for continuing inclusion of Texas in either the PM2.5 or ozone portion of the Clean Air Transport Rule.

And I am happy to answer questions if time permits.

[The prepared statement of Mr. Shaw follows:]

Testimony of Dr. Bryan W. Shaw, Chairman of the Texas Commission on Environmental Quality

As Chairman of the Texas Commission on Environmental Quality (TCEQ), I appreciate the opportunity to provide testimony and information to the U.S. Senate Subcommittee on Clean Air and Nuclear Safety at the hearing entitled "Oversight: Review of EPA Regulations Replacing the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR)". This is a critical topic regarding the effect of recent EPA actions on the environment, electric reliability, and commerce throughout our nation, as well as in the state of Texas. As I have said before, a strong economy does not need to come at the cost the environment and Texas has shown that to be true.

The TCEQ regularly weighs matters that effect the environment and economy. We value regulation that addresses real environmental risks while being based on sound science and compliance with state and federal statutes. In every case where Texas disagrees with EPA's action, it is because EPA's action is not consistent with these principles.

NESHAP/MACT Utility Rule

On May 3, 2011, the United States Environmental Protection Agency (EPA) proposed a National Emission Standards for Hazardous Air Pollutants (NESHAP) rule for coal- and oil-fired electric utility steam generating units (EGU) under Section 112 of the federal Clean Air Act (FCAA). The proposed NESHAP rule (40 Code of Federal Regulations (CFR) Part 63, Subpart UUUUU) would establish maximum achievable control technology (MACT) emission limits for certain hazardous air pollutants (HAP) for new and existing EGUs rated equal to or greater than 25 megawatts (MW) that are fired with coal, liquid oil, or solid oil-derived (e.g., petroleum coke or petcoke) fuels as well as integrated gasification combined cycle (IGCC) EGUs. The proposed rule would also establish work practice standards, monitoring, testing, recordkeeping, and other requirements for affected EGUs.

The TCEQ staff's evaluation indicates that the proposed rule is not feasible for coal-fired EGUs. Based on the current state of technology, the TCEQ anticipates that no new coal-fired EGUs will be built in the country if the EPA adopts the rule as proposed and that many existing coal-fired EGUs will be shut down. The TCEQ is very concerned about the severe adverse impacts that the EPA's proposed NESHAP rule and other EPA regulatory initiatives targeting EGUs may have on the reliability of the electrical power system in Texas and consequently, adverse effects on other sectors of the economy and public.

The TCEQ considers many aspects of the proposed NESHAP rule to be technologically infeasible for coal-fired EGUs, in particular the proposed emission limits for new units. We believe that this regulation as proposed will effectively end construction of new coal-fired EGUs in the country for the foreseeable future. The EPA's own Integrated Planning Model (IPM) results support this assessment. Such an outcome is contrary to Section 112 of the FCAA. Section 112(d)(3) is clear that new unit emission limits must be achievable. While the EPA has certain discretion on setting MACT emission limits for new units under Section 112(d), the EPA cannot establish emission limits that cannot be achieved with available technology. TCEQ believes that the proposed NESHAP will severely impact the reliability of the electrical power system despite the EPA's claims to the contrary. It is not reasonable for the EPA to claim there is no risk to electrical power reliability from this proposed NESHAP when the proposed rule would prohibit new construction of coal-fired EGUs, a component of the current electrical power fleet that is vital to the stability of electrical power system and meeting the energy needs of the citizens of Texas.

A recent study conducted by NERA Economic Consulting (NERA) estimates that the number of coal unit retirements resulting from the proposed utility NESHAP rule and the Clean Air Transport Rule (CATR) will be substantially greater than that projected by the EPA. The EPA estimates the coal unit retirements from these two regulatory initiatives to total approximately 11 gigawatts (GW) in capacity. NERA estimates that approximately 48 GW of coal units will retire as a result of these two rules, almost five times greater than the EPA's estimate.

Just last week, the Brattle Group, a consulting firm of economic and financial experts, presented an analysis to the Public Utility Commission of Texas (PUC) that estimated coal-fired shutdowns within the Electric Reliability Council of Texas (ERCOT) resulting from these regulations would range between 5 GW and 12 GW, depending on power prices. These estimates may still be low because Brattle's assessment did not predict the shutdown announced earlier in the week of CPS San Antonio's 841 MW Deeley plant, nor does it include non-ERCOT, such as the possible retirement of AEP's Welsh 2 plant, mentioned at the same PUC meeting.

We question whether it is appropriate for EPA to establish energy policy for the country. In multiple parts of the preamble of the proposed NESHAP rule, the EPA mentions encouraging or achieving cleaner fuels for EGUs. FCAA Section 112 may not be used as a mechanism for EPA to drive national energy policy. In particular, Section 112(d)(3) specifies that the EPA must determine MACT limits based on the best controlled "similar" source. The EPA is ignoring this provision of Section 112(d)(3) when it seeks to establish emission limits that are "fuel neutral," as the EPA describes, to encourage and achieve cleaner fuel-burning EGUs and thereby affect the fuel mix of the nation's electrical energy fleet. The EPA is, in fact, setting energy policy for the country by undertaking regulatory initiatives that the EPA admits result in a complete shift in new electrical power production capacity.

Furthermore, the utility NESHAP rule is littered with multiple, significant errors that EPA made in the MACT analysis for the proposed mercury limits on coal-fired EGUs as well as other aspects of the proposed rule. More specifically, the EPA's quality assurance and quality control procedures for the data handling and processing for this regulatory effort are clearly flawed. In addition to the major errors made by the EPA in converting reported mercury emissions that was recently publicized, the TCEQ has found other errors and discrepancies in the data used in the MACT analysis. The EPA should review all the data relied upon for this regulatory effort to assure the public and the regulated community that the EPA is using correct data and calculations for this MACT analysis.

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Next, the EPA's economic analysis is misleading and misrepresents the actual costs and benefits of the proposed rule. EPA has relied on co-benefits associated with emission reductions of non-HAP pollutants to justify the exorbitant cost of this regulation.

Basic cost information, such as expected capital and operating costs for expected control equipment, is not provided to support the EPA's estimated $10.9 billion annualized social cost estimate. Furthermore, as the EPA admits (76 FR 24979), nearly all of the monetized benefits are the result of assumed co-benefits from emission reductions from particulate matter (PM) and other non-HAP pollutants. The EPA projects the annualized private compliance costs to the power industry in 2015 to be $10.9 billion (in 2007 dollars) and approximately $10 billion in both 2020 and 2030. EPA values the benefits of reduced mercury at $5 million or less. It nevertheless projects total benefits of between $59 billion to $140 billion (using a 3% discount rate) and $53 billion to $130 billion (using a 7% discount rate) due almost entirely to expected co-benefits from reductions in mortality related to emissions of particulate matter with aerodynamic diameter of 2.5 micrometers or less ($PM_{2.5}$) assuming a 55% reduction in sulfur dioxide (SO_2) emissions beyond the base case, including the proposed Clean Air Transport Rule (CATR). Given that SO_2 is not a HAP and is already regulated under other FCAA requirements, the EPA should re-analyze its benefit analysis to only account for benefits associated with the specific HAP to be regulated. While the EPA includes assumed co-benefits in their monetized benefits analysis, the costs of co-impacts that would affect the social cost estimates do not appear to be included, such as job losses outside the EGU sector (RIA, Table 9-6, page 9-15) and costs to third parties due to higher energy prices and decreased reliability. The EPA's approach to their cost-benefit analysis is misrepresentative and biased toward the benefit.

If EPA confined its cost benefit analysis to only the specific HAP that poses a hazard to public health after imposition of the requirements of the FCAA, any health benefits would be insubstantial compared to the cost of regulation. In the EPA's 2005 reconsideration of the 2000 finding, they take the reasonable position that "it may not be "appropriate" to regulate remaining utility HAP emissions if the health benefits expected as the result of such regulation are marginal and the cost of such regulation is significant and therefore substantially outweighs the benefits." Regulation cannot be "appropriate" where, as here, its direct benefits associated with reductions in HAP emissions are substantially outweighed by its costs.

Toxicological Evaluation

<u>Mercury</u>
EPA misrepresents the risks associated with mercury emissions and ignores the negligible effects of this rule on risk reduction.

The TCEQ acknowledges public concerns with methylmercury in the environment, but U.S. EGUs do not contribute significantly to the current potential risk to public health resulting from all natural and anthropogenic sources of mercury worldwide. Any mercury reductions resulting from the proposed utility NESHAP rule would result in an insignificant change in the overall risk from mercury from all sources. Thus, the

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potential risk from other sources of mercury would still remain and the timeframe for reductions, if any, in levels of mercury in fish tissue is impossible to predict. The production of methylmercury in water bodies is complex and influenced by a number of factors in addition to deposition, including land use, water and sediment chemistry.

The EPA takes the position that it must consider EGU mercury emissions in conjunction with other sources of mercury deposition, and that if all sources of mercury deposition pose a hazard to public health or the environment that EPA is then required to regulate mercury from EGU (and by extension, all utility HAP) emissions under Section 112. This position leads to extreme conservatism where even a de minimis amount of emissions would have to be regulated. The EPA's analysis for mercury states that "if U.S. EGU impacts to watersheds included in the risk assessment were zeroed-out, for a significant majority of those watersheds, total exposure would still exceed (and in most cases, significantly exceed) the RfD."

The legislative history of Section 112(n)(1)(A) indicates that Congress viewed mercury emissions as a global phenomenon and that an uncontrollable amount of risk from mercury would remain regardless of the extent to which U.S. utilities are controlled (Legislative History of the Clean Air Act Amendments of 1990, at 872 (Oct. 27, 1990) (statement of Sen. Durenberger)). In the EPA's 2000 finding, it was estimated that about 60% of total mercury deposited in the U.S. came from U.S. anthropogenic air emission sources. The EPA further said that of that 60%, approximately 30% was from U.S. EGU mercury emissions, which translated into about 18% of total deposition in the U.S. at that time. In 2000, the EPA also estimated that EGU mercury emissions would increase from 46 tons in 1990 to over 60 tons in 2010. Contrary to EPA's 2000 scenario, U.S. mercury emissions did not increase, but actually decreased to less than 30 tons a year. It is apparent that these estimates were inaccurate. In the preamble to the current utility NESHAP proposal, it is stated that EGUs, on average, contribute about 2% of total mercury deposition across the country. These discrepancies raise serious questions as to the basis of the 2000 finding.

Multiple sources of data suggest the EPA has overestimated the effects of methylmercury at low concentrations in its estimate of the reference dose (RfD). It is likely the RfD is too conservative, as it is based on a study from the Faroe Islands where the types of seafood consumed (whale meat and blubber) were very different from the typical consumption of seafood in other countries and contained other contaminants, including PCBs. Other organizations tasked with deriving a safe exposure level, including ATSDR, have used other available and more relevant studies involving methylmercury exposure in fish consumers to evaluate risk and have developed levels higher than the EPA's RfD.

Furthermore, the TCEQ is unaware of any documented adverse human health effects in the U.S. resulting from fish containing methylmercury. This runs contrary to the EPA's assertion that fish ingestion leading to blood mercury levels above the RfD constitute a public health hazard. The TCEQ's position is supported by recent data from the Centers for Disease Control's (CDC) National Health and Nutrition Examination Survey (NHANES), 2003-2008. The CDC's survey shows the mean blood mercury level for pregnant women is 0.69 micrograms per liter (μg/L) (far below the EPA's RfD for methylmercury of 5.8 μg/L in blood). Furthermore, all blood mercury levels of 8,373 participants aged one year and older in the U.S. who took part in NHANES during 2003–2004 were below 33 μg/L, with an average blood mercury level of 0.797 μg/L and a 95th percentile blood mercury level of 4.90 μg/L. Although some individuals did have blood mercury levels greater than the RfD, none had blood mercury levels above the effects level (58 μg/L) associated with an increased proportion of abnormal scores on the Boston Naming Test for children exposed in utero.

A Texas-specific study conducted in 2004 by Texas Department of State Health Services (DSHS) determined that even when subsistence fishers are eating fish from Caddo Lake with elevated methylmercury, women of child-bearing years did not have blood mercury levels greater than the RfD. Thus, the connection between methylmercury in fish and adverse health effects in the U.S. is not fully understood and could involve other factors. For example, the protective effects of fatty acids and selenium in fish consumed by populations that eat large amounts of fish were not taken into account in the EPA's assessment. Because of the uncertainties involved in using the RfD and the lack of evidence that reductions in mercury emissions would provide any widespread reduction in concentrations of methylmercury in fish, the EPA should instead focus efforts on those regulations that would have a measurable and real public health benefit to the U.S. population.

<u>Non-mercury HAPs</u>

The EPA's rationale for determining that it is appropriate and necessary to regulate non-mercury HAPs is contrary to its 2000 finding, is scientifically unsound, arbitrary, and neither appropriate nor necessary.

The EPA incorrectly states that it made an appropriate and necessary finding for non-mercury HAP in 2000. The EPA did not, in fact, find that non-mercury HAP posed a public health risk in 2000 and the additional analysis performed for the utility NESHAP rule does not support such a finding for non-mercury HAP today.

The EPA repeatedly makes the claim that the volume of HAPs emitted by EGUs demonstrates that it is appropriate and necessary to control non-mercury HAPs through this rule. However, Congress' direction to the EPA under Section 112(n)(1)(A) of the FCAA requires EPA to regulate utilities *only if* the EPA finds that utility emissions pose a hazard to public health after imposition of the requirements of the FCAA. Based on the EPA's own inhalation risk assessment and the EPA's own admission in the proposed rule, public health risks are well within acceptable ranges for all non-mercury HAPs. Regulation is therefore not "appropriate."

The EPA defends its appropriate and necessary determination for acid gases with unsupported and untested conclusions that acid gas emissions from EGUs aggravate acidification of ecosystems. However, Section 112(n)(1)(A), which is the basis for listing EGUs, only speaks to hazards to public health after imposition of the requirements of the FCAA as a basis for such listing. Since, for example, the maximum chronic impacts of hydrogen chloride (HCl) emissions noted in the case study were less than 10% of the reference concentration developed by the EPA, it is apparent that HCl emissions from EGUs do not pose a hazard to public health.

Furthermore, the EPA calculated emission factors for hydrofluoric acid were omitted from the case study risk assessment and, therefore, little can be deduced about the potential for public health hazard. Basing regulation of acid gases on ecosystem effects, especially effects that are not supported with adequate technical justification, is not supported under Section 112(n)(1)(A).

Finally, both acid gases and PM are regulated through other programs of the FCAA. As discussed in other TCEQ comments, regulation is therefore not "necessary."

Technological feasibility, MACT floor analysis, and proposed emission limits

The EPA's MACT floor analysis for existing lignite coal-fired EGU subcategory (designed to burn coal with a caloric value less than 8,300 Btu/lb and a height-to-depth ratio of 3.82 or greater) is flawed and does not include the minimum number of units required by Section 112(d)(3)(A).

The MACT floor analysis for mercury emissions from new and existing EGUs designed to burn lignite (coal having a calorific value of less than 8,300 Btu/lb in a unit with a furnace height-to-depth ratio of 3.82 or greater) only considered the emissions of two facilities. For existing sources, the MACT floor cannot be less stringent than the average emission limitation achieved by the best-performing 12 percent of existing sources for source categories with 30 or more sources, or the best-performing 5 sources for source categories with fewer than 30 sources. In the document National Emission Standards for Hazardous Air Pollutants (NESHAP) Maximum Achievable Control Technology (MACT) Floor Analysis for Coal- and Oil-fired Electric Utility Steam Generating Units – REVISED, dated May 18, 2011, the EPA states that the subcategory of new and existing EGUs designed to burn a coal having a calorific value of less than 8,300 Btu/lb in a unit with a furnace height-to-depth ratio of 3.82 consists of less than 30 units. As such, a minimum of five sources should have been used in developing the MACT floor per Section 112(d)(3)(A). The EPA's revised mercury MACT analysis spreadsheet indicates that the EPA had emissions data on 11 units within this subcategory, six of which are located within Texas. Emissions data on more than five units were available to the EPA for this subcategory, and the EPA has provided no justification for their deviation from the requirements of Section 112(d)(3)(A). Furthermore, the EPA is only using a single run from each of the two units selected for the existing unit MACT floor that gives the lowest possible result and thereby ignores test data that would raise the average emission result. This is compounded by the fact that the EPA is using the overall deviation from all the runs from the units to adjust the average. It is not statistically valid to apply a deviation to an average result when the deviation is determined from a larger population than the average. The EPA must apply the deviation from all the runs to the average result of all the runs.

In other words, EPA has cherry-picked data, using different approaches for establishing various MACT floor limits, some of which are highly questionable from a scientific and a common-sense perspective. In some cases, a single test run is used to set the emission limits. In other cases, the EPA has established the emission limit using test runs where the results were below the method detection limits by arbitrarily multiplying the detection limit by three.

Multiple and drastically different approaches have been used to select the emissions data for establishing various MACT floor limits. In some MACT floor analyses, the EPA uses the average of three test runs from the unit selected for the new unit MACT floor. In other analyses, the EPA uses the lowest run of three test runs. In at least one case, the EPA MACT floor analyses spreadsheet indicates that the mean of multiple runs is used, when in reality the cell formula for the mean uses the average of a single cell representing the lowest test run with no explanation given. Such variability in the data selection process without explanation renders any decision premised on such data technically specious and arbitrarily skewed. The EPA should be using a consistent approach to selecting the data for establishing the MACT floors and provide a detailed explanation of their approach. Any deviation from the process must be justified and explained clearly so the public has the opportunity to comment. In addition, relying on isolated test runs to establish regulatory emission limits when additional data is available is questionable and technically unsound. The EPA should be making maximum use of the data available rather than arbitrarily excluding valid test data.

The speciated non-mercury metal HAPs limits are derived piece-meal from eight different coal-fired EGUs with different fuels (lignite, bituminous, and subituminous fuels) and different designs (conventional boilers and fluidized bed-fired), and these limits are not feasible based on the data that the EPA relied upon to perform the MACT analysis. None of the units that EPA used to develop the non-mercury metal HAP limits for new units actually meet all the limits.

Emission limits during startup, shutdown, and malfunctions

EPA is revising provisions that address startup shutdown malfunction provisions such as those mentioned previously. This is a result of a 2008 court case involving the exemption in the general provisions of 40 Code of Federal Regulations Part 63 that exempted sources from complying with NESHAP emission standards during start-up, shutdown, and malfunctions. The EPA has been revising various NESHAP rules in response to the court mandate since last year. The EPA's approach has varied from rule to rule. However, for the utility NESHAP rule, EGUs would be required to meet the same emission rates established for "normal operation" as they would during start-up, shutdown, and malfunction. As the EPA has proposed this rule, these changes create a scenario where compliant operation is simply not possible.

Compliance schedules

The EPA is inappropriately relying on states to provide a one-year extension to the compliance time allowed rather than delay finalization of the NESHAP rule. States are encouraged to begin working with utility companies early to assess which sites may need extension; however, the EPA has provided no clear guidance on how states should handle such extensions. Inconsistency in how states handle requests for extensions could create localized grid reliability issues and possible interstate conflicts for EGUs that service multiple states.

The TCEQ disagrees with the EPA's assessment that retrofitting existing facilities to meet the proposed NESHAP is achievable. Support information in EPA's proposed NESHAP includes an Assessment of Retrofits for the Air Toxics Rule. Specifically, the EPA estimates in Table 1 of its Assessment that 146 gigawatts (GW) worth of fabric filter baghouses will have to be constructed. This translates to approximately 300 to 400 fabric filters baghouses, depending upon the size of units retrofitted, in a three year period or four year period including the one extension. EPA also estimates additional scrubbers, selective catalytic reduction (SCR) systems, and carbon injection systems would need to be built. EPA's Assessment of Retrofits for the Air Toxics Rule does not factor-in construction required by the EPA's Clean Air Transport Rule that requires additional scrubbers, SCRs, and particulate controls be added at power plants. **Such large scale retrofit initiatives to any single industry have never before been mandated and implemented in a three to four year period.** EPA's assessment also does not take into consideration permitting and building production facilities to provide activated carbon, trona[1], and other pollution control technologies that will be used by utilities to comply with the proposed NESHAP standards.

The TCEQ also objects to the EPA's stated belief (76 FR 25054) that the ability of permitting authorities to grant one-year extensions along with other compliance tools ensures the emissions reductions will occur "while safeguarding completely against any risk of adverse impacts on the electricity system reliability."

Electric grid reliability

EPA asserts that the federal government will take action to ensure grid reliability, but provides no specifics for the states and the public on which to comment.

Instead of specifics, EPA makes several vague statements about steps to ensure a reliable and reasonably-priced supply of electricity, particularly regarding localized issues, without providing any details concerning what authority would be exercised. In one discussion (76 FR 24979), the EPA indicates that the federal government will work with companies to ensure a reliable and reasonably priced supply of electricity. In a separate discussion (76 FR 24979), the EPA states that it believes it has the ability to work with companies making good faith efforts to comply with the standards so that consumers in those areas are not adversely affected. The EPA should be clear about the steps it may take and what the federal government might do to provide all parties the opportunity to comment on the appropriateness and legality of such contemplated actions by EPA and other agencies of the federal government.

The TCEQ does not agree with the EPA's assumptions in its electrical power system reliability assessment or the EPA's assertions that there is sufficient surplus reserve margin in the electric generating capacity to avoid grid reliability problems from EGU

[1] Trona is a material used in dry sorbent injection for acid gas control.

retirements that the EPA anticipates. This disagreement is based on the fact that the EPA's assumptions and conclusions are not consistent with recent information from ERCOT. Reliability of the electrical power system cannot be evaluated in the grossly simplistic way that the EPA proposes. Instead of relying on EPA's IPM to assess reliability, the EPA must reevaluate the impact of their regulatory initiatives on the nation's electric grid reliability based on regional program information such as ERCOT's.

The EPA maintains that grid reliability should not be impacted. However, in the EPA's RIA and in their white paper entitled "Resource Adequacy and Reliability in the IPM Projects for the Toxics Rule," the EPA makes several incorrect assumptions. The EPA indicates that IPM only applies limitations on transmission capability between regions and assumes unlimited transmission capability within a model region (e.g., power generated anywhere in ERCOT can be transmitted anywhere in ERCOT); and this is not correct. Electrical power cannot be transmitted in an unlimited manner from anywhere to anywhere within a region as large as ERCOT. Fundamental principles of electrical transmission such as thermal restrictions on transmission lines and voltage stability restrict the distance that power can transmitted over power lines within the region. Further, the EPA indicates that IPM reduced the operational capacity from excess reserves that are assumed unnecessary in order to meet the approximately 10 GW of retired capacity that is expected from the proposed rule. However, it is unclear how or whether the EPA has accounted for units classified as Reliability-Must-Run (RMR) facilities that are necessary to ensure grid reliability in specific local areas.

The 25% surplus reserve margin that EPA cites as an indication that projected retirements will not affect reliability is a national average and is not consistent with ERCOT's local projections for Texas. While information from ERCOT indicates that the ERCOT region currently has 15.9% of surplus reserve (ERCOT 2010 Capacity, Demand, and Reserve Report, Winter Update, January 6, 2011), ERCOT expects that this surplus reserve will drop to 13.6% by 2017 even without impacts of the EPA's regulatory initiatives, which is slightly less than ERCOT's target reserve of 13.75%. A recent ERCOT report entitled "Review of the Potential Impacts of Proposed Environmental Regulations on the ERCOT System," was issued on May 11, 2011 and focused mainly on gas unit replacement. The report found that without additional replacement generation, the reserve margins could be reduced to less than 2% by 2015 as a direct result of the EPA's regulatory initiatives on EGUs. This estimated drop in reserve margins is significant, given the ERCOT report did not have time to fully analyze/consider the impacts of the NESHAP rule on coal-fired powered plants, which may jeopardize reserve margins to an even greater extent. The report also anticipates localized impacts on transmission reliability in the Houston and Dallas-Fort Worth areas. Copies of these ERCOT reports are available at: http://www.ercot.com/news/presentations/.

If the EPA adopts the utility NESHAP rule as proposed, the TCEQ expects severe consequences to the reliability of the Texas electrical power system in the short term for the existing coal-fired EGU fleet and in the ability of the utility industry to meet the future energy demands of Texas. The consequences of the risks to the electrical power system are beyond the EPA's superficial analysis of the potential impact to the cost of electricity. In the public health and environmental evaluation for this proposed NESHAP, the EPA must consider the consequences to public health and the environment resulting from unavailable, unreliable, or unaffordable electricity.

Even considering the EPA's attempt to correct the major errors it made in calculating mercury emissions, the TCEQ does not consider the proposed NESHAP rule to be feasible for the coal-fired EGU fleet in Texas. **If the proposed NESHAP is adopted without major changes from the proposal, the TCEQ is very concerned that the reliability of the Texas electrical power system will be severely compromised.** The TCEQ anticipates that the ultimate outcome of the proposed NESHAP rule may be rolling blackouts and cost-prohibitive electricity. Without reliable and affordable electricity, sensitive populations may be at risk during severe winter weather or hot summer temperatures. Additionally, failure of the electrical power system for even a short duration has adverse environmental consequences as well. A power failure on wide geographic scale results in the operation of tens of thousands of back-up emergency generators, which are typically diesel-fired engines. Rather than pointing to vague steps that the EPA and the federal government may take to address electrical power system reliability problems after they occur, the EPA should be considering the consequences of their actions on the electrical power system and building an adequate safety margin into their rulemaking efforts to ensure that the electrical power system of the country is protected.

Clean Air Transport Rule

The EPA proposed a rule, known as the Clean Air Transport Rule (CATR), requiring 31 states and the District of Columbia to reduce power plant emissions that contribute to ozone and fine particle pollution in other states. The proposal is intended to help eastern states meet Federal Clean Air Act (FCAA) obligations regarding interstate transport of air pollution for the 1997 eight-hour ozone and fine particulate matter ($PM_{2.5}$) and 2006 $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS). The proposal would require reductions in the ozone season (May through September) of nitrogen oxides (NO_X) emissions that cross state lines for states under the ozone requirements and reductions in annual sulfur dioxide (SO_2) and NO_X for states under the $PM_{2.5}$ requirements. The proposed rule includes Texas only under the ozone season requirements, but sought comment on the inclusion of Texas as a "Group 2 SO2 Trading" state. To assure emissions reductions, the EPA is proposing to immediately implement federal implementation plans (FIP) for each of the states covered by the rule; and states may subsequently choose to develop State Implementation Plan (SIP) revisions to replace the federal plan.

This rule represents another case where EPA has inadequately rationalized the need for a complex regulatory scheme to solve a non-existent problem. TCEQ is focused on the possibility that EPA may include Texas for transport that influences $PM_{2.5}$ concentrations, which would be illegal and unjustified. However, even if Texas was removed from the $PM_{2.5}$ transport portion of CATR, there are still significant errors and technical flaws associated with Texas' inclusion in the ozone transport portion.

Particulate Matter Transport

The CATR, as proposed in August 2010 by EPA, did not include Texas in the annual program for nitrogen oxides (NO_X) and SO_2 emission reductions to address $PM_{2.5}$ transport. In fact, EPA's proposed rule acknowledges that Texas power plant emissions, as modeled by EPA, do not exceed the threshold for inclusion in the $PM_{2.5}$ portion of CATR. Within this rule, EPA has developed a questionable scenario under which CATR would make higher sulfur coals more cost effective than lower sulfur fuels. The cascading result of this price point is that Texas' SO_2 emissions would cause an air quality effect exceeding the threshold. EPA uses this scenario to take comment on whether Texas should be included in the program as a "group 2" state. EPA conjectures,

> [I]**f** . . . price effects took place and **if** the rule is finalized as proposed, sources in states not covered by the proposed rule **might** choose to use higher sulfur coals. Increased uses of such coals **could** thus increase SO_2 emissions in those states. [2] (Emphasis added.)

In no part of this 256 page rule (or its subsequent three notices) does the EPA provide Texas with proposed emission limits, allocation budgets, or specify proposed requirements for Texas. If the EPA wanted to consider including Texas in the SO_2 Group 2 Trading Program because of assumed future concerns with $PM_{2.5}$, then the EPA should have proposed the rule in that manner or proposed an alternative that included Texas so that affected entities would be given adequate notice to comment. Further, any inclusion of Texas in the $PM_{2.5}$ program should be proposed with an adequate rationale and evidence supporting the need for this inclusion. If the final rule does include Texas in the SO_2 Group 2 Trading Program at adoption of this rulemaking, potentially regulated entities would have been denied the opportunity to comment on the adequacy of the SO_2 budgets, new unit set-aside, and variability limits.

Procedurally, if Texas is included in the final rule, the rule would satisfy neither the Administrative Procedure Act nor the President's Executive Order calling for adequate notice and participation from affected parties. EPA's disregard of these procedural, legal obligations portends more litigation and judiciary involvement in their final resolution at significant cost to the public.

Technically speaking, this rule is another example of EPA fabricating a scenario in order to justify its actions. Consider that the inclusion of Texas relies first on the assumption from EPA's models that the cost of low sulfur coal will increase and the cost of high sulfur coal will decrease. The second assumption on which their argument relies is the notion that switching coal types is not only logistically possible, but legally possible. All coal-fired power plants in Texas operate under state and federal permits that have explicit restrictions on fuel types as well as SO_2 emissions limits. Significant emission increases resulting from fuel switching would require permit modifications that would certainly require an assessment and authorization of additional SO_2 emissions. EPA ignores or disregards the significant effort that would be required to obtain this type of

[2] See 75 FR 45284.

large-scale permit modification, especially in light of the recent revision of the SO_2 NAAQS. In the TCEQ's comments on the proposed rule, staff also identified significant mischaracterizations of the current fuel mix for at least four facilities in Texas. This type of flawed logic and inaccurate technical analysis should not be used as a basis for any rule, much less under the hypothetical scenario that EPA devises as a means to include Texas in this program.

Economic effects
This rule, if we correctly understand its final form, puts at risk the economic future of power generation and those dependent on affordable electricity in Texas. It also places vulnerable citizens at a significant health and safety risk. For example, elderly and low-income populations whose health and welfare are dependent on reliable energy would face significant adverse consequences resulting from such a rule. While air pollution regulation is certainly necessary to protect the health of our citizens, the elements of this regulation pertaining to Texas' SO_2 emissions are not necessary for public health protection, and only result in negative consequences.

The President's Executive Order calls for "careful analysis of the likely consequence of regulation, including consideration of underlying science, or alternatives, of costs and benefits and of simplified, harmonized, and flexible methods for achieving regulatory goals." Because the possibility of including Texas was not adequately fleshed out as a part of the rule proposal, EPA certainly did not adequately assess the impacts of this rule on Texas, nor did Texas have the opportunity to comment on the possible consequences.

If coal-fired power plants in Texas are faced with these significant emission reductions, decisions regarding the operation of these plants may result in considerable reductions in the safety margins of power operation of this state. Said differently, the strong disincentives for operation of coal-fired power plants would undoubtedly result in significant cost to energy consumers including the possible shutdown of base-load units. Manufacturing and production plants also rely on affordable energy to continue or even expand operation. This economic "ripple effect" has certainly not been fully considered by EPA. Again, because the proposal did not contain any specifics on how Texas would be regulated under this scheme, we are not able to fully evaluate the significant effects, such as shutdowns, of this rule.

The resulting effect of increased cost of power and power shortages, such as rolling blackouts, would not only jeopardize the personal and economic health of Texas citizens, but also endanger lives. Whether it is cost-prohibitive to operate electricity or electricity is simply unavailable, vulnerable populations, such as the elderly and low-income, will be put at risk if EPA pursues inappropriate regulation of SO_2 in Texas under the guise of $PM_{2.5}$ transport.

Ozone Transport

In order to establish the need to regulate Texas under the ozone transport portion of CATR, the EPA takes a baseline emission inventory, conducts photochemical modeling and assesses the impacts on other nonattainment areas to determine that controls are necessary in Texas. EPA's technical analysis is flawed at each step of this process.

First, the emissions included in the modeling do not account for significant NO_x emissions reduction in the Houston-Galveston-Brazoria area. In fact, EPA assumes that at least 19,000 tons per year of NO_x emissions would be present in a future year that have been already reduced under the Texas SIP. Second, and not surprisingly because the inventory is flawed, EPA's model over-predicts in both Texas and in East Baton Rouge, Louisiana, which is the one area to which Texas is linked in the proposed rule. Of particular concern is the fact that Baton Rouge is currently monitoring well below the 1997 eight-hour ozone standard, with a 2009 design value of 80 parts per billion (ppb), and the EPA has just finalized a determination of the attainment for the area under the 1997 eight-hour ozone standard. Therefore, we question EPA's rationale in deciding to include Texas given EPA has acknowledged that the Baton Rouge area is no longer a nonattainment area.

In its comments provided to EPA on this rule, TCEQ identified inconsistencies in design value calculation methods, underestimated cost per ton for NO_x reductions, and inaccurate information in its planning model for numerous facilities in Texas. Therefore, EPA's technical analysis used to support Texas' inclusion in the Transport Rule ozone-season NO_x trading program relies on incomplete data, flawed modeling, and modeling calculations contrary to actual monitored values. The EPA is misleading the public and itself about the quality of information used to form the cornerstone of the Transport Rule.

SIP Gap

Under the FCAA section 110(k), the EPA has a non-discretionary duty to take final action on revisions to State Implementation Plan (SIP) submittals made by states within 18 months of submittal. EPA's failure to act on TCEQ's SIP submittals has caused a significant "SIP Gap" in Texas. While there is an expected delay between TCEQ's rule adoption and EPA approval/disapproval, numerous years of delay has caused and continues to cause uncertainty for the regulated community and the general public who want to understand environmental laws that govern their business or the industry in their community.

To legally force EPA to act on some of TCEQ's SIP submittals, a lawsuit was filed by Business Coalition for Clean Air. In 2009, EPA entered into a settlement agreement that binds EPA to act on 24 SIP submittals by specific time frames. These SIP submittals appear to be taking priority over all other submittals, even though TCEQ continues to submit rule revisions that address EPA concerns, such as public participation – however, an expeditious and meaningful review by EPA has yet to occur.

As of June 21, 2011, EPA has exceeded its federally-mandated 18 month timeframe for about 40 SIP submittals from the TCEQ. The oldest of these is from December 1989 (although those rules have been subsequently amended).

Testimony of Dr. Bryan W. Shaw, Chairman of the Texas Commission on Environmental Quality

On August 9, 2010, I sent a letter to EPA expressing my concern that EPA and TCEQ have drifted away from the agreement made at an October 8, 2009 meeting that we would work together on fixing rules. This agreement was subsequently confirmed in a TCEQ letter dated October 23, 2009. EPA's response continued to find additional faults with TCEQ's air permitting program and made little effort to get back to the agreement to review and fix TCEQ rules.

Most recently - in what appears to be motivated by one of the looming settlement agreement deadlines - EPA sent a letter requesting the TCEQ withdraw its SIP submittal of the previous oil and gas standard permit and permit by rule. In lieu of EPA thoroughly reviewing the rules to specify any deficiencies, TCEQ was requested to withdraw its rules 16 years after they were submitted to EPA.

Perhaps EPA's most well-known and most detrimental (to-date) failure to act is their inaction on the Texas Flexible permit program, which EPA delayed by almost thirteen years. During this thirteen year period, over one hundred flexible permits were issued to major Texas businesses such as refineries, petrochemical companies, and power plants. At the same time, TCEQ and EPA continued to discuss the flexible permit program, which EPA did not formally disapprove in a September 2009 Federal Register Notice, when EPA clearly identifying perceived deficiencies. To continue working on solutions to EPA's identified issues with the flexible permits, TCEQ revised its rules. Regardless, all the flexible permit holders have been required to tell EPA how they plan to transition to a different type of permit or be subject to EPA enforcement.

TCEQ, the citizens of Texas, and the regulated community need certainty from EPA to ensure the continued protection of public health and the environment in conjunction with sustainable economic growth.

Conclusion

EPA's practice of prosing technically flawed and inadequate rules, in combination with a lack of action where needed within the SIP process, leaves all sectors of industry in a reactive mode. How could any facility plan for economic growth where tomorrow's regulatory demands are in constant flux?

Unfortunately, the energy sector is a captive recipient of EPA's attention. Unlike other industry, the possibility of moving to a more industry-friendly regulatory environmental outside of the US is not an option. These regulations have vast economic effects, not limited to the direct energy generation costs that will be felt by every energy consumer, but also through the indirect effects of higher costs associated with the cost of manufacturing goods, and regrettably, the potential for lost jobs, as all sectors struggle to absorb these costs.

Businesses need certainty to drive our economy and thrive. Businesses should be subject to reasonable and appropriately protective regulation. For citizens to be protected from harmful pollution, both federal and state governments need to focus their resources on real risks, instead of creating false crises that frighten the public and misuse public resources.

Senator CARPER. Thanks so much, Dr. Shaw.
Ms. Tierney, please proceed.

STATEMENT OF SUE TIERNEY, MANAGING PRINCIPAL, ANALYSIS GROUP, INC.

Ms. TIERNEY. Thank you, Chairman Carper and Ranking Member Barrasso. Thank you very much for this opportunity to come and speak to you. I have looked at these issues for 20 years, during which time I was both a utility commissioner in Massachusetts, a regulator, and Secretary for the Environment, and was an original member of the Ozone Transport Commission.

I thought I would look at the question of whether or not these regulations relating to mercury, air toxics, and sulfur dioxide and nitrogen oxide are achievable so that Americans can have both clean air and public health issues, as well as reliable electricity supplies. And I think very strongly the answer is yes. Six reasons I want to give you today, and they are amplified in my written testimony.

One, the industry has a tremendously successful track record in its mission of providing reliable supply. There are no circumstances under which there is a situation where the utilities have allowed a shutdown of a plant for a reason, including clean air, where there were going to be reliability considerations.

No. 2, the regulations, as we have heard today, are not a surprise; they have been in the works for many, many years, and the technologies that are available in the marketplace are achievable, they are feasible, and many utilities and electric companies have considerable options in what to put in place to comply.

No. 3, many plants are ready to respond. As we have heard, many States have already moved forward on strict mercury regulations. There are court orders in place that bring about the kinds of changes we are likely to see. We have already talked this morning about the regulations that have affected American Electric Power. But, additionally, the CEOs of many of the largest coal-owning fleets indicate that they are ready to comply with these rules, and those include Excel, Duke, Florida Power & Light, Wisconsin Energy, Edison, PP&L, NRG, and TVA, one of the Nation's largest owners of coal plants.

Additionally, the low gas prices that we are enjoying in the United States have not only lowered prices of electricity for American consumers in the last few years, but they are putting pressure on coal plants to retire. We have heard this morning about the number of older, inefficient, and uncontrolled units that operate very rarely, and those are likely to move to retirement.

No. 4, the studies. There have been so many studies in the last year on whether or not this set of regulations are achievable by the industry. Many of those studies were performed prior to the time when EPA had actually issued its proposed regulations. Now that we see that there is more flexibility, the range of pessimistic estimates of retirements are too large. The more reasonable ones indicate that these are manageable impacts.

No. 5, industry and its regulators have a very robust set of tools to respond. The system planning organizations, the grid operators, the transmission organizations do plans. States require utilities in many parts of the Country to do integrated resource plans. The wholesale markets in a third of the Country are very vibrant. We are seeing plants under construction totaling 42 gigawatts as of today. We are seeing plants in advanced states of development and permitting, almost 30 gigawatts on top of that.

So there is a very strong, vibrant marketplace. States are getting prepared. One can avoid some of the costs, as you just said, Mr. Chairman, through energy efficiency, and many of the States with the lowest prices for electricity and heavy reliance on coal actually have the largest opportunity for energy efficiency and saving customer bills.

Finally, there is very clear market evidence that this is doable. I already mentioned that CEOs have been reporting to investments, according to SEC rules that require them to comment truthfully on their ability to comply. AEP and Duke, which are part of the PJM interconnection system in the Midwest and Mid-Atlantic area, have indicated that by 2014 and 2015, when the rules go into effect, they will be ready. And the PJM auction for making sure that they have enough power supply in that time period in the future came forward with many more offers for both energy efficiency, demand response, and new generation that would enable the region to comply adequately.

So I want to say with confidence that these regulations are doable and Americans don't have to choose between clean air and public health on the one hand and affordable electricity and reliable electricity on the other. Thank you.

[The prepared statement of Ms. Tierney follows:]

Summary of Testimony of
Susan F. Tierney, Ph.D.
Managing Principal, Analysis Group, Boston
Before the
U.S. Senate Environment and Public Works Committee
Subcommittee on Clean Air and Nuclear Safety
June 30, 2011

Oversight Hearing:
Review of EPA Regulations Replacing the Clean Air Interstate Rule (CAIR)
and the Clean Air Mercury Rule (CAMR)

Chairman Carper, Ranking Member Barrasso, and members of the Subcommittee:

I appreciate the opportunity to testify on the U. S. Environmental Protection Agency's implementation of various provisions of the Clean Air Act and address the question of whether the newly proposed regulations will adversely affect reliability in the power sector and its ability to serve electricity users in the United States.

Of specific interest to the Subcommittee are impacts of the EPA's proposed "Clean Air Transport Rule" ("CATR"), affecting emissions of sulfur dioxide and nitrogen oxides from fossil-fuel power plants in the Eastern half of the U.S., and the proposed "Mercury and Air Toxics Rule" ("Utility Toxics Rule"), affecting emissions of hazardous air pollutants emitted from most coal- and oil-fired power plants throughout the country. Acting upon court orders, EPA's two new regulations would replace the Clean Air Interstate Rule ("CAIR") and the Clean Air Mercury Rule ("CAMR") and would address the problems of interstate transport of air pollution and the emissions of toxic air pollutants that are damaging to human health.

These are important regulations from an air quality and public health point of view. But are they achievable? Can the nation get both the benefits of lower pollution and improved air quality, while also keeping the lights on? Can the industry respond effectively within the allowable time frames, so that Americans don't have to choose between achievement of the health benefits the Clean Air Act requires and the electric system reliability that underpins the U.S. economy? I strongly believe that the answer to all of these questions is yes.

My testimony offers the following reasons why I answer those questions in the affirmative:

1. The U.S. electric industry has a proven track record of doing what it takes to provide the nation with reliable electricity. Regulated electric utilities, competitive electric companies, grid operators, and regulators have a strong mission orientation, along with regulatory requirements, that together ensure that reliable electricity supply is a priority.
2. By 2011, it is not reasonable to suggest that EPA's CATR and Utility Toxics Rule are a surprise, or that EPA's proposed regulations will require actions that are technically and economically infeasible. These regulations have been in the works for many years. EPA's proposals allow more flexibility in compliance approaches than previously anticipated.

3. Many factors besides these new regulations have encouraged owners of coal-fired power plants to take steps to reduce their air emissions. Many states have already adopted regulations as strict as those proposed by EPA. Some companies with facilities affected by the CATR and Utility Toxics rules are already under court orders to achieve similar outcomes even without the new regulations. And many companies have already taken steps to install appropriate control equipment: in recent months, chief executive officers of some of the most affected utility companies in different parts of the country have told their investors that they are already or will be ready to meet the new EPA air regulations. These facts occur within a context in which low natural gas prices are putting pressure on many of the oldest, least-efficient and uncontrolled coal plants to retire for economic reasons.
4. Much attention has been, and will continue to be, paid to the impacts of the regulations on electric system reliability. Many assessments published in the past year have called attention to potential gaps that could arise in the absence of market, utility and regulators' responses. These studies highlight potential plant retirements under different sets of assumptions, with the more reasonable estimates indicating strongly that the impacts are manageable, as long as industry and its regulators respond in a timely fashion.
5. The industry has various tools to assure that reliability will not be adversely affected. Among the more important tools are: the strong system-planning processes of utility transmission companies and regional transmission organizations (grid operators); the opportunities for companies to obtain power resources through the wholesale power markets that exist in many of the affected parts of the country; the strong least-cost planning processes that exist for utilities in other affected areas; the interest and ability of developers of new power projects to bring new supplies to the market; the fact that state and federal have a strong track record of taking the steps necessary to ensure that the companies they supervise are meeting their obligation to provide reliable electric service; the large reservoirs of untapped cost-effective energy efficiency in affected states that can be mined relatively rapidly and can help ease impacts on consumers' electricity bills; and the statutory tools available to EPA, the Federal Energy Regulatory Commission ("FERC"), the U.S. Department of Energy ("DOE"), and the President to take actions to ensure reliable system conditions when all else fails.
6. Finally, recent market developments provide practical, real-world evidence that the EPA clean air regulations are manageable. Notably, the nation's largest competitive wholesale power market – PJM, serving much of the mid-Atlantic and Midwest regions affected by the EPA regulations – has recently conducted its annual auction to purchase capacity so that it will be available far in advance of need. The PJM auction elicited far more capacity offers from existing and new suppliers than is needed for reliability purposes during the period when EPA's new air rules will go into effect.

For these reasons, I urge the Senate to continue to take interest in this important topic, but to do so with an expectation that the industry will respond innovatively and effectively, and with confidence that Americans can get the benefit of clean air and reliable electricity. This is do-able.

Testimony of
Susan F. Tierney, Ph.D.
Managing Principal, Analysis Group, Boston
Before the
U.S. Senate Environment and Public Works Committee
Subcommittee on Clean Air and Nuclear Safety
June 30, 2011

Oversight Hearing:
Review of EPA Regulations Replacing the Clean Air Interstate Rule (CAIR)
and the Clean Air Mercury Rule (CAMR)

Good morning, Chairman Carper, Ranking Member Barrasso, and Members of the Subcommittee.

My name is Susan Tierney, and I am a Managing Principal at Analysis Group, Inc., an economic consulting firm headquartered in Boston, Massachusetts.

I appreciate the opportunity to testify on whether the U. S. Environmental Protection Agency's proposals to replace the Clean Air Interstate Rule and the Clean Air Mercury Rule will have adverse reliability impacts on the power sector and electricity users in the United States. I do not think that they will. The EPA's proposals to replace those prior rules (as required by the courts) do not put the nation in a position of having to choose between public health and keeping the lights on. Both can be achieved as EPA moves forward to implement the Clean Air Act and as the industry responds creatively, responsibly, and cost-effectively so that Americans can get the benefit of clean air and reliable electricity. This is do-able.

My opinion is based in part on my nearly three decades of public and private-sector experience[1] on electric system economics and regulation, on the economics of air and water policy, and on

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[1] I have been involved in issues related to public utilities, ratemaking and regulation, and energy and environmental economics and policy for over 25 years. During this period, I have worked on electric and gas industry issues as a utility regulator and energy/environmental policy maker, consultant, academic, and expert witness. I have been a consultant and advisor to private energy companies, grid operators, government agencies, large and small energy consumers, environmental organizations, and other organizations on a variety of economic and policy issues in the energy sector. Before becoming a consultant, I held several senior governmental policy positions in state and federal government, having been appointed by elected executives from both political parties. I served as the Assistant Secretary for Policy at the U.S. Department of Energy from early 1993 through summer 1995, having been nominated by President Bill Clinton and confirmed by the U.S. Senate. I held senior positions in the Massachusetts state government as Secretary of Environmental Affairs (1991-1993); Commissioner of the Department of Public Utilities (1988-1991); Executive Director of the Energy Facilities Siting Council (during the mid-1980s); and Senior Economist for the Executive Office of Energy Resources (during the early 1980s). My Ph.D. in regional planning is from Cornell University. I previously taught at the University of California at Irvine, and recently co-taught a course at the Massachusetts Institute of Technology. I currently sit on several corporate and non-profit boards and commissions, including as a director of Evergreen Solar, Inc., and EnerNOC, Inc.; chair of the Advisory Council of the National Renewable Energy Laboratory and the Energy Foundation's Board of Directors; a director of the Clean Air Task Force, World Resources Institute, Clean Air – Cool Planet, and the Alliance to Save Energy; and a member of the

issues at the intersection of electric system planning, system operations, economic and environmental regulation and performance, and system reliability. My opinion also stems from my analyses[2] of various studies of electric reliability that have been carried out in the past year, combined with my knowledge of competitive power markets, the electric industry and its economic and environmental regulation.

I understand that the Subcommittee is particularly interested in the impacts of the EPA's proposed "Clean Air Transport Rule" ("CATR"), which affects emissions of sulfur dioxide ("SO_2") and nitrogen oxides ("NO_X") from fossil-fuel power plants in the Eastern half of the U.S., and the proposed "Mercury and Air Toxics Rule" ("Utility Toxics Rule"), which affects emissions of hazardous air pollutants emitted from most coal- and oil-fired power plants throughout the country. Together, these two proposed regulations would replace the Clean Air Interstate Rule ("CAIR") and the Clean Air Mercury Rule ("CAMR"), as ordered by the courts, in order for the new rules to properly address the problems of interstate transport of air pollution and the emissions of toxic air pollutants that are damaging to human health.

These are important regulations from an air quality and public health point of view. But are they achievable? Will the nation be able to get the benefits of lower air pollution and improved air quality, while also keeping the lights on? Can the industry respond effectively within the allowable time frames, so that Americans don't have to choose between achievement of the health benefits the Clean Air Act requires and the electric system reliability that underpins the functioning of the U.S. economy? I strongly believe that the answer to all of these questions is yes.

NYISO's Environmental Advisory Council. I serve on the Secretary of Energy's Advisory Board, where I am a member of its Gas Subcommittee that is examining shale gas development; and I chair of the Policy Subgroup of the National Petroleum Council's study of the North American natural gas and oil resource base. Previously, I served as co-chair of the National Commission on Energy Policy; a director of the Electric Power Research Institute; chair of the Electricity Innovation Institute's Board of Directors; a member of the Advisory Council of the Independent System Operator – New England; a representative to committees of the North American Electric Reliability Council; a member of the National Academy of Sciences' Committee on Enhancing the Robustness and Resilience of Electrical Transmission and Distribution in the United States to Terrorist Attack; and a member of the U.S. Secretary of Energy's Electric Reliability Task Force.

[2] I have published several analyses on this topic in the last year, some of which are co-authored: M. J. Bradley & Associates, LLC and Analysis Group, *Ensuring a Clean, Modern Electric Generating Fleet while Maintaining Electric System Reliability: Summer Update 2011 Update*, June 2011 (hereafter referred to as "MBJA/Analysis Group Summer Reliability 2011 Update")(available at http://www.analysisgroup.com/uploadedFiles/News_and_Events/News/MJBA_Reliability_Report_Update_Summer2011.pdf); Susan Tierney and Charles Cicchetti, "The Results in Context: A Peer Review of EEI's 'Potential Impacts of Environmental Regulation on the U.S. Generation Fleet,'" May 2011 (available at http://www.analysisgroup.com/article.aspx?id=12468); Susan F. Tierney, "Electric Reliability under New EPA Power Plant Regulations: A Field Guide," January 18, 2011 (available at http://www.wri.org/stories/2011/01/electric-reliability-under-new-epa-power-plant-regulations-field-guide); and M. J. Bradley & Associates, LLC and Analysis Group., *Ensuring a Clean, Modern Electric Generating Fleet while Maintaining Electric System Reliability*, 2010 (hereinafter referred to as "MJBA/Analysis Group 2010 Reliability Analysis") (available at http://www.analysisgroup.com/uploadedFiles/News_and_Events/News/MJBA_Reliability_Report_Update_Summer2011.pdf). Additionally over the past year, I have been invited to speak on this topic at conferences sponsored by the National Association of Regulatory Utility Commissioners, the Bipartisan Policy Center, the Massachusetts Institute of Technology, the National Association of Clean Air Agencies, and other organizations.

I offer the following reasons why I answer those questions in the affirmative, and describe each of these reasons in my testimony below:

1. The U.S. electric industry has a proven track record of doing what it takes to provide reliable power supplies.
2. By 2011, EPA's CATR and Air Toxics are not surprises: they have been anticipated for some time, and now offer more flexible options than previously expected.
3. Many things besides these new regulations have caused owners of affected plants to have taken steps already to modernize their facilities so that their facilities will be ready for the new EPA regulations.
4. Much attention has been, and will continue to be, paid to the impacts of the regulations on electric system reliability. This has helped send signals to affected parties about the need for action. The more reasonable estimates indicate strongly that the impacts are manageable.
5. There are various tools in place in the industry to assure that reliability will not be adversely affected.
6. Finally, recent market developments provide practical evidence that the impacts of the EPA clean air regulations are manageable.

THE INDUSTRY HAS A PROVEN TRACK RECORD ON RELIABILITY ISSUES

The starting point is that the U.S. electric industry has a proven track record of doing what it takes to provide the reliable power supplies. Regulated electric utilities, competitive electric companies, grid operators, and regulators have a strong mission orientation, along with regulatory requirements, which together ensure that reliable electricity supply is a priority.

For many decides, the U.S. electric industry has developed institutions, operating and planning requirements, system plans, operating approaches, emergency response protocols, and billions of dollars of investment to assure reliable electricity supply. The industry is keenly aware that the American economy and standard of living depend upon reliable power supplies to run computers, lighting systems and lamps, clocks and cell phones, TVs and radios, air conditioners and refrigerators, streetlights and traffic signals, clocks, ATMs and security systems, high-precision equipment, agricultural machines, factory production processes, and countless other devices. With some notable exceptions, utilities and other electric companies and their workers, investors, and suppliers, have provided what Americans take for granted and what public officials insist upon: that electricity be reliably available around the clock, with increasing levels of environmental performance to assure worker and community safety and public health.

It is normal practice in the electric industry to look ahead several years to ensure that there will be sufficient supplies available to meet anticipated customer demand under a wide range of contingencies. It can take several years to put in place the new generating equipment, transmission facilities, and other resources needed to ensure adequate supply. The North American Electric Reliability Corporation ("NERC"), for example, works with regional reliability organizations representing all parts of the U.S. to assess conditions in upcoming years. These assessments provide information about future needs to decision makers in utilities, power generation companies, providers of energy efficiency services, equipment manufacturers, investment organizations, fuel suppliers, public agencies, and others. The norm is decision-making under conditions of uncertainty, given that capital commitments must be made years ahead of a power plant going into operation and with only estimates of future fuel prices, demand levels, public policies, and other important factors.

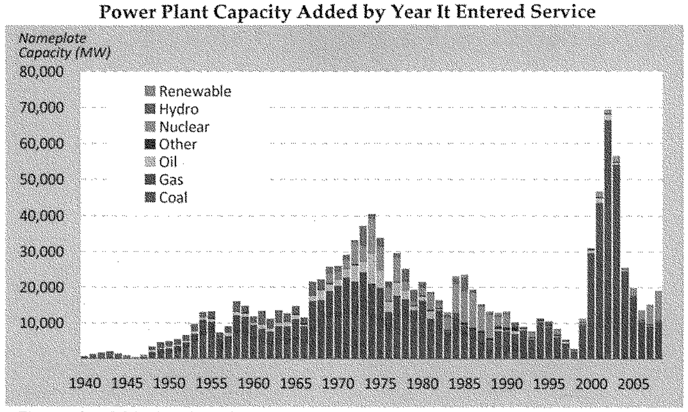
The electric industry has responded well in prior periods (such as the mid-1990s) when Clean Air Act requirements led to investments in new pollution-control equipment and new additions to generating capacity. There were no reliability problems arising from those actions, in spite of concerns raised that there would be equipment shortages and difficulties adding control equipment on so many power plants in a constrained period of time.

Further, developers of power plant have been able to attract sufficient investment and receive approvals to build far more generating capacity than is anticipated to be needed in the next decade: Between 1999 and 2008, for example, in response to a variety of market, regulatory and economic signals, the electric sector added almost 270 gigawatts (GW) of natural gas-fired generating capacity, the equivalent of more than 80 percent of the entire existing U.S. coal fleet.[3] Indeed, in just three years between 2001 and 2003, the electric industry built over 160 GW of new generation,[4] many times the amount that analysts project will retire over the next five years (as I describe further below). Much of this capacity remains underutilized today – a fact that can also assist in managing power plant outages required to install pollution-control systems.

[3] EIA, *Annual Electric Generator Report: Form EIA-860*, 2008. Currently, there are more than 17,000 electric generation units in the United States with a combined nameplate capacity of over 1,030 GW. In 2010, coal-fired generation produced 45 percent of the nation's electricity, followed by natural gas (24 percent) and nuclear (20 percent), with the remaining amount produced through a combination of hydroelectric power, oil, wind and other miscellaneous fuel types. Analysis of monthly and annual power generation data in Energy Information Administration ("EIA"), "Electric Power Generation and Consumption Data by Month and State, 2001 to the Present" (available at http://www.eia.gov/cneaf/electricity/epa/epa_sprdshts_monthly.html).

[4] *Analysis from:* MJBA/Analysis Group 2010 Reliability Analysis, page 9.

Power Plant Capacity Added by Year It Entered Service



Source: Figure 3 from MJBA/Analysis Group 2010 Reliability Analysis, page 9, with figure sourced from *Ceres, et al., Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States, June 2010.*

EPA'S NEW CLEAN AIR RULES HAVE BEEN ANTICIPATED FOR A LONG TIME, AND EPA HAS PROPOSED RELATIVELY FLEXIBLE COMPLIANCE OPTIONS

By 2011, EPA's CATR and Utility Toxics Rule cannot reasonably be viewed as unexpected or a surprise. These regulations have been in the works for several years, with prior incarnations of these regulations (in the form of CAIR and CAMR) having been known to the industry for many years. And there are many reasons why these regulations will introduce less incremental change than has sometimes been reported:

- The proposed CATR would replace EPA's 2005 CAIR, which was initially proposed in December of 2003.[5] In December 2008, the U.S. Court of Appeals for the D.C. Circuit ruled that EPA reconsider its CAIR proposal, but had the rule remain in place until EPA issued a replacement (which EPA believed, at the time, would take two years to do) to address the Clean Air Act's provisions relating to the transport of air pollutant across state boundaries.[6] EPA issued its newly proposed CATR in July 2010.
- Similarly, EPA began its regulatory process relating to mercury emissions in 2003, with the CAMR proposal finalized in March 2005.[7] The Court of Appeals also vacated the CAMR rule in December 2008, and sent it back to the EPA for replacement. EPA issues in newly proposed Utility Toxics rule in March 2011.

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[5] http://www.epa.gov/cair/rule.html

[6] http://www.epa.gov/cair/. Also, EPA, "Factsheet: Proposed Transport Rule Would Reduce Interstate Transport of Ozone and Fine Particle Pollution" (available at http://www.epa.gov/airtransport/pdfs/FactsheetTR7-6-10.pdf).

[7] http://www.epa.gov/oar/mercuryrule/rule.html

- Several elements of the new proposals allow for flexibility in affected companies' responses. For example:
  - The CATR allows intrastate and limited interstate trading of emission allowances for SO_2 and NO_X, consistent with the Clean Air Act:
  - The Utility Toxics rule allows companies with multiple boilers and generating units at a single station to demonstrate compliance through emissions averaging across the units.
  - And EPA has proposed a "work practice standard" (with annual performance testing of units using "good combustion practices") to control emissions of dioxins and furans, rather than setting a numeric emissions limit. Together, these various provisions allow for flexibility in meeting the new regulations.

The bottom line is that these new clean-air requirements have been anticipated for a long time. EPA has proposed relatively flexible compliance options to ensure satisfactory compliance by affected companies, the majority of which have already taken steps to reduce their emissions of regulated air pollutants.

MANY PLANTS ARE ALREADY – OR SOON WILL BE – EQUIPPED WITH NEEDED CONTROLS, AND ECONOMIC CONDITIONS IN FOSSIL FUEL MARKETS FAVOR NATURAL GAS RELATIVE TO MANY EXISTING COAL-FIRED POWER PLANTS

Many factors besides these new clean air regulations have caused owners of affected plants to take steps to modernize their facilities and reduce their air emissions: many states have already adopted regulations ahead of the federal standards; many of the pollution-control technologies have been tested and are in commercial application; some companies (such as AEP) with facilities affected by the CATR and Air Toxics rules, are already under court orders to achieve these outcomes; and many companies have already taken steps to install control appropriate equipments. These conditions occur within a backdrop in which supplies of natural gas have caused gas prices to drop, putting pressure on many of the oldest, least-efficient and uncontrolled coal plants to retire for economic reasons.

- EPA's proposed standards for the Utility Toxics rule – which were based on an extensive data collection effort from companies owning coal plants – are do-able.
  - Several states – including Illinois, Massachusetts, New Jersey, Connecticut, Delaware, and New York – already impose more stringent mercury-emissions limits on coal-fired power plants than have been proposed by EPA.
  - Many of the technologies that are available to satisfy EPA requirements are already in commercially application, with the industry having extensive experience with the installation and operation of these control systems.[8]

[8] MJBA/Analysis Summer 2011 Reliability Update; Northeast States for Coordinated Air Use Management, *Control Technologies to Reduce Conventional and Hazardous Air Pollutants from Coal-Fired Power Plants*, March 31, 2011, page 2.

- The data collected by EPA in the course of developing the replacement to the CAMR indicate that that power plants meeting the proposed standard have a wide variety of pollution-control systems and configurations that are reducing their mercury emissions. Analysis of the plants that submitted stack-test data to EPA indicate that: nearly 60 percent of these plants are currently achieving the proposed mercury-emissions standard; nearly 70 percent currently achieve the proposed emissions standard for particulate matter ("PM") emissions; and 73 percent are currently achieving the proposed hydrogen chloride ("HCl") emissions standard.[9]

- New, lower natural gas prices are already putting economic pressure on coal facilities even in the absence of EPA regulations
  - As mentioned previously, there are many existing and under-utilized gas-fired power plants in the regions that will be affected by the clean air rules. Even taking into account the effects of the post-2008 economic downturn on power plant output, lower gas natural gas prices (and higher coal prices[10]) to utilities and independent power producers have meant that gas-fired power plants increased their output from 20 percent of all power production in the U.S. in 2007, to 24 percent in 2010, while coal-fired generation decreased from 50 percent in 2007 to 45 percent in 2010. Gas-fired generation increased in absolute terms, while coal-fired generation decreased in absolute levels over that period.[11]
  - Expected low natural gas prices also contribute to basic economic conditions that favor replacing much of the older, less efficient coal-fired power plants that lack emissions controls with new gas-fired generating capacity. The figure below shows the extent to which the availability of greater supplies of natural gas has

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[9] This translates to more than 100 units (out of a total of 178) for mercury; more than 119 units (out of a total of 172) for PM emissions; and 158 units (out of a total of 217) for HCl emissions. Note that rather than requiring companies to comply with standards for each individual hazardous air pollutant emitted from coal-fired generating units, however, EPA has proposed the use of "surrogates," simplifying the monitoring and compliance requirements of the rule. For example, PM has been proposed as a surrogate for all non-mercury metal HAPs, including arsenic, cadmium, chromium, and lead. HCl is being used as a surrogate for all acid gas HAPs. No surrogate was used for mercury. MJBA/Analysis Summer 2011 Reliability Update.

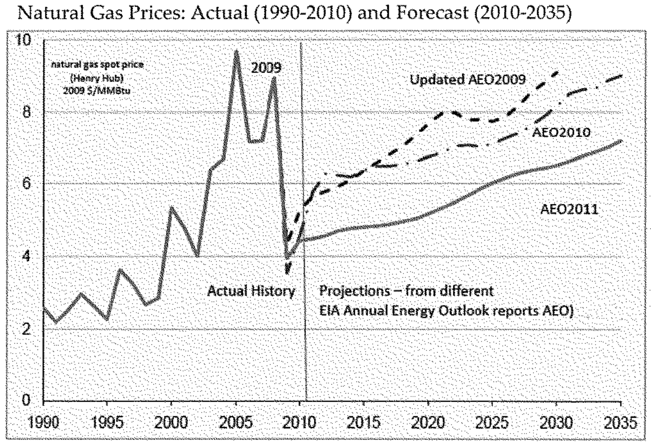
[10] The average prices (in nominal dollars per short ton) of coal to power companies from 2006 through 2010 were:

Average delivered price of coal to:	2006	2007	2008	2009	2010
Electric utilities	$34.26	$36.06	$41.32	$44.47	$45.09
Independent power producers	$33.04	$33.11	$38.98	$39.94	$41.40
Source: William Watson, Nicholas Paduano, Tejasvi Raghuveer and Sundar Thapa, EIA, "U.S. Coal Supply and Demand: 2010 Year in Review," June 1, 2011 (available at http://www.eia.gov/coal/review/pdf/feature10.pdf)					

[11] Analysis of monthly and annual power generation data in EIA, "Electric Power Generation and Consumption Data by Month and State, 2001 to the Present" (available at http://www.eia.gov/cneaf/electricity/epa/epa_sprdshts_monthly.html).

lowered the Energy Information Administration's outlook for natural gas prices over the last three years (from the 2009 forecast to the 2011 forecast).

Natural Gas Prices: Actual (1990-2010) and Forecast (2010-2035)



R. Newall, EIA, The Long-term Outlook for Natural Gas, presentation to the Saudi Arabia – United States Energy Consultation, February 2, 2011

- At least some of the companies that own a substantial amount of the nation's coal-fired generating units have recently reported that they are well positioned to comply with the upcoming EPA regulations. As reported in a recent analysis I co-authored with MJ Bradley Associates for the Clean Energy Group, recent corporate earnings statements by chief executive officers of electric generating companies highlight several important themes : (1) companies have long anticipated these rules; (2) early investments have positioned these companies well for compliance; and (3) the impact on electricity rates can be managed. The excerpts below are from our study (MJBA/Analysis Group Summer 2011 Reliability Update):
    - Benjamin G.S. Fowke, III, President and Chief Operating Officer of Xcel Energy, said: "Like many of our peers, we are in the process of evaluating what if any impact [EPA's Utility Toxics Rule] may have on our operations. Based on our preliminary review we do not anticipate that the rule will require extensive changes to our plans at [Northern States Power] and [Public Service Company of Colorado]...Our proactive steps to reduce emissions through the MERP project in Minnesota and our plans for the Clean Air-Clean Jobs Act in Colorado put us in good position to comply with these rules." April 28, 2011, Xcel Energy Inc. 1st Quarter 2011 Earnings Call

- Jim Rogers, President and CEO of Duke Energy, said: "[T]he anticipation of more stringent environmental rules has long been part of our business plan. Over the past 10 years, we have spent $5 billion retrofitting existing units with updated emissions controls…Today, approximately 75% of our current coal generation capacity has scrubbers in operation. This will increase to approximately 90%, once our fleet modernization program and related retirements are completed… We have really mitigated a lot of the risk and the cost associated with this program by the early steps that we took." May 3, 2011, Duke Energy 1st Quarter 2011 Earnings Call
- According to Gale Klappa, Chairman, President and CEO of Wisconsin Energy: "We really see very little impact on customer electric rates or our capital plan between now and 2015 as a result of all the new EPA regulations that have been proposed…We might see 1% to 2% increase our best guess. So that gives you an example of how well we are positioned from the environmental standpoint in terms of complying with even the new proposed rule." May 3, 2011, Wisconsin Energy Corporation 1st Quarter 2011 Earnings Call
- Theodore Craver, chairman, president and CEO of Edison International said: "We installed the necessary equipment back in 2009 and are already achieving these [mercury] limits. U.S. EPA's rule contained other draft provisions covering acid gases and non-mercury metals, which we can meet by installing the pollution control equipment we have been planning to use at Midwest Gen to meet our SO_2 emissions commitments to the Illinois EPA." May 2, 2011, Edison International 1st Quarter 2011 Earnings Call
- William Spence, Chief Operating Officer, Executive Vice President and President of PPL Generation, said: "Our proactive approach to environmental compliance positions the PPL fleet favorably for future EPA regulation. Ninety-six percent of the competitive coal generation is scrubbed, 88 percent has NO_x controls already installed." February 4, 2011, PPL 4th Quarter 2010 Earnings Call
- Mauricio Gutierrez, Executive Vice President and Chief Operating Officer of NRG reports that: "The proposed [Utility Toxics Rule] provides flexibility in that compliance can be achieved through facility averaging and company selected control technology. It also recognizes the inherent differences in mercury emissions from lignite coal…[t]he key takeaway is that we do not expect at this time any additional environmental CapEx beyond what we have previously announced." May 5, 2011, NRG Energy 1st Quarter 2011 Earnings Call
- The Tennessee Valley Authority ("TVA"), which owns 17,000 MW of coal-fired generating capacity, announced plans in April 2011 to retire 18 older coal-fired generation units at three power plants (2,700 MW) as part of the utility's vision of being one of the nation's leading providers of low-cost and cleaner energy by 2020. The utility will replace "older and less-economical generation with cleaner sources." Tom Kilgore, TVA's President and CEO, said that a "variety of

electricity sources, rather than heavy reliance on any single source, reduces long-term risks and helps keep costs steady and predictable....In the longer term, these actions reinforce our vision to keep bills low, keep our service reliability high and further improve air quality as we modernize the TVA power system." TVA Press Release, April 14, 2011.

- At least one more company with a substantial amount of coal-fired generating capacity affected by these air rules is already under court orders to achieve similar outcomes as the new regulations:
  - American Electric Power signed a consent decree with EPA and other parties in 2007 in which AEP agreed to retire, retrofit, or re-power most of the units that AEP has recently announced it plans to retire.[12] This reinforces the view that many environmental improvements (and potential plant retirements) have been in the works for some time. In response to questions from an investment analyst, AEP's chief executive officer recently suggested that the retirements were reasonable: "Throughout I think almost all of 2009 those plants probably didn't run 5% of the time because natural gas prices were such that they simply weren't dispatching. When we shut those down there will be some cost savings as well. And on balance we think that that's the appropriate way to go not only to treat our customers but also to treat our shareholders near and long term with that small amount of the fleet going offline."[13]

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[12] Consent Decree entered in the U.S. District Court for the Southern District of Ohio, Eastern Division, with respect to U.S.A and State of New York, et. al. v. American Electric Power et al. (Civil Action No C2-99-1250 (Consolidated with C2-99-1182)), U.S.A. v. American Electric Power (Civil Action No C2-05-360), and Ohio Citizen Action, et. al. v. American Electric Power, et. al. (Civil Action No. C2-04-1098), 2007. The 2007 Consent Decree required AEP to retire, retrofit or repower, by no later than 12/31/2015, 3,900 MWs of the units covered under the decree; of those units, AEP has chosen to retire 3,055 MW and repower 845 MW. In the 2007 Consent Decree, AEP agreed to retire, retrofit or repower 4,500 MWs of its generating capacity. The 2007 Consent Decree covered all units AEP has now proposed for retirement, with the exception of the Welsh unit, whose retirement appears to be related to permitting commitments associated with other generating units in Texas.

[13] Transcript of Sanford C. Bernstein & Co. Strategic Decisions Conference, June 1, 2011 (available at http://ofchq.snl.com/Cache/A43E47486F11287831.pdf):

> Question (by Hugh N. Wynne, Senior Analyst, Sanford Bernstein): "So those [CATR and Mercury and Air Toxics] rules come into effect in 2014 and 2015. AEP disclosed that as a result of those rules there's about 5.5 gigawatts of coal-fired generation capacity that would be vulnerable to closure due to the high cost of compliance. We estimate the output of those plants at about 12 million megawatt hours annually. The generation gross margin associated with AEP's off-system sales would seem to imply that that generation is worth about $150 million or maybe $0.20 a share to AEP. Similarly if you were to lose the capacity revenues owned by Ohio Power on the sale of capacity from those plants it seems to me that about $180 million of annual revenue should be at risk or about $0.25 per share. Does AEP view the risk of the closure of these plants in similar terms? And if so what are your plans to mitigate these potential losses?"
>
> Answer: (Michael G. Morris, Chairman & Chief Executive Officer) "Well this is probably one of those places where I saddle up with the team from FE. If in fact 80 gigawatts close, most of it in the central section of the United States, capacity prices and energy prices will more than adequately compensate us for the 5,500 megawatts going off the line. As you know those are high-cost plants and dispatch infrequently, I am not

MANY STUDIES HAVE CALLED ATTENTION TO THE RELIABILITY ISSUES, WITH THE MORE REASONABLE ONES SUGGESTING THAT THE IMPACTS ARE MANAGEABLE.

Much attention has been, and will continue to be, paid to the impacts of the regulations on electric system reliability – in part because it is so important to the American economy. Many assessments have been published – calling attention to the potential supply gaps that could arise in the absence of market, utility and regulators' responses. These studies highlight ranges of impacts on potential plant retirements under quite-different sets of assumptions. The more reasonable estimates indicate strongly that the impacts are manageable.

My colleagues at MJ Bradley Associates and I performed a review of many such studies last August,[14] on behalf of the Clean Energy Group, and we did an update again a few weeks ago.[15] Additionally, I have analyzed carefully many other reports written on this topic and prepared a "field guide" to their results.[16] Many if not most of the studies were performed prior to EPA's issuance of both proposed clean air rules, so did not assume the amount of flexibility built into those proposals. Most assumed a range of scenarios in which there were three basic types of analyses: (a) a base case (no EPA rules, and coal-plant retirements driven by unfavorable economics); (b) a series of "moderate" cases (in which a report's author assumed relative flexibility in compliance options); and (c) "strict" cases (in which the reports' analyses assumed strict, inflexible regulatory compliance). Few if any of the studies examined the extent to which new electric resource options not already formally announced would come forward, and in no case that I am aware of did a study assume that there would be a *robust* market response (including new power plants, implementation of new energy-efficiency and other demand-side measures that may now become economical, or even transmission reconfigurations) in combination with the more moderate cases consistent with EPA regulations. As a result, in my opinion the suite of studies tend to overstate the gap in resources.

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sure on your 12 million megawatt hours, we can surely supply you with data on that going forward. But, I think that going forward prices of capacity and energy would take care of that. Today – in fact, throughout I think almost all of 2009 those plants probably didn't run 5% of the time because natural gas prices were such that they simply weren't dispatching. When we shut those down there will be some cost savings as well. And on balance we think that that's the appropriate way to go not only to treat our customers but also to treat our shareholders near and long term with that small amount of the fleet going offline."

[14] MJBA/Analysis Group 2010 Reliability Analysis.

[15] MBJA/Analysis Group Summer 2011 Reliability Update.

[16] See also S. Tierney and C. Cicchetti, "The Results in Context: A Peer Review of EEI's "Potential Impacts of Environmental Regulation on the U.S. Generation Fleet," May 2011; and S. Tierney, "Electric Reliability under New EPA Power Plant Regulations: A Field Guide," January 18, 2011, http://www.wri.org/stories/2011/01/electric-reliability-under-new-epa-power-plant-regulations-field-guide.

Even the results I report below, which select the more moderate cases, overstate these impacts for this reason.

Study:*	Estimated Capacity Retirements (Coal-Fired):	Notes and document title
PIRA (4/2010)	30-40 GW	PIRA, "North American Environmental Markets Service: EPA's Upcoming MACT: Strict Non-Hg Regs Can Have Far-Reaching Market Impacts."
ICF for INGAA (5/2010)	50 MW	Report prepared by ICF for Interstate Natural Gas Association of America, "Coal-Fired Electric Generation Unit Retirement Analysis."
ICF for EEI (5/2010)	25 GW	(Scenario 1 – CAIR and MACT) Report prepared by ICF for Edison Electric Institute, "Preliminary Reference Case and Scenario Results."
Credit Suisse (7/2010)	50 GW	Credit Suisse, "A Thought…CATR is First Step in Changing the Coal Fleet."
Bernstein (10/2010)	65 GW	Hugh Wynne et al., Bernstein Research, "U.S. Utilities: Coal-Fired Generation Is Squeezed in the Vice of EPA Regulation; Who Wins and Who Loses?"
NERC (10/2010)	6 GW	Based on the "moderate" CATR and MACT cases. North American Electric Reliability Corporation, "2010 Special Reliability Scenario Assessment: Resource Adequacy Impacts of Potential U.S. Environmental Regulation."
	25 GW	Based on the "strict" CATR and MACT cases. Same document.
CRA (12/2010)	35 GW	Ira Shavel and Barclay Gibbs (Charles River Associates), "A Reliability Assessment of EPA's Proposed Transport Rule and Forthcoming Utility MACT."
ICF for EEI (1/2011)	24 GW	Scenario with CATR and MACT (flexibility) Report prepared by ICF for EEI, "Potential Impacts of Environmental Regulation on the U.S. Generation Fleet."
Note: Currently there is approximately 1,030 GW of generating capacity in the U.S., of which approximately 330 GW is coal-fired generation.		

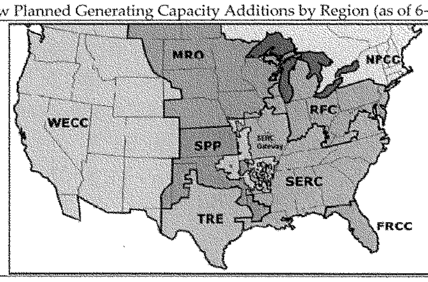
In my opinion, these estimates likely overstate the impacts of EPA's proposed clean air regulations: for one thing, EPA's regulations are more flexible than had been anticipated by the studies. And the industry has a wider range of options for responding to capacity needs than was assumed in the studies above. Finally, low gas prices are a fundamental disadvantage for owners of older and inefficient and uncontrolled coal-fired generating capacity.

MANY TOOLS EXIST TO ASSURE RELIABILITY

The industry has various tools to assure that reliability will not be adversely affected. Among others, these include:

- Well in advance of need for new electric capacity resources, there is considerable information available to decision makers to provide signals about upcoming regulatory requirement.
  - Federal administrative procedures inherently provide significant advanced notice of pending changes in environmental requirements.
  - EPA has built into its proposals a reasonable level of flexibility from a technology point of view.
  - The many electric reliability ("resource adequacy") assessments have called attention to the issues, and identified the regional markets where inefficient coal plants may retire. They also indicate amounts of capacity needed from the market (i.e., utilities, competitive power companies and other resource suppliers (e.g., companies providing demand-side measures that reduce the amount of needed new generating capacity)).
  - There are long-term capacity planning processes in many of the nation's regional wholesale markets (such as in PJM, NYISO, and ISO-NE) and in virtually all of the areas where state regulators review the resource plans of traditionally regulated utility companies.
  - The electric industry has proven experience in adding additional generating capacity, transmission solutions and demand-side measures when and where needed, and in coordinating effectively to address reliability concerns. Already, 42 GW (or 41,983 megawatts (MW)) of new plant capacity is under construction in various regions of the country for an in-service date of 2014 – the year when both the CATR and Utility Toxics Rules would be in effect. Another 27 GW of generating capacity is in advanced phases of permitting and in-service dates by 2014. (An additional 388 GW of new plant capacity has been announced but I have not included it here, in light of its much less advanced status.) While experience tells us that not all of this capacity will make it into commercial operation, there is a relatively high likelihood of plants already under construction moving forward to completion.

New Planned Generating Capacity Additions by Region (as of 6-2011)



Reliability region	Generating Capacity (MW) Under Construction by Region						
	2011	2012	2013	2014	2015+	Total	Total by end of 2014:
TRE	365	1,228	-	-	304	1,897	1,593
FRCC	308	6	1,295	-	26	1,635	1,609
MRO	435	1,044	261	-	206	1,945	1,740
NPCC	3,571	1,644	367	640	945	7,166	6,221
RFC	3,608	1,419	142	159	6	5,334	5,328
SERC	2,960	6,896	1,790	702	23	12,371	12,348
SPP	1,080	582	7	-	-	1,669	1,669
WECC	3,042	4,294	2,546	1,593	759	12,235	11,475
Total	15,368	17,113	6,407	3,094	2,268	44,251	41,983

	Generating Capacity (MW) in Advanced Development Phases but Not Under Construction						
	2011	2012	2013	2014	2015+	Total	Total by end of 2014:
TRE	1	2,030	-	1,000	3,635	6,666	3,031
FRCC	105	88	217	1,295	4,563	6,268	1,705
MRO	86	295	50	-	1,226	1,656	430
NPCC	364	865	1,174	829	2,214	5,446	3,232
RFC	251	653	684	19	5,974	7,581	1,607
SERC	153	862	654	1,392	12,585	15,646	3,061
SPP	118	627	-	-	138	883	745
WECC	1,342	1,567	4,960	5,675	17,031	30,574	13,544
Total	2,420	6,986	7,738	10,210	47,366	74,720	27,354

Source of data: SNL Financial

- Other tools are available to ensure reliability as time gets closer to compliance deadlines in the EPA regulations:
  - State and federal regulators do not sit idly by in the face of big important challenges, such as the reliability and resource planning issues introduced by the EPA clean air regulations.

- State and federal regulations have a strong track record of taking the steps necessary to ensure that the companies they supervise are meeting their obligation to provide reliable electric service.
- At present, there is active coordination underway by many federal agencies (EPA, FERC, DOE) involved in policy making for policies affecting the power sector.
- State agencies with responsibility for energy, utility and environmental regulations are in discussions to learn about each other authorities and potential actions that the various agencies in affected states may take to assure smooth industry responses in their states.
- The national associations of public officials in those states (the National Association of Regulatory Utility Commissioners, the National Association of State Energy Offices, and the National Association of Clean Air Agencies) are assisting the states in these efforts.
- Grid operators (e.g., Regional Transmission Organizations) and regional reliability councils in various regions are conducting studies to assess the timing of reliability issues, and to get ready for additional actions in later years. The grid operators will be able to coordinate scheduling of outages to support reliable operations.
- Some states have begun to call for and review utility plans to comply with EPA regulations and to assure local reliability requirements.
- Some states (like New York State) are updating statutes to support timely reviews of proposals to site new power plant projects. Other states (e.g., California) have experience with streamlining permitting processes to assure timely state agency reviews of plans.

- Close-to and during the compliance period, there are several safeguards that prevent reliability problems from occurring:
  - EPA has the ability to extend the deadlines in the Utility Toxics for one year on a case-by-case basis for affected generating units where the owner has taken steps to comply in a timely fashion but still needs more time to assure reliable system operations.
  - Grid operators have the ability to deny requests for plant retirements where such plant closures would raise reliability concerns. There are examples where the parties have negotiated consent decrees to allow continued operation while steps are taken to mitigate the reliability issues. Examples are: PJM's denial of Exelon's request to close the Eddystone plant in Pennsylvania; the consent decree affecting continued operation of the Salem Harbor power plant in Massachusetts while steps were being undertaken to address local reliability issues that would arise in the event the plant retired; and the FERC's denial of the closure of the

Potomac River Generation outside of Washington, DC, based in part on reliability concerns raised by the DOE.

- The DOE and the President may exercise emergency authority to assure that electric system reliability is not adversely impacted as companies take steps to comply with EPA clean air regulations. DOE has previously exercised this authority.

RECENT MARKET DEVELOPMENTS PROVIDE PRACTICAL EVIDENCE THAT THE IMPACTS ARE MANAGEABLE.

Finally, there are already practical signs that the market is responding to the expectation that the EPA clean air regulations will go into effect. Examples include:

- The previously mentioned recent statements of CEOs of companies that own coal-fired generating units, which indicate that their companies are reasonably well-positioned and that the impacts are manageable.
- The expeditious actions of states and utility companies to implement steps deemed to be important for cleaner energy production and public health. A prime example is the recent effort in Colorado to implement a state law (the Colorado Clean Energy – Clean Jobs Law) that required the state's utilities to take actions similar to those required by the EPA's clean air regulations. Within one year of enactment of that act, the state's largest utility (Xcel Energy) had filed plans to comply by shutting down a coal plant and replacing it with a new gas-fired generating station, which the state's public health agency and utility commission reviewed for compliance with that new law as well as the state's long-standing requirements for least-cost planning.
- The recent results of the PJM May 2011 "forward capacity auction," which confirm that the 13-state PJM region will have ample electricity supply after proposed EPA clean air rules take effect on or before January 2015. This last example deserves a longer explanation, below, because it exemplifies some of the creative ways that the industry is responding to the EPA regulations in conjunction with other long-standing electric requirements.

PJM operates the nation's largest integrated power market that includes hundreds of generating units providing electric power to 54 million customers in 13 mid-Atlantic and Midwestern states, as well as the District of Columbia. With over one-sixth of total U.S. generating capacity, PJM is also home to many of the plants that will be affected by the CATR and the Utility Toxics rules. Each year, to assure that there is sufficient generating capacity to meet future demand in upcoming years, PJM solicits proposals from power suppliers willing to provide capacity to the market three years forward. The winners in each year's PJM Reliability Pricing Model ("RPM") auction commit to being available to provide electric service during that future time period, and to receive compensation (capacity payments) for doing so.

As indicated by the results of the May 2011RPM auction for power supply for the period from

May 31, 2014 through June 1, 2015, PJM will have more than enough capacity to meet federal reliability standards set by NERC in the year in which both the EPA's proposed clean air rules would be in effect. Notably, more than 4 GW of new capacity came into the market with this auction, including new generation and new demand-side resources such as energy efficiency and demand response. This outcome shows the variety of ways in which market participants are providing efficient responses to power requirements as well as environmental requirements.

In addition, power companies in PJM (such as AEP and Duke-Ohio) that do not participate in the capacity auction are required to certify that they have adequate capacity to ensure reliable service. These companies have confirmed that they have sufficient electric capacity to meet their needs through June 1, 2015 – more than five months after the EPA rules are expected to take effect.

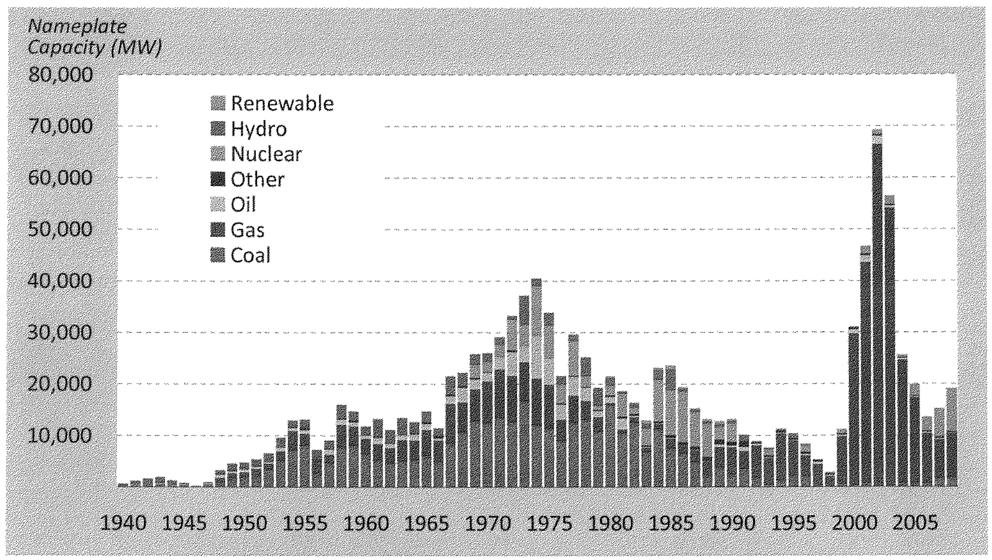
In my opinion, the PJM auction results also reinforce a key finding in the MJBA/Analysis Group 2010 Reliability Analysis and many studies since then: that the system has the tools to address the retirement of old, inefficient coal-fired units, preserve reliable service for customers.

CONCLUSION

For these reasons, I strongly believe that the nation does not need to trade off improvements in public health for lower electric reliability. Both of these are essential "givens" for Americans.

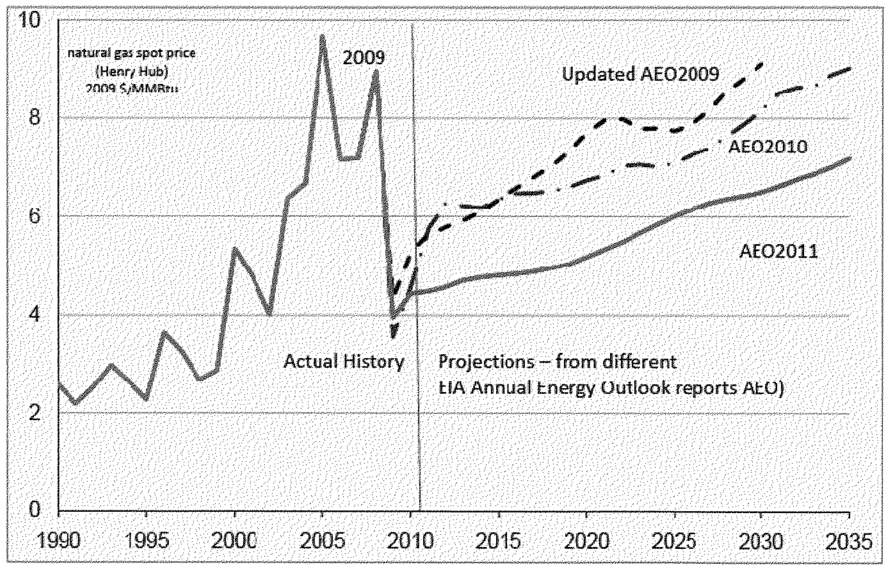
I urge the Senate to continue to take interest in this important topic, but to do so with an expectation that the industry will respond innovatively and effectively, and with confidence that Americans can get the benefits of both clean air and reliable electricity. This investment in cleaning up and modernizing the nation's power supply system is important and do-able. In my opinion, there is no reason to delay the implementation of the Clean Air Transport Rule or the Utility Toxics Rule.

Power Plant Capacity Added by Year It Entered Service



Source: Figure 3 from M. J. Bradley & Associates, LLC and Analysis Group., *Ensuring a Clean, Modern Electric Generating Fleet while Maintaining Electric System Reliability*, 2010, page 9, with figure sourced from *Ceres, et al., Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States, June 2010.*

Natural Gas Prices:
Actual (1990-2010) and Energy Information Administration Forecast (2010-2035)



R. Newall, EIA, The Long-term Outlook for Natural Gas, presentation to the Saudi Arabia – United States Energy Consultation, February 2, 2011

Estimates of Capacity Retirements Due to EPA Clean Air Rules

Study:*	Estimated Capacity Retirements (Coal Plants)	Notes and document title
PIRA (4/2010)	30-40 GW	PIRA, "North American Environmental Markets Service: EPA's Upcoming MACT: Strict Non-Hg Regs Can Have Far-Reaching Market Impacts."
ICF for INGAA (5/2010)	50 MW	Report prepared by ICF for Interstate Natural Gas Association of America, "Coal--Fired Electric Generation Unit Retirement Analysis."
ICF for EEI (5/2010)	25 GW	(Scenario 1 – CAIR and MACT) Report prepared by ICF for Edison Electric Institute, "Preliminary Reference Case and Scenario Results."
Credit Suisse (7/2010)	50 GW	Credit Suisse, "A Thought…CATR is First Step in Changing the Coal Fleet."
Bernstein (10/2010)	65 GW	Hugh Wynne et al., Bernstein Research, "U.S. Utilities: Coal-Fired Generation Is Squeezed in the Vice of EPA Regulation; Who Wins and Who Loses?"
NERC (10/2010)	6 GW	Based on the "moderate" CATR and MACT cases. North American Electric Reliability Corporation, "2010 Special Reliability Scenario Assessment: Resource Adequacy Impacts of Potential U.S. Environmental Regulation."
	25 GW	Based on the "strict" CATR and MACT cases. Same document.
CRA (12/2010)	35 GW	Ira Shavel and Barclay Gibbs (Charles River Associates), "A Reliability Assessment of EPA's Proposed Transport Rule and Forthcoming Utility MACT."
ICF for EEI (1/2011)	24 GW	Scenario with CATR and MACT (flexibility) Report prepared by ICF for EEI, "Potential Impacts of Environmental Regulation on the U.S. Generation Fleet."

Current generating capacity in the U.S.:
Approximately 1,030,000 MW (with ~330 MW of coal-fired capacity)

Exhibit to Testimony of Susan Tierney –
Before the Senate Committee on Environmental and Public Works Subcommittee on Clean Air and Nuclear Safety

ANALYSIS GROUP
ECONOMIC, FINANCIAL and STRATEGY CONSULTANTS

New Planned Generating Capacity Additions by Region:
Capacity Under Construction and In Advanced Development (2011-2015+)

New Planned Generating Capacity Additions by Region (as of 6-2011)

	Generating Capacity (MW) Under Construction by Region						
Reliability region	2011	2012	2013	2014	2015+	Total	Total by end of 2014:
TRE	365	1,228	-	-	304	1,897	1,593
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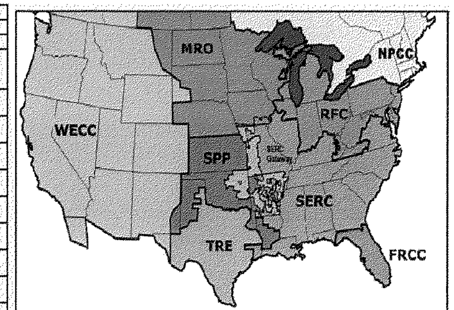
Source of data: SNL Financial



Regional electrical reliability regions

Current generating capacity in the U.S.
Approximately 1,030,000 MW

Written Responses to Follow-Up Questions
Submitted by

Susan F. Tierney, Ph.D.
Managing Principal, Analysis Group, Boston

On August 19, 2011

In Response to Questions From
Senator Thomas R. Carper

Following the Hearing of the
U.S. Senate Environment and Public Works Committee
Subcommittee on Clean Air and Nuclear Safety
June 30, 2011

Oversight Hearing:
Review of EPA Regulations Replacing the Clean Air Interstate Rule (CAIR)
and the Clean Air Mercury Rule (CAMR)

Question 1:

During the hearing, you discussed the recent analysis by the Electric Reliability Council of Texas (ERCOT), Review of the Potential Impacts of Proposed Environmental Regulations on the ERCOT System. Could you please further explain why you see the report as supporting your conclusion that electric generators can comply with EPA's clean air regulations without threatening the reliability of the electric system? Could you explain what assumptions were made in that Texas study with regard to how Texas might be affected by the Transport Rule?

Response to Question 1:

At the hearing, I was asked to discuss the May 2011 study prepared by ERCOT with respect to potential impacts on power system reliability that might arise as Texas power plant owners respond to the upcoming EPA regulations. In response, I described the ERCOT report's statement that Texas would not likely experience many coal plant retirements as a result of the EPA regulation. I had relied on a prior careful review of the ERCOT report, which stated specifically that it had examined the implications of four potential environmental rule changes that would affect Texas' power plants: the Clean Air Transport Rule; the Clean Air Act regulations relating to hazardous air pollutants; Clean Water Act Section 316(b) affecting power plants' cooling-water intake structures; and proposed regulations on disposal of coal combustion residuals.

In light of that review, at the hearing I was surprised by comments of my co-panelist, Dr. Bryan Shaw, Chairman of the Texas Commission on Environmental Quality, who stated when questioned by Senator Barrasso, that the ERCOT report had not considered that the Clean Air Transport Rule would include Texas, since the ERCOT report stated otherwise.

On July 19th, ERCOT's President and CEO, Mr. H.B. "Trip" Doggett, issued a statement indicating that ERCOT's report "did not address the impact of SO2 restrictions on coal plants in ERCOT because these restrictions on Texas were not included as part of the EPA's earlier rule proposal." This assumption was not clear from reading the report itself. Mr. Doggett's statement also went on to say that ERCOT had not had time to review the July 7th Cross-State Air Pollution rule.

As ERCOT reviews the potential impacts, it will undoubtedly take into account not only the recently experienced new system peaks that occurred during the extended heat wave in August 2011, but also the projections of growing demand, the significant proposals to add new generating capacity, the recent transmission expansion projects that have been completed, and the proposals for additional new transmission investment. I previously noted in my original testimony that in ERCOT, there is 1,897 MW of generating capacity under construction (with 1,593 expected to come on line by the end of 2014); 6,666 MW of generating capacity in advanced development phases (with 3,301 MW proposed to come on line by the end of 2014). Additionally, another 9,910 MW of new generating capacity has been announced to be in service by the end of 2014.

Texas has also made substantial investment in transmission improvements in recent years, and in ERCOT there are plans for additional projects to maintain reliability and efficient electric system operations. On December 30, 2011, ERCOT issued a press release stating that:

> "ERCOT Releases Annual Transmission Planning Reports: Nearly $2 billion in transmission improvements completed since 2009; up to $9 billion in projects to maintain reliability and improve grid efficiency under review.
>
> "The Electric Reliability Council of Texas, grid operator and manager of the electric market, is reviewing transmission projects for the next five years which could add nearly 8,000 miles of transmission to the grid, according to the 2010 transmission report filed today with the Public Utility Commission.
>
> "The annual Electric System Constraints and Needs Report identifies existing and potential constraints in the transmission system that pose reliability concerns or may increase costs to the electric power market and Texas consumers. The Long-Term System Assessment, filed in conjunction with the transmission report provides a 10-year outlook of transmission needs.
>
> "Transmission projects up to $9 billion under review: Up to $9 billion in projects to maintain reliability and improve grid efficiency are under review, which could add an estimated 7,866 circuit miles of transmission and 27,026 megavolt

amperes (MVA) of autotransformer capacity to the grid. The planned projects include the Competitive Renewable Energy Zones (CREZ) transmission additions that are planned to be in service by the end of 2013. Aside from the CREZ transmission additions, the largest projects planned through 2015 include three new 345-kilovolt (kV) lines totaling 368 miles…

"Completed transmission improvements total $2 billion: In addition to the five-year outlook, the report reviews transmission improvements completed since 2009. These totaled 1,933 circuit miles of transmission and 12,299 MVA of autotransformer capacity with an estimated cost of $2 billion. The largest projects were two new 345-kV lines completed in 2010, including a 114-mile line in the south zone and a 74-mile line in the south central zone.

"Congestion costs lowest since 2002: The report also analyzes historic congestion costs – the cost incurred when more expensive generation is deployed to resolve transmission overloading or imbalance and maintain electricity flows within safe operating limits. Congestion costs in 2010 were the lowest they have been since 2002.

"Long-Term System Assessment takes 10-year view: The Long-Term System Assessment, which takes a 10-year view of transmission needs, does not provide specific recommendations but is intended to inform the five-year planning process by providing a longer term view of system reliability needs and indicating system needs that require solutions that will take longer than five years to implement.

"The study consisted of two parts: an analysis of the reliability needs of the system based on peak-load system conditions; and an evaluation using scenario analysis of the cost-effectiveness of potential economic projects to improve system efficiency. The conclusions in the assessment included:

- While numerous transmission system upgrades will be needed due to expected load growth over the next 10 years, particularly in the Dallas-Fort Worth and Houston areas, the analysis showed few, incremental long-lead-time projects to be warranted.
- There is a potential need for new transmission import capacity into the Houston metropolitan area.
- Load growth in areas north and west of Dallas may require additional transmission infrastructure in the next 10 years."

Question 2:

> ***During the hearing, we heard concerns regarding the ability of companies that own affected coals plants to comply on time with EPA's proposed Utility Toxics Rule. Could you please elaborate on what regulatory tools already exist to address specific situations of a company needing additional time to install emission controls, and whether those tools are sufficient to address the concerns we heard raised?***

Response to Question 2:

There are many existing statutory authorities and regulatory/risk-management tools that exist to ensure that electric system reliability can be maintained, even as the industry responds to the EPA regulations. Congress has already provided the tools needed to ensure that implementation of regulations designed to protect public health do not end us in a clash with other critical objectives, such as reliable electricity supply. The principal tools that may help provide for extra time for compliance, in order to ensure electric reliability, are as follows:

First, Section 112(i)(3)(B) of the Clean Air Act gives the EPA the ability, on a case-by-case basis, to extend the compliance deadlines of individual companies with generating units that need to comply with the Utility Toxics Rule, so as to give them one further year to install control technology.

> "(B) The Administrator (or a State with a program approved under subchapter V of this chapter) may issue a permit that grants an extension permitting an existing source up to 1 additional year to comply with standards under subsection (d) of this section if such additional period is necessary for the installation of controls. An additional extension of up to 3 years may be added for mining waste operations, if the 4-year compliance time is insufficient to dry and cover mining waste in order to reduce emissions of any pollutant listed under subsection (b) of this section."

Second, the Clean Air Act (Section 112(i)(4)) also gives the President of the United States the authority to extend compliance deadlines for the Toxics Rule where such extensions are necessary to assure electric system reliability.

> "(4) Presidential exemption. The President may exempt any stationary source from compliance with any standard or limitation under this section for a period of not more than 2 years if the President determines that the technology to implement such standard is not available and that it is in the national security interests of the United States to do so. An exemption under this paragraph may be extended for 1 or more additional periods, each period not to exceed 2 years. The President shall report to Congress with respect to each exemption (or extension thereof) made under this paragraph. "

Third, under Section 202(c) of the Federal Power Act, the U.S. Department of Energy may override Clean Air Act control requirements in limited emergency circumstances where there is a finding that an electric emergency exists. Under the DOE's regulations that implement this authority:

> "§ 205.371 Definition of emergency. "Emergency," as used herein, is defined as an unexpected inadequate supply of electric energy which may result from the unexpected outage or breakdown of facilities for the generation, transmission or distribution of electric power. Such events may be the result of weather conditions, acts of God, or unforeseen occurrences not reasonably within the power of the affected "entity" to prevent. An emergency also can result from a sudden increase in customer demand, an inability to obtain adequate amounts of the necessary fuels to generate electricity, or a regulatory action which prohibits the use of certain electric power supply facilities. Actions under this authority are envisioned as meeting a specific inadequate power supply situation. Extended periods of insufficient power supply as a result of inadequate planning or the failure to construct necessary facilities can result in an emergency as contemplated in these regulations. In such cases, the impacted "entity" will be expected to make firm arrangements to resolve the problem until new facilities become available, so that a continuing emergency order is not needed. Situations where a shortage of electric energy is projected due solely to the failure of parties to agree to terms, conditions or other economic factors relating to service, generally will not be considered as emergencies unless the inability to supply electric service is imminent. Where an electricity outage or service inadequacy qualifies for a section 202(c) order, contractual difficulties alone will not be sufficient to preclude the issuance of an emergency order."

In a notable recent example, the Secretary of the Department of Energy used this authority to order that that the Potomac River Generating Station remain in operation in order to assure reliability of the electric supply to the District of Columbia, even though the plant had been found to be in violation of air pollution requirements. The plant was ordered to remain open until the regional grid operator provided a plan to assure electric reliability. As described in regulatory orders at the time:

> "On December 20, 2005, the Secretary of Energy entered an order finding that an emergency exists under section 202(c), and ordered the Plant to generate electricity.[Footnote 2 - below] The December 20 Order found that an emergency situation exists in the Washington, D.C. area, due to shortages in electric energy, facilities for the generation of electric energy, and facilities for the transmission of electric energy, as well as other causes. The Secretary of Energy directed Mirant to operate in a manner that provides reasonable electric reliability but that also minimizes any environmental harm from operation of the Plant.."
>
> > Footnote 2: U.S. Department of Energy, Order No. 202-05-2 (December 20, 2005) (December 20 Order). Authority under section 202(c) was transferred to the Secretary of Energy in 1980 by the Department of Energy Organization Act, Pub. L. 95-91, 91 Stat. 565 (42 U.S.C. § 7101).

> *Public Utility District No. 2 of Grant County, Washington*, 95 FERC ¶ 61,338 at n. 49 (2001). Here, we will therefore substitute "Secretary of Energy" for references to the Commission. Section 202(c) states that "[d]uring the continuance of any war in which the United States is engaged, or whenever the [Secretary of Energy] determines that an emergency exists by reason of a sudden increase in the demand for electric energy, or a shortage of electric energy of facilities for the generation or transmission of electric energy, or of fuel or water for generating facilities, or other causes, the [Secretary of Energy] shall have the authority, either upon its own motion or upon complaint, with or without notice, hearing, or report, to require by order such temporary connections of facilities and such generation, delivery, interchange, or transmission of electric energy as in its judgment will best meet the emergency and serve the public interest."

Source: Federal Energy Regulatory Commission, *District of Columbia Public Service Commission*, 114 FERC ¶ 61, 017 (Docket No. EL05-145-000), Order on Petition and Complaint, January 9, 2006.

I attach to this response (Attachment 1) a report I have recently co-authored, in which we describe the manner in which the regional grid operator and local transmission company developed transmission plans and implemented transmission equipment upgrades to assure that the region would have reliable power even if the power plant were closed down. (See P. Hibbard, P. Darling and S. Tierney, "Potomac River Generating Station: Update on Reliability and Environmental Considerations," July 19, 2011.)

Question 3:

Please explain to what extent energy efficiency and other "unconventional" tools may be available to address the retirement of older, inefficient coal-fired power plants.

Response to Question 3:

As I explained in my June 30th 2011 testimony before the Subcommittee on Clean Air and Nuclear Safety, there are many "unconventional tools" available to help ensure that the electric industry's (and power markets') response to EPA regulations minimize costs to consumers. By "unconventional tools," I refer to a variety of actions that can be taken besides the two obvious ones (adding pollution-control equipment and/or fuel-switching equipment on power plants so that they can satisfy clean air regulations; or retiring plants where it is uneconomical for the owner to add such controls).

These "unconventional tools" include such things as energy efficiency, off-system purchases of power from existing or new power plants, transmission upgrades, demand-response contracts, distributed generation, rate-design policies to send pricing signals to customers about the cost to produce power at different times of day, and so forth. These "unconventional tools" are hardly outside the norm in any respect: they are steps taken by countless utilities, grid operators, power producers, other market participants, and electricity consumers in countless locations around the country to make sure that the electric system can operate in a safe, reliable, economical, and environmentally acceptable way.

In a recent speech I presented to the Aspen Energy Policy Forum this summer, I provided some examples of the ways that we can use energy efficiency opportunities and actions, demand-response capacity, distributed generation, and transmission alternatives as tools to modernize our electric system, save customers money, reduce environmental impacts, and assure electric reliability. My presentation (S. Tierney, "Unconventional Approaches: Part of the Electric Industry's Response to Upcoming EPA Regulations," Panel on Infrastructure Reliability and Adequacy, Aspen Energy Policy Forum, July 5, 2011) is attached here as Attachment 2 to my responses.

Question 4:

Based on your expertise, please explain whether you see EPA's air regulations as a threat to job growth.

Response to Question 4:

In my experience as a state utility regulator and a state cabinet officer responsible for implementing environmental regulations, I am aware of the tensions that often exist on the eve of implementing new regulations that will impose costs of an industry (and sometimes on the consumers of its products), and the fears that such regulations will lead to jobs losses. Often, though, the very capital investments and expenditures that will be made by the industry to respond to regulatory requirement can – and do - produce positive economic activities in the local and regional communities affected.

I note (and attach here) two recent studies that have examined the job impacts of the EPA's air regulations. One (Attachment 3) is a report ("New Jobs, Cleaner Air: Employment Effects Under the Planned Changes to the EPA's Air Pollution Rules") published in February 2011 by CERES, and co-authored by J. Heintz, H. Garrett-Peltier and B. Zipperer of the Political Economy Research Institute (PERI) of the University of Massachusetts). The other (Attachment 4) is a report ("Why EPA's Mercury and Air Toxics Rule is Good for the Economy and America's Workforce") is authored by C. Cicchetti, Navigant Consulting, July 2011.

In the forward to the CERES/PERI study, CERES' President Mindy Lubber summarizes that "Since 1970, investments to comply with the Clean Air Act have provided $4 to $8 in economic benefits for every $1 spent on compliance, according to the nonpartisan Office of Management and Budget. Since the passage of the Clean Air Act Amendments in 1990, U.S. average electricity rates (real) have remained flat even as electric utilities have invested hundreds of billions of dollars to cut their air pollution emissions. During the same period, America's overall GDP increased by 60 percent in inflation-adjusted terms." The PERI researchers found that if the electric industry were required to comply with "stringent" EPA compliance rules with capital investments reaching almost $200 billion between 2010-2015 ("including almost $94 billion on pollution controls and over $100 billion on about 68,000 megawatts of new generation capacity), there would likely be net positive benefits:

> "Constructing such new capacity and installing pollution controls will create a wide array of skilled, high-paying jobs, including engineers, project managers, electricians, boilermakers, pipefitters, millwrights and iron workers....[B]etween 2010 and 2015, these capital investments in pollution controls and new generation will create an estimated 1.46 million jobs or about 291,577 year-round jobs on average for each of those five years....[T]ransforming to a cleaner, modern fleet through retirement of older, less efficient plants, installation of pollution controls and construction of new capacity will result in a net gain of over 4,254 operation and maintenance (O&M) jobs across the Eastern

Interconnection. Distribution of these O&M jobs will vary from state-to-state, depending on where coal plants are retired (O&M job reduction) and where new generation capacity is installed (O&M job gains)."

- Over the five years, investments in pollution controls and new generation capacity will create significant numbers of new jobs in each of the states within the Eastern Interconnection, more than offsetting any job reductions from projected coal plant closures.
- The largest estimated job gains are in Illinois, (122,695), Virginia, (123,014), Tennessee, (113,138), North Carolina (76,966) and Ohio (76,240).
- In states with net O&M job reductions, projected gains in capital improvement jobs will provide enough work to fully offset the O&M job reductions. The construction of pollution controls will create a significant, near-term increase in new jobs. O&M job reductions are likely to occur later in the period."

Source: CERES/PERI report, Executive Summary

Dr. Cicchetti's study reviewed the EPA's benefit/cost estimates prepared as part of the proposed Utility Toxics Rule, and concluded that the methodology understated the net economic benefits of the proposed rule:

> This report evaluates EPA's benefit-cost analysis as well as quantifies additional benefits that EPA chose not to monetize or include in their final benefit-cost results. EPA's analysis is both comprehensive and conservative, and the proposed Toxics Rule would result in an additional $10.5 billion in annual benefits that EPA did not quantify or include in its analysis.
>
> EPA, nevertheless, concluded that the annual benefits of the proposed Toxics Rule would dwarf the compliance costs, yielding net benefits (benefits minus costs) of about $42 billion to $129 billion per year. Some have argued that EPA's benefit-cost analysis is faulty because it includes co-benefits from SO2, NOX, particulate matter (PM), and greenhouse gas (GHG) emissions, which are not directly regulated by the proposed Toxics Rule. Those who suggest that it is improper for EPA to calculate co-benefits from reductions of non-hazardous pollutants, which are regulated under other sections of the Clean Air Act, have a fundamental lack of knowledge of the core economic concept of opportunity benefits and a poor understanding of how to conduct an benefit-cost or economic impact analysis.1 EPA's benefit-cost analysis is comprehensive and relies upon sound and proven scientific methods and data.
>
> Moreover, EPA's benefit-cost analysis was extremely conservative. EPA ignores the likely overestimate of compliance costs and likely underestimate of realized benefits of the proposed Toxics Rule and fails to substitute a reasonable degree of new energy efficiency and demand-side management. Because it already had enough information to conclude that the benefits of the proposed Rule far

outweigh the costs, EPA also chose not to quantify many additional benefits. In this Report, we identify an additional $8.2 billion in annual benefits plus $2.3 billion in likely energy efficiency savings resulting from EPA's proposed Toxics Rule. These include the combined employer business savings for lost workdays, employee recruiting, training, integration, and replacement, and avoided restricted outdoor activities; reduced health care and insurance costs, and increased employment at a time when the economy is stressed. …This study also examines some of the second and third order effects that EPA did not calculate. The additional analysis in this Report shows that the proposed Toxics Rule would add 115,520 jobs, GDP growth of $7.170 billion, and additional tax receipts of $2.689 billion. These results are summarized in the following table:

	EPA Calculations in Regulation Impact Analysis	Adding Energy Efficiency ($2.3 million in 2015)	Adding Additional Analysis in this Report
Net Benefits	$42-$129 billion	$44.3-$131.3 billion	$52.5-$139.5 billion
Job Increases	35,970	n/a	115,520
Healthcare Savings	$3.445 billion	n/a	$4,513 billion
GDP Increases	n/a	n/a	$7.170 billion
Increased Tax Revenues	n/a	n/a	$2.689 billion

Source: C. Cicchetti, July 2011, executive summary.

Question 5:

Please provide any other comments you have in response to points raised by other witnesses on your panel.

Response to Question 5:

I affiliate myself with the testimony of the Honorable Collin O'Mara, Secretary of the Environment and Energy for Delaware, where he described the difficulty of states in attaining local air quality standards when they are downwind of power plants in other states where those plants have been allowed to operate with much-higher level of air emissions. As a former state environmental cabinet officer in a state in such a situation, I know the challenges – not to mention, fundamental unfairness – of the situation that Secretary O'Mara described as a "double-whammy", in that the downwind states "face both a competitive disadvantage economically from increased energy costs as well as greater public health and environmental impacts due to the lack of regulatory equity."

I note that my responses above (to Questions 2 and 3) provide information that provides additional information to provide context for the testimony of my co-panelist, Ms. Barbara Walz, Senior Vice President for Policy and Environmental at Tri-State Generation and Transmission Association, Inc., where she states that "the timeline for installation of controls is not achievable." Her comments do not take into account the existing authorities of DOE and the President to take steps where necessary to avert an electric reliability problem that might arise where affected electric companies act in good faith and need more time to comply with the regulations.

My response to Question 1 addresses some of the points raised in the testimony of my co-panelist, Dr. Bryan Shaw, Chairman of the Texas Commission on Environmental Quality.

Attachment 1

ANALYSIS GROUP
ECONOMIC, FINANCIAL and STRATEGY CONSULTANTS

Potomac River Generating Station: Update on Reliability and Environmental Considerations

Analysis Group, Inc.

Paul J. Hibbard
Pavel G. Darling
Susan F. Tierney

July 19, 2011

1. EXECUTIVE SUMMARY

The American Clean Skies Foundation retained Analysis Group to evaluate: (1) whether the operation of the Potomac River Generating Station ("PRGS") is still required to ensure that the District of Columbia and neighboring areas have adequate and reliable sources of electric power; and (2) the potential reductions in air pollution that could result if the PRGS were retired.

The PRGS is a 482 MW coal-fired electric generating station owned by a subsidiary of GenOn Energy, Inc. ("GenOn"). The Station comprises five separate steam turbines built between 1949 and 1957, all of which remain in operation. The facility sits on the banks of the Potomac River in the northern part of the city of Alexandria, Virginia.

In 2005, state environmental officials in Virginia cited the plant as having violated various air pollutant standards and ordered its owners to upgrade the plant or shut it down. In response, the owners chose to shut down the facility, but were prevented from doing so when the U.S. Department of Energy ("DOE") required the plant to continue operating in order to maintain electric reliability in the District of Columbia area. The Federal Energy Regulatory Commission ("FERC") also directed the local District of Columbia utility, Potomac Electric Power Company ("PEPCO"), and the Pennsylvania New Jersey Maryland Interconnection ("PJM" – the Regional Transmission Organization serving that area) to submit a plan for preserving reliability in the area without relying on the PRGS. PEPCO and PJM recommended investing in various transmission upgrades so that the District would be able to meet local reliability requirements. Subsequently, most such transmission upgrades were made and have gone into commercial operation. Meanwhile, the plant's owners made various equipment changes at the plant to improve its emissions profile. Even so, the plant has continued to operate less and less over time. New questions have also arisen about the future of the plant in light of the changing economics of power generation (e.g., the price of natural gas relative to coal), upcoming federal environmental regulations, and other factors.

We analyzed the reliability and air emission impacts of a potential retirement of the PRGS. Our main conclusions are as follows.

First, with respect to electric reliability issues:

- Based upon the substantial transmission system upgrades that have been put in place since 2005, we do not think that relevant authorities would find the PRGS needs to remain in operation in order for the District of Columbia to have reliable power supply. Our conclusion is consistent with the prior 2008 determinations of PEPCO and PJM.
- The plant no longer operates very much, in any event. Last year, the combined output of all PRGS units represented only five percent of the total generation in the local "PEPCO area" of the PJM electrical region. And PRGS supplied only two percent of

the total generation in the local MidAtlantic area of PJM and just 0.3 percent of the wider PJM grid.

- Prior to any future retirement of the PRGS plant, reliability issues would need to be analyzed by PJM and PEPCO. Such analyses could result from a request by PRGS's owner to deactivate the facility. Alternatively, an analysis of the need for continued operation of the PRGS could come from a request or requirement of FERC or the Public Service Commission of the District of Columbia ("PSC").

Second, as regards air pollution:

- Based on our simulation analysis of regional power system operations in the local region with and without PRGS, we found that the retirement of the PRGS would likely reduce air pollutants in the region – especially compared to the potential for PRGS to emit nitrogen oxides ("NO_x"), sulfur dioxide ("SO_2"), and carbon dioxide ("CO_2"), rather than its emissions levels in recent years.
- We estimate that retirement could reduce emissions of CO_2 by up to as much as 600,000 tons annually, if PRGS' potential output were replaced by other plants.
- The results related to impacts on the formation of ground-level ozone are similar. Total NO_x emissions could drop very substantially.
- Perhaps even more importantly from the perspective of local/regional air quality associated with ozone and particulates, PRGS retirement would reduce NO_x and SO_2 during the summer months, when air quality is typically at its worst in the northern Virginia/District of Columbia area. We estimate that plant closure could lead to reductions during the period June – August of approximately 1.9 million lbs of NO_x emissions, and 325,000 lbs of SO_2 emissions, if PRGS' potential generation were replaced by other plants in the region.
- These are upper limits on emissions reductions, since in recent years PRGS has run far less than its potential output.

In short, significantly lower emissions would likely result from retirement of PRGS, particularly in summer months, resulting in mitigation of the risks associated with climate change and improvement in local and regional air quality.

Our report provides an overview of the PRGS; summarizes historical background on environmental and reliability concerns associated with the power plant and its operation within the Washington DC area; explains changes that have occurred in the regional electrical system to address the reliability issues; reports data on recent operating history and emission control commitments made by the owners of the PRGS facility; and provides the results of our analysis of potential emissions from power station operations.

2. INTRODUCTION AND BACKGROUND ON THE POTOMAC RIVER GENERATION STATION

The PRGS is a 482 MW[1] coal-fired electric generating station owned by a subsidiary of GenOn Energy, Inc. ("GenOn"). The Station has five separate steam turbines built between 1949 and 1957, all of which remain in operation today. See Table 1. Further, the Station sits on an approximately 25-acre waterfront property in the rapidly-growing area of Alexandria, Virginia.[2]

Table 1

Potomac River
Power Plant Units - Details

	Potomac River ST 1	Potomac River ST 2	Potomac River ST 3	Potomac River ST 4	Potomac River ST 5
Generator Information					
Prime Mover	Steam Turbine	Steam Turbine	Steam Turbine	Steam Turbine	Steam Turbine
In-Service Month/Year	9/1949	6/1950	6/1954	2/1956	5/1957
Nameplate Capacity (MW)	92	92	110	110	110
Summer Net Capacity (MW)	88	88	102	102	102
Winter Net Capacity (MW)	88	88	102	102	102
Primary Fuel Type	Bituminous Coal	Bituminous Coal	Bituminous Coal	Bituminous Coal	Bituminous Coal
Secondary Fuel Type	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil

The PRGS has for many decades burned substantial amounts of coal, with relatively high emissions of air pollutants, exacerbating air quality concerns in the heavily populated region around Washington DC (and beyond), and contributing to the accumulation of greenhouse gases in the atmosphere.[3] With some of the older generating units in the region, and being located in a densely populated area, the PRGS has been the subject of environmental concerns for some time. In 2005 the Virginia Department of Environmental Quality ("Virginia DEQ") cited the facility as being in serious violation of the National Ambient Air

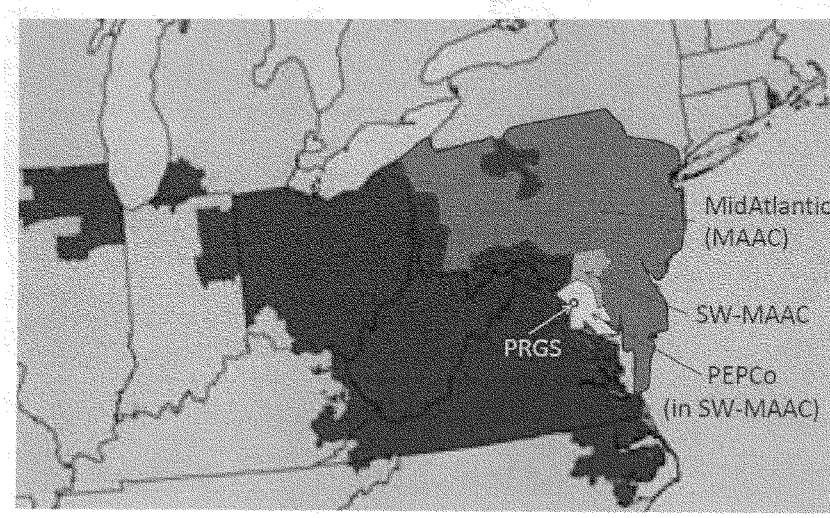
[1] Net summer capability.
[2] U.S Department of Health and Human Services, "Review of Ambient Air Monitoring Data, Mirant Potomac River Generating Station, Alexandria, Virginia", March 21, 2011, Appendix C.
[3] In 2010, PRGS burned 400,187 tons of coal and emitted 1.1 million tons of CO_2, 2.9 million pounds of NO_x, and 2.8 million pounds of SO2. Data from SNL.

Quality Standards ("NAAQS") for sulfur dioxide ("SO_2"), nitrogen dioxide ("NO_2") and particulate matter, requiring the unit to take action or shut down.[4]

From an electrical point of view, the PRGS is part of PJM's interconnected and integrated electric system serving not only parts of Northern Virginia and the District of Columbia, but also much of the MidAtlantic region and parts of the Midwest. In the PJM area, power plants are dispatched to provide reliable and economical supplies to the region's electricity consumers.

Within PJM, there are various zones reflecting the systems of various participating transmission companies. The PRGS is located electrically in the PEPCO load zone, in the Mid-Atlantic Sub- Region of PJM ("Mid-Atlantic" or "MAAC") – comprised of the PEPCO, Baltimore Gas & Electric ("BGE") and other utility transmission areas, as shown in Figure 1. The Mid-Atlantic Southwest ("Mid-Atlantic-SW") Zone is comprised of PEPCO and BGE.

Figure 1: Map of the PJM Region, with MAAC, SW-MAAC and the PEPCo Areas



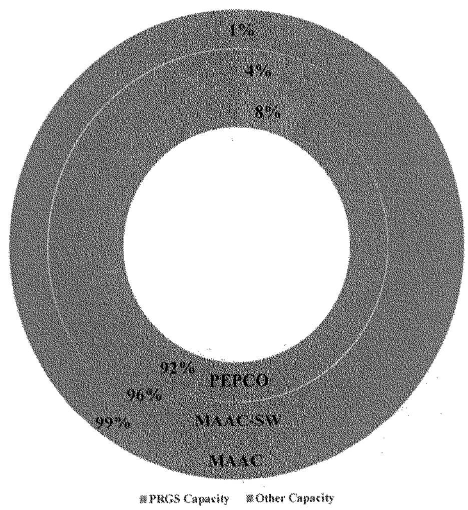
Source: Analysis Group based on PJM maps

[4] Letter from Robert G. Burnley, Director, Commonwealth of Virginia Department of Environmental Quality, to Lisa D. Johnson, President, Mirant Potomac River LLC, August 19, 2005.

The PRGS represents a small fraction of the total generating capacity in the areas of interest. In 2010, the combined capacity of all PRGS units represented approximately eight percent of the total capacity (6,345 MW) in the PEPCO region, four percent of the total capacity (11,751 MW) in the Mid-Atlantic-SW region of PJM, and one percent of total Mid-Atlantic capacity (a total of 66,047 MW). See Figure 2.

Figure 2

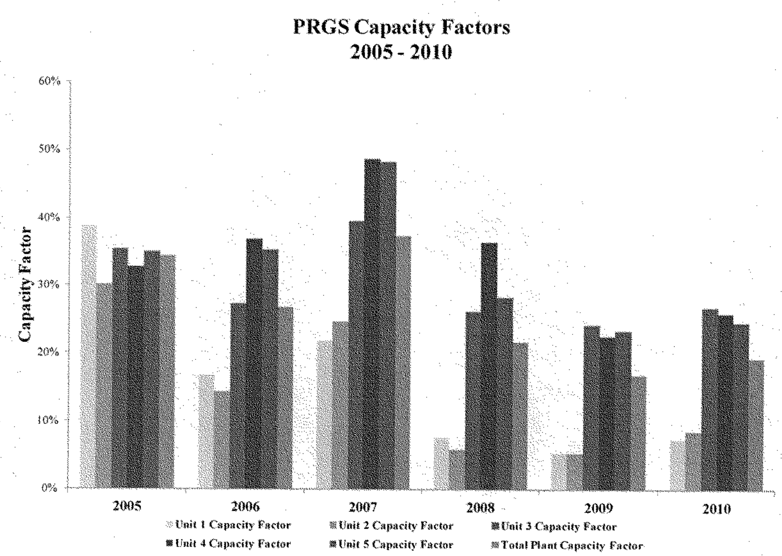
PRGS Share of Capacity in PEPCO, MAAC-SW, and MAAC Regions



Note: The MAAC-SW region is defined as the PEPCO region plus the BGE region. The MAAC region is defined as the PJM Mid-Atlantic Area Council region.
Source: Energy Velocity Data.

Power production at the PRGS units has varied, up and down, since 2005, with some years having much higher output than others. As shown in Figure 3, the facility's capacity factor ("CF") ranged between 17 and 37 percent.[5] Individual unit capacity factors over this time period have ranged from a low of 5 percent (for Unit 1, the oldest unit, in 2009) to a high of 49 percent (for Unit 4 in 2007).

Figure 3



Source: SNL Data.

Thus, reliance on the PRGS from the perspective of total energy output is less than its contribution to total regional generating capacity. With 8 percent of the capacity, the PRGS units together represented only 5 percent of the total generation in the PEPCO region, 2

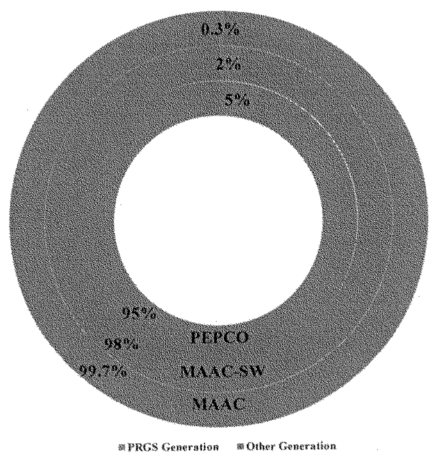
[5] Capacity factor measures the actual production of energy from the facility compared to what its production would be over the same time period if operating continuously at maximum output. Consequently, a CF of 10 percent means the unit produced only about one tenth of what it could have produced.

percent of the total Mid-Atlantic-SW generation, and just 0.3 percent of total power production in the Mid-Atlantic region.[6] See Figure 4.

At various times over the past decade, public concerns have been raised with regard to two issues relating to the PRGS: (1) its role in assuring reliable electricity to consumers in the local areas, and how that would be affected if the plant were to retire; and (2) its environmental impacts, such as those that led the Virginia DEQ to cite the facility as being in serious violation of air quality standards and ordering the plant to take action or shut down.

Figure 4

PRGS Share of 2010 Generation in PEPCO, MAAC-SW, and MAAC Regions



Note: The MAAC-SW region is defined as the PEPCO region plus the BGE region. The MAAC region is defined as the PJM Mid-Atlantic Area Council region.
Source: Energy Velocity Data.

[6] Total PEPCO region output in 2010 was 17 Terawatt-hours (TWh). Total Mid-Atlantic-SW output was 40 TWh; and total Mid-Atlantic generation of 277 TWh.

3. PRGS OPERATIONS AND LOCAL ELECTRIC SYSTEM RELIABILITY – HISTORY AND CONTEXT

Reliability Concerns Emerge[7]

Concerns over electric system reliability in the Washington DC area began with a PJM evaluation of the potential retirement of the PRGS in June 2005.[8] The report identified a number of potential reliability issues that could flow from the PRGS' retirement and highlighted the following technical issues:

- An outage of either of two parallel transmission lines (the Palmers Corner – Blue Plains – Potomac River 230 kV circuits) would result in an overload of the other remaining circuit. This potential reliability concern could be mitigated by new transmission lines (i.e., two new 230 kV circuits parallel to the existing circuits).
- Numerous voltage criteria violations could occur on the PEPCO system, requiring different equipment solutions – the installation of reactive compensation, with substation upgrades – to remedy this problem.
- Substation upgrades would also be required to address potential overloads due to line fault from potential stuck breakers.
- Line loading concerns could also arise on five high voltage circuits and two 500/230 kV transformer facilities, with resolution of these concerns best evaluated as part of a more comprehensive study for the area.

The potential for the identified reliability concerns to become reality emerged at about the same time. In August of 2005 the Virginia DEQ sent a letter to Mirant (PRGS' owner at the time), stating that the plant was in serious violation of the NAAQS for SO_2, NO_2, and particulate matter (specifically, PM10).[9] DEQ requested that Mirant "immediately undertake such action as is necessary to ensure protection of human health and the environment, in the area surrounding the Potomac River Generating Station, including the potential reduction of levels of operation, or potential shut down of the facility."[10] Mirant responded, stating that as of midnight on August 21, 2005, the output of all burners at the PRGS was reduced to the lowest possible level, and in light of not having found a way to operate the plant in

[7] To conduct this review, Analysis Group relied on public documents tracking the performance of the PRGS, reliability issues related to it, progress of transmission system upgrades to address reliability issues in the DC area, data from SNL on power plant unit operations and costs, and PJM data on hourly electrical load.
[8] "Reliability Evaluation for the Potential Retirement of Potomac River Generation," PJM, June 10, 2005.
[9] Letter from Robert G. Burnley, Director, Commonwealth of Virginia Department of Environmental Quality, to Lisa D. Johnson, President, Mirant Potomac River LLC, August 19, 2005.
[10] Letter from Robert G. Burnley, Director, Commonwealth of Virginia Department of Environmental Quality, to Lisa D. Johnson, President, Mirant Potomac River LLC, August 19, 2005.

accordance with NAAQS, Mirant planned to "shut down all five units at the power plant no later than midnight tonight, August 24, 2005."[11]

On August 25, 2005, the Office of the People's Counsel ("OPC") of the District of Columbia filed a motion with FERC related to closure of the PRGS.[12] The OPC raised its concern that if the plant closed, residential customers would not only be subject to reliability concerns but would also have to pay for any transmission upgrades that may be necessary in the event of the closure of the PRGS. The OPC requested, therefore, that FERC and the Secretary of Energy take steps to prevent the shutdown of the power plant. On the same day, the DC PSC filed an emergency petition with FERC requesting that FERC require the PRGS to continue operating.[13]

Several months later, the Secretary of Energy, using its emergency powers under the Federal Power Act,[14] issued an order declaring that an emergency existed due to a shortage of generation and transmission capacity in the area surrounding the PRGS.[15] DOE's order found that the central area of the District of Columbia was essentially served only by the PRGS and flows over two 230 kV transmission lines, and that the transmission infrastructure was inadequate to move power into the DC area from neighboring facilities (Benning Road and Buzzard Point generating facilities) if the PRGS facility were to retire. DOE raised concerns about the importance of power supply to critical federal agencies in the DC area and the Blue Plains wastewater treatment plant which, according to PEPCO, would have to release untreated sewage into the Potomac River within 24 hours of an electrical outage. Consequently, DOE ordered that:

- If one or both of the 230 kV transmission lines were out of service, the PRGS would be needed, with an amount of power specified by PJM.
- When producing electricity, Mirant would be required to use pollution control equipment and measures to minimize violations of NAAQS.
- Mirant would have to take all feasible steps to minimize the start-up time of PRGS for the purposes of providing electric reliability.[16]

[11] "Mirant Potomac River." Letter from Lisa D. Johnson. President. Mirant Potomac River LLC. to Robert G. Burnley. Director. Commonwealth of Virginia Department of Environmental Quality. August 24. 2005.
[12] "Notice of Filing of Emergency Petition and Complaint." District of Columbia Public Service Commission, FERC Docket No. EL05-145-000. August 25, 2005.
[13] "Office of the People's Counsel of the District of Columbia's Motion to Intervene." Office of the People's Counsel. District of Columbia, FERC Docket No. EL05-145-000. August 25, 2005.
[14] The Secretary of Energy is granted such powers by section 202(c) of the Federal Power Act (FPA). 16 U.S.C. § 824a(c). and section 301(b) of the Department of Energy Organization Act. 42 U.S.C. § 7151(b). which state. in part, that during "a shortage of electric energy or of facilities for the generation or transmission of electric energy…the Commission shall have authority…to require by order such temporary connections of facilities and such generation. delivery. interchange, or transmission of electric energy as in its judgment will best meet the emergency and serve the public interest."
[15] United States Department of Energy Order No. 202-05-3. District of Columbia Public Service Commission Docket No. EO-05-01. December 20. 2005.
[16] Ibid.

Given the air quality concerns with regard to continued operation of the PRGS plant under these conditions, additional steps followed.

The Transmission Response and PRGS Plans

At the beginning of 2006, FERC initiated a sequence of steps to accomplish an upgrade of the regional power system around Washington, DC, so as to assure reliable power system operations. FERC directed PJM, as the regional grid operator, and PEPCO, as the local transmission company, to "develop and implement a comprehensive plan to preserve reliability in the region."[17] PJM and PEPCO submitted their reliability plan in response to FERC's order on February 8, 2006.[18]

The plan included certain near-term and longer term plan elements.[19] Specifically, PEPCO proposed in the near-term to install two 69kV lines between the Palmers Corner and Blue Plains substations (with a planned in-service date of June 2006) in order to serve the Blue Plains wastewater treatment plant from the Palmers Corner substation rather than from the Potomac River substation and to reduce the total amount of load served from the PRGS.

Looking to longer-term plan elements, PEPCO proposed to construct two 230kV transmission lines between the Palmers Corner substation and the Blue Plains switching station, with an anticipated in-service date of June 2007. According to PEPCO, construction of these lines was anticipated to resolve all reliability concerns, including those that would result from the retirement of the PRGS. PEPCO also requested extension of DOE's order for continued operation of the PRGS until construction for the transmission projects were completed, and committed to continue to evaluate the potential need for additional transmission infrastructure on PEPCO and neighboring systems in order to address the permanent loss of the PRGS generating capacity.[20]

Throughout the rest of 2006 and into 2007, a number of factors indicated a change in outlook for continued operation of the PRGS. The reliability issues meant that at least temporarily, the plant would need to remain in service. In June of 2006, EPA issued an order allowing the PRGS to return to near capacity generation, provided the plant does not exceed federal air

[17] "PEPCO, PJM Directed to Develop Comprehensive Plan to Assure Continued Power Grid Reliability," Federal Energy Regulatory Commission News Release, January 9, 2006.
[18] Letter from Kirk J. Emge, General Counsel, Potomac Electric Power Company, and Vincent P. Duane, Deputy General Counsel, PJM Interconnection LLC, to Magalie R. Salas, Secretary, Federal Energy Regulatory Commission, RE: District of Columbia Public Service Commission, Docket No. EI05-145-000 Joint Compliance Filing of Potomac Electric Power Company and PJM Interconnection, LLC, February 8, 2006.
[19] The information we have relied upon in our analysis is the public portion of this report, since much of the information in the Plan is redacted as Critical Energy Infrastructure Information (CEII).
[20] Letter from Kirk J. Emge, General Counsel, Potomac Electric Power Company, and Vincent P. Duane, Deputy General Counsel, PJM Interconnection LLC, to Magalie R. Salas, Secretary, Federal Energy Regulatory Commission, RE: District of Columbia Public Service Commission, Docket No. EI05-145-000 Joint Compliance Filing of Potomac Electric Power Company and PJM Interconnection, LLC, February 8, 2006.

quality standards.[21] In this context, a PEPCO spokesperson stated that the absence of the PRGS put PEPCO's reliability "at risk."[22] At the beginning of 2007, the DC PSC urged DOE to "think twice" before allowing the expiration of its emergency order, which kept the PRGS running for reliability reasons.[23] The DC PSC suggested that only if a new reliability study, performed after the installation of the additional transmission resources into DC, were to indicate that reliability concerns no longer existed should the DOE emergency order be allowed to end. Mirant argued that the completion of transmission upgrades should not be presumed to lead to the retirement of the PRGS, without a thorough review of the reliability situation.[24]

In February 2007, PJM addressed these issues for the first time in its 2006 Regional Transmission Expansion Plan ("RTEP").[25] RTEP noted an expectation that the plant would remain available under certain circumstances until at least July 2007. It also stated that the potential violations of reliability criteria associated with plant closure would not be fully rectified until "various RTEP upgrades are completed in 2008."[26] The plan stated that the final status of the PRGS "has not yet been established, pending the outcome of regulatory decisions on whether and to what extent the plant must be upgraded to meet environmental standards."[27]

The Apparent Elimination of the Need for PRGS

For the remainder of 2007 and into 2008, progress was made on the transmission system upgrades. Technical review of PEPCO and PJM transmission plans by the state and federal authorities all point to an expectation that once these lines entered service, there would no longer be a need for the PRGS in order to maintain power system reliability in the Washington DC area. For example, on July 9, 2007, in consideration of PJM's installation of the additional 230 kV transmission lines into the DC area, DOE allowed its 2005 emergency order forcing the PRGS to operate to expire, and noted "now that we have seen the installation of the added lines...the emergency condition we felt existed has passed and there is no reason for the department to extend the order."[28]

[21] Gowen, Annie, "EPA Lets Mirant Increase Output," The Washington Post, June 3, 2006.
[22] Gowen, Annie, "EPA Lets Mirant Increase Output," The Washington Post, June 3, 2006.
[23] "DC Regulators Press Energy Secretary to Keep Mirant Plant in Virginia Running," Platts Global Power Report, January 18, 2007.
[24] E-Mail from Debra Raggio Bolton, Vice President & Assistant General Counsel, Mirant Potomac River LLC, to Anthony J. Como, Office of Electricity Delivery and Energy Reliability, U.S. Department of Energy, RE: Special Environmental Analysis, DOE/SEA-04, Potomac River Generating Station, Reply to Comments, January 30, 2007.
[25] PJM 2006 Regional Transmission Expansion Plan, PJM, February 27, 2007
[26] PJM 2006 Regional Transmission Expansion Plan, PJM, February 27, 2007, p. 71.
[27] PJM 2006 Regional Transmission Expansion Plan, PJM, February 27, 2007, p. 71.
[28] Loveless, Bill, "With New Transmission Lines to DC, DOE Lets Emergency Order Run Out," Platts Inside Energy, July 9, 2007.

In July 2007, PEPCO submitted its monthly progress report to FERC on progress addressing the reliability concerns surrounding the potential retirement of the PRGS.[29] In this progress report, PEPCO indicated the completion of construction of the 230 kV transmission lines as well as all related tasks as outlined in the February 8, 2006 plan. PEPCO also requested relief from the requirement to submit monthly progress reports to FERC. In response, in August 2007, FERC found that the construction of the new transmission lines had "provided new capacity to adequately serve load absent the Potomac River Generating Station power plant," and that PEPCO and PJM had completed the long-term plan that they had earlier filed with FERC.[30] However, FERC did require PEPCO and PJM to respond to additional reliability questions that had been identified in response to a previously-issued FERC discovery question and noted in the February 2007 PJM RTEP.

On September 24, 2007, PJM responded with a report to FERC saying that: "PJM and PEPCO are confident that they successfully have addressed the potential reliability problems they identified earlier, including actual and projected violations of any reliability standards and/or reliability criteria, in the Washington, D.C. area absent the Potomac River Generating Station power plant." [31] This was accomplished through the installation of additional transmission lines, and the installation of additional equipment serving the transmission systems for the DC area as well as the Baltimore area. The transmission facilities identified as needed to resolve reliability issues are presented in Table 2, below, including the upgrade identification and description, projected completion date, and status/percent complete. This was the status of these facilities as of the filing of the September 24, 2007 PJM Report to FERC. On January 10, 2008 FERC issued a decision accepting the PJM report as having met FERC's requirements and indicating that the "order constitutes final agency action."[32]

[29] Letter from Amy L. Blauman, Assistant General Counsel, Potomac Electric Power Company, to Kimberly Bose, Secretary, Federal Energy Regulatory Commission, RE: District of Columbia Public Service Commission, Docket No. EL05-145-000, Monthly Progress Report for June, 2007, and Request to Confirm Termination of Reporting Requirement, July 13, 2007.
[30] "Order on Reporting Requirements," FERC Docket Nos. EL05-145-000 & EL05-145-001, August 24, 2007.
[31] Letter from Jeffrey W. Mayes, Senior Counsel, PJM Interconnection LLC, and Craig Glazer, Vice President, Federal Government Policy, PJM Interconnection LLC, to Kimberly D. Bose, Secretary, Federal Energy Regulatory Commission, RE: District of Columbia Public Service Commission, EL05-145 -001, September 24, 2007.
[32] Letter from Joseph H. McClelland, Director, Office of Electric Reliability, Federal Energy Regulatory Commission, to Craig Glazer, Vice President of Federal Government Policy, PJM Interconnection LLC, RE: Submission of Report on Potomac River Generating Station and Washington, D.C. Area Reliability Problems, January 10, 2008.

Table 2 – Transmission Upgrades

Upgrade ID	Description	Trans. Owner	PJM Required Date	TO Projected Date	Status Code	Percent Complete	Cost Estimate	State
b0039.1	BGE Reactive Upgrades	BGE	6/1/2007	6/1/2004	In-Service	100%	$ 9.12	MD
b0039.2	PEPCO Reactive Upgrades	PEPCO	6/1/2007	6/1/2005	In-Service	100%	$ 2.64	MD
b0039.5	Install Waugh Chapel 230kV 360MVAR capacitor bank	BGE	6/1/2006	6/1/2006	In-Service	100%	$ 1.70	MD
b0247	Install 14 MVAR of 69kV bus capacitors at Quince Orchard	PEPCO	6/1/2006	6/1/2006	In-Service	100%	$ 0.45	MD
b0248	Install 14 MVAR of 69kV bus capacitors at Norbeck	PEPCO	6/1/2006	6/1/2006	In-Service	100%	$ 0.45	MD
b0249	Install 28 MVAR of 69kV bus capacitors at Bells Mill	PEPCO	6/1/2006	12/2/2005	In-Service	100%	$ 0.72	MD
b0250	Install 108 MVAR of feeder capacitors at various locations	PEPCO	6/1/2006	6/1/2006	In-Service	100%	$ 2.76	MD
b0251	Install 100 MVAR of 230kV capacitors at Bells Mill	PEPCO	6/1/2009	6/1/2010	Eng. & Planning	15%	$ 3.90	MD
b0252	Install 100 MVAR of 230kV capacitors at Bells Mill	PEPCO	6/1/2009	6/1/2010	Eng. & Planning	10%	$ 3.00	MD

Upgrade ID	Description	Trans. Owner	PJM Required Date	TO Projected Date	Status	Percent Complete	Cost Estimate	State
b0002	Increase emergency rating of Windy Edge - Lakespring - Texas 115 kV	BGE			In-Service	100%	$ 3.77	MD
b0010	Replace Northwest 230/115 kV transformers with 500 MVA transformers	BGE		5/1/2003	In-Service	100%	$ 9.00	MD
b0030	Construct a new 230kV tower line to separate the existing Brandon Shores-Riverside DCTL to eliminate MAAC 2C violation	BGE	6/1/2005	1/1/2007	In-Service	100%	$ 4.00	MD
b0031.1	Replace one (1) Conastone 230 kV breaker #6 (GCB) (2322/2302 line)	BGE		5/14/2004	In-Service	100%	$ 0.50	MD
b0031.2	Replace one (1) Conastone 230 kV breaker #5(ATB) (500-2/2322 line)	BGE		3/7/2003	In-Service	100%	$ 0.22	MD
b0032	Upgrade two Waugh Chapel 230 kV breakers	BGE			In-Service	100%	$ -	MD
b0035	Change Calvert Cliffs unit 1 & 2 GSU tap settings	BGE		5/1/2004	In-Service	100%	$ -	MD
b0039.1	BGE Reactive Upgrades	BGE	6/1/2007	6/1/2004	In-Service	100%	$ 9.12	MD
b0039.2	PEPCO Reactive Upgrades	PEPCO	6/1/2007	6/1/2005	In-Service	100%	$ 2.64	MD
b0039.5	Install Waugh Chapel 230kV 360MVAR capacitor bank	BGE	6/1/2006	6/1/2006	In-Service	100%	$ 1.70	MD
b0146.1	Replace Quince Orchard 230kV circuit breaker for line 23029	PEPCO	6/1/2006	6/1/2006	In Service	100%	$ 1.75	MD
b0146.2	Installation of two additional 230kV circuit breakers at Quince Orchard substation on circuits 23028 and 23029	PEPCO	6/1/2006	12/31/2006	In-Service	100%	$ 3.04	MD
b0150	Modify fixed tap settings of Waugh Chapel 500/230 kV transformers	BGE	6/1/2005	6/1/2005	In-Service	100%	$ -	MD
b0152.1	Add 1-230 kV breakers at High Ridge	BGE	6/1/2005	6/1/2005	In-Service	100%	$ 0.59	MD
b0152.2	Install 230kV breaker at High Ridge for line 2336	BGE	6/1/2006	6/1/2006	In-Service	100%	$ 0.59	MD
b0167	Upgrade Oak Grove 230kV Breaker 13C	PEPCO	6/1/2006	12/31/2005	In-Service	100%	$ 0.20	MD
b0168	Upgrade Oak Grove 230kV Breaker 5C	PEPCO	6/1/2006	12/31/2006	In-Service	100%	$ 0.21	MD
b0187	Upgrade Dickerson Station "D" 230kV 1A	PEPCO	6/1/2006	6/1/2006	In-Service	100%	$ 0.21	MD
b0188	Upgrade Dickerson Station "D" 230 kV 1B	PEPCO	6/1/2006	6/1/2006	In-Service	100%	$ 0.21	MD
b0189	Upgrade Dickerson Station "D" 230 kV 2A	PEPCO	6/1/2006	6/1/2006	In-Service	100%	$ 0.21	MD
b0190	Upgrade Dickerson Station "D" 230 kV 2B	PEPCO	6/1/2006	6/1/2006	In-Service	100%	$ 0.21	MD
b0191	Upgrade Dickerson Station "D" 230 kV 3A	PEPCO	6/1/2006	12/31/2006	In-Service	100%	$ 0.21	MD
b0192	Upgrade Dickerson Station "D" 230 kV 3B	PEPCO	6/1/2006	12/31/2006	In-Service	100%	$ 0.21	MD
b0193	Upgrade Dickerson Station "D" 230 kV 5A	PEPCO	6/1/2006	12/31/2006	In-Service	100%	$ 0.21	MD
b0194	Upgrade Dickerson Station "D" 230 kV 6C	PEPCO	6/1/2006	12/31/2006	In-Service	100%	$ 0.21	MD

Upgrade ID	Description	Trans. Owner	PJM Required Date	TO Projected Date	Status	Percent Complete	Cost Estimate	State
b0219	Install two new 230kV circuits between Palmers Corner and Blue Plains	PEPCO	6/1/2007	7/1/2007	In-Service	100%	$ 91.00	MD
b0228	Upgrade Burtonsville - Sandy Springs 230kV circuit	PEPCO	6/1/2010	6/1/2010	Eng. & Planning	0%	$ 0.40	MD
b0238.1	Modify Dickerson Station H 230 kV	PEPCO	6/1/2009	6/30/2009	Eng. & Planning	5%	$ 2.00	MD
b0244	Install a 4th Waugh Chapel 500/230kV transformer, terminate the transformer in a new 500 kV bay and operate the existing in-service spare transformer on standby and other assoc. configuration changes	BGE	5/31/2008	6/1/2008	Eng. & Planning		$ 29.80	MD
b0247	Install 14 MVAR of 69kV bus capacitors at Quince Orchard	PEPCO	6/1/2006	6/1/2006	In-Service	100%	$ 0.45	MD
b0248	Install 14 MVAR of 69kV bus capacitors at Norbeck	PEPCO	6/1/2006	6/1/2006	In-Service	100%	$ 0.45	MD
b0249	Install 28 MVAR of 69kV bus capacitors at Bells Mill	PEPCO	6/1/2006	12/2/2005	In-Service	100%	$ 0.72	MD
b0250	Install 108 MVAR of feeder capacitors at various locations	PEPCO	6/1/2006	6/1/2006	In-Service	100%	$ 2.76	MD
b0251	Install 100 MVAR of 230kV capacitors at Bells Mill	PEPCO	6/1/2009	6/1/2010	Eng. & Planning	15%	$ 3.90	MD
b0252	Install 100 MVAR of 230kV capacitors at Bells Mill	PEPCO	6/1/2009	6/1/2010	Eng. & Planning	10%	$ 3.00	MD
b0288	Brighton Substation - Add 2nd 1000 MVA 500/230kV transformer, 2 500kV circuit breakers and miscellaneous bus work	PEPCO	6/1/2009	6/1/2009	Eng. & Planning	30%	$ 33.10	MD
b0298	Replace both Conastone 500/230kV transformer banks with larger transformers, replace breakers #4 & #7 and other configuration changes	BGE	5/31/2009	5/31/2009	Eng. & Planning		$ 43.50	MD
b0298.1	Replace Conastone 230kV breaker 500-3/2323	BGE	5/31/2008	9/23/2007	Eng. & Planning		$ 1.00	MD
b0319	Burches Hill Substation - Add 2nd 1000 MVA 500/230kV Transformer	PEPCO	6/1/2011	6/1/2011	Eng. & Planning	20%	$ 36.70	MD
b0366	Install 4th Ritchie 230/69kV transformer	PEPCO	6/1/2011	6/1/2011	Eng. & Planning	10%	$ 11.50	MD
b0367	Reconductor 230kV Quince Orchard to Dickerson circuits 33 & 35	PEPCO	6/1/2011	6/1/2011	Eng. & Planning	10%	$ 20.00	MD
b0375	Upgrade Dickerson - Pleasant View 230kV Circuit	PEPCO	6/1/2011	6/1/2011	Eng. & Planning	10%	$ 5.00	MD/VA
b0467.1	Reconductor the Dickerson - Pleasant View 230kV circuit	PEPCO	6/1/2011		Eng. & Planning		$ 5.00	MD
b0474	Add a fourth 230 / 115 kV transformer, two 230 kV circuit breakers and a 115 kV breaker at Waugh Chapel	BGE	6/1/2012		Eng. & Planning		$ 17.00	MD
b0475	Create two 230 kV ring buses at North West, add two 230 / 115 kV transformers at North West and Create a new 115 kV station at North West	BGE	6/1/2012		Eng. & Planning		$ 20.00	MD
b0476	Rebuild High Ridge 230kV substation to Breaker and Half configuration.	BGE	6/1/2012		Eng. & Planning		$ 65.50	MD
b0477	Replace the Waugh Chapel 500/230 kV transformer #1 with three single phase transformers	BGE	6/1/2012	6/1/2011	Eng. & Planning		$ 26.00	MD
b0478	Reconductor the four circuits from Burches Hill to Palmers Corner and replace terminal equipment	PEPCO	6/1/2012		Eng. & Planning		$ 14.50	MD
b0496	Replace existing 500/230 kV transformer at Brighton	PEPCO	6/1/2012		Eng. & Planning		$ 18.00	MD
b0497	Install a second Conastone - Graceton 230 kV circuit and replace Conastone 230 kV breaker 2323/2302	BGE	6/1/2012		Eng. & Planning		$ 13.00	MD
b0499	Install third Burches Hill 500/230 kV transformer	PEPCO	6/1/2012		Eng. & Planning		$ 35.00	MD

As can be seen in Table 2, while much progress had been made in completing the upgrades needed to address the reliability concerns, a number of upgrades were still in progress, primarily in the engineering and planning phase of development. However, as of May 2011, a review of the PJM transmission upgrade status list shows that only 5 projects remain in the engineering and planning phase, with all but two of the remaining projects expected to be in-service by the end of 2012. See Table 3.

Table 3

Projects Noted by PJM in 2007 as Necessary for Reliability After June 2008
Projects Currently Less Than 100% Complete

Upgrade ID	Description	PJM Required Date - 2007	PJM Required Date - Current	TO Projected Date - 2007	TO Projected Date - Current	Percent Complete	Project Phase
b0319	Burches Hill Substation - Add 2nd 1000 MVA 500/230 kV Transformer	6/1/2011	6/1/2011	6/1/2011	6/8/2011	85%	Construction Activities
b0367	Reconductor 230 kV Quince Orchard to Dickerson circuits 33 & 35	6/1/2011	6/1/2011	6/1/2011	6/19/2011	40%	Construction Activities
b0375[1]	Upgrade Dickerson - Pleasant View 230 kV circuit	6/1/2011		6/1/2011			
b0467.1	Reconductor the Dickerson - Pleasant View 230 kV circuit	6/1/2011	6/1/2011		6/1/2011	40%	Construction Activities
b0474	Add a fourth 230 / 115 kV transformer, two 230 kV circuit breakers and a 115 kV breaker at Waugh Chapel	6/1/2012	6/1/2012		6/1/2012	15%	Engineering and Planning
b0475	Create two 230 kV ring buses at North West, add two 230/115 kV transformers at North West and Create a new 115 kV station at North West	6/1/2012	6/1/2012		6/1/2012	44%	Construction Activities
b0476	Rebuild High Rdige 230 kV substation to Breaker and Half configuration	6/1/2012	6/1/2012		6/1/2012	27%	Construction Activities
b0477	Replace the Waugh Chapel 500/230 kV transformer #1 with three single phase transformers	6/1/2012	6/1/2012	6/1/2011	6/1/2011	40%	Construction Activities
b0478	Reconductor the four circuits from Burches HILl to Palmers Corner and replace terminal equipment	6/1/2012	6/1/2012		6/1/2012	15%	Engineering and Planning
b0496	Replace existing 500/230 kV transformer at Brighton	6/1/2012	6/1/2013		6/1/2013	15%	Engineering and Planning
b0497	Install a second Conastone - Graceton 230 kV circuit and replace Conastone 230 kV breaker 2323/2302	6/1/2012	6/1/2014		6/1/2014	5%	Engineering and Planning
b0499	Install third Burches Hill 500/230 kV transformer	6/1/2012	6/1/2013		12/31/2012	20%	Engineering and Planning

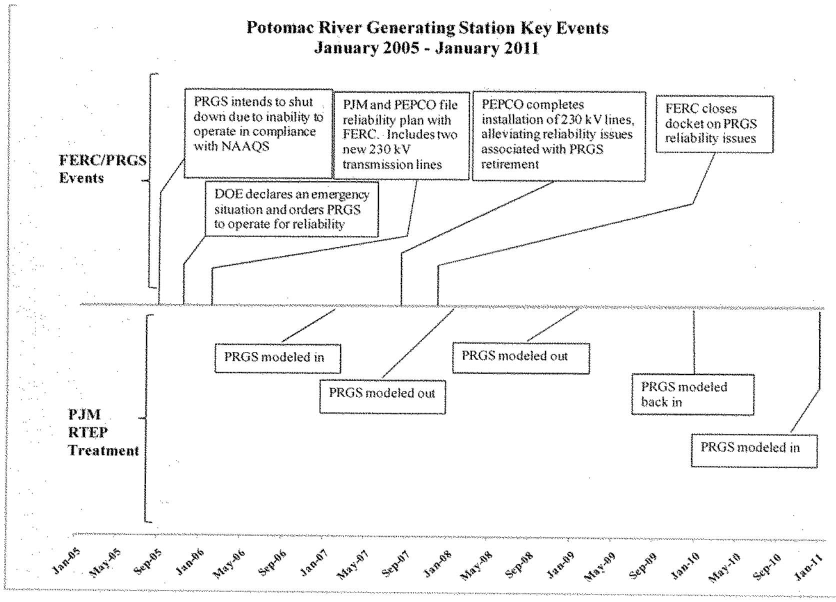
Note:
1. No information about this upgrade was available on the PJM website.

Source:
"Transmission Construction Status", PJM, http://pjm.com/planning/rtep-upgrades-status/construct-status.aspx, accessed May 17, 2011.

Observations as of 2011

These events that occurred during 2007/2008 were the culmination of a long, deliberative process of policy and analysis, and subsequent transmission system upgrade activities, involving several government agencies (FERC, the DOE, the DC PSC, and transmission system planners and operators (PJM and PEPCO). They key events and reliability modeling assumptions related to the PRGS are summarized in Figure 5.

Figure 5



The process of careful review and mitigation of local reliability issues involved the parties responsible for assuring adequate supply of electricity to consumers in the potentially affected areas. PJM, as the entity responsible for reliable operations of the bulk power system in the area, took steps to assess the original request to retire a generating unit, and to plan the transmission system in the near and long term to support reliable grid operations in all contingencies. PJM tracks changes in the system, including demand, generation unit changes, as well as the status of upgrade development, construction and activation. For example, if the owner of a power plant located in the PJM region wishes to deactivate, or retire, the power plant, it must provide notice no later than 90 days prior to the proposed deactivation date for the unit.[33] Following a deactivation request, PJM reviews the potential impacts on power system reliability if a plant were to retire. Upon a retirement decision, PJM assumes that the unit is out of service in subsequent regional transmission planning evaluations of power system reliability.

Thus, when Mirant declared it would shut down the PRGS in August of 2005, PJM began to assume in its RTEP that PRGS was retired. As regulatory events unfolded over time with respect to the PRGS (from both an environmental and reliability point of view), PJM has variously modeled the PRGS as in or out of service. Figure 5 above depicts the treatment of the PRGS in various PJM assessments taken from annual RTEPs.

PJM currently models the PRGS as in service, and GenOn (the current owner of the plant, which was sold by Mirant) has not filed a deactivation request for the station. Should it do so, PJM will need to conduct a transmission analysis to confirm that retirement of the plant will not create reliability concerns, and the focus of that analysis is likely to center on transmission system contingencies in the Washington DC area. Based upon a review of the events of the past five years related to requirements by FERC on PJM and PEPCO, and the substantial transmission system upgrades that have been put in place as a result of these regulatory requirements and specifically to address reliability concerns associated with the potential retirement of the PRGS, we expect that it is unlikely that PJM will find the station needed for reliability if GenOn were to request deactivation.

A deactivation request is not the only path to a reliability evaluation at this point in time. As has happened in the past, any decision to retire the PRGS will likely attract a heavy degree of attention from state, district, and federal governmental authorities to ensure that plant closure – which may be warranted for economic and air quality reasons – will not lead to reliability violations within the critical Washington DC area. It would be prudent in light of the many indicators pointing towards the potential retirement of generation facilities for economic and environmental compliance reasons to initiate a retirement review for the PRGS at this time.

To the extent that the PRGS is facing difficult decisions related to plant economics and/or compliance with environmental requirements that will become effective and will likely require decisions on new capital investment for compliance in the next few years, a proactive approach to a reliability evaluation will help confirm that reliability will be preserved in the District, and that the decision by GenOn with respect to continued operation of the PRGS can be made on the basis solely of economic and financial considerations. Importantly, such an

[33] PJM OATT - Part V - Generation Deactivation, page 339.

analysis could be initiated as a reliability scenario analysis by PJM, or could be requested or required by the DC PSC, FERC, and/or US DOE.[34]

4. PRGS POLLUTION CONTROL AND EMISSION IMPACTS

The Regulatory and Economic Setting for Continued Operation

The original context for the historical interest in retiring the PRGS focused on environmental issues associated with the plant. Recall that in 2005, the Virginia DEQ cited the facility as being in violation of various air pollution standards designed to protect the health of residents in the local and regional area. Importantly, local public health impacts of power plant operation are often most important during summer peak load conditions, and this is no different for the Washington DC metropolitan area. Plant operations during hot summer conditions tend to strongly exacerbate already poor air quality conditions.

Six years later, in 2011, the environmental issues are different, but nonetheless remain challenging. Several factors could affect the continued viability of the plant going forward: the old age, relatively poor efficiency, and emission profile of the PRGS; the emergence of new environmental requirements affecting coal plants with compliance periods starting in the next few years; the continued risk of carbon control requirements occurring sometime in the future; and significant changes in fuel market conditions that affect the relative attractiveness of output at many gas-fired power plants relative to older and less efficient coal-fired power plants. Together, these factors would present difficult decisions for the owner of a facility, like the PRGS, in the coming months or years. The Station's generating units are among the oldest in the region, ranging from 54 to 61 years old. The emergence of relatively abundant, low-priced natural gas has dramatically affected energy market revenues for all generators across the region. And emerging federal environmental regulations are likely to impose significant additional capital costs for emission controls on the plant.

The PRGS has a history of challenges in meeting environmental requirements and addressing the concerns of environmental regulators. The 2005 citation issued by the Virginia DEQ caused the plant owners to take action to remedy the problem or shut down (which it almost did). In July 2008, the PRGS' then-owner, Mirant, and the City of Alexandria entered into a project schedule and agreement regarding the implementation of emissions controls at the PRGS.[35] As part of the agreement Mirant agreed to deposit $34 million in an escrow account for purposes of implementing a detailed list of pollution control technology at the PRGS. In

[34] See, for example, DOE's authority under Section 202(c) of the Federal Power Act, 16 U.S.C. 825a(c) and section 301(b) of the Department of Energy Organization Act, U.S.C. 7151(b).

[35] "Project Schedule and Agreement," Between Mirant Potomac River, LLC, and the City of Alexandria, Virginia, July 14, 2008.

July of 2010, the Virginia DEQ issued new permit limits on the Station's emission, in part to lower emissions at a time when they contribute to public health concerns during the summer ozone season. Finally, in 2011 GenOn entered into an agreement with the Virginia DEQ to pay $276,000 to settle a number of emission violations.[36]

GenOn is likely to need to install additional controls to comply with forthcoming air, coal-ash handling, and possibly water quality requirements of the U.S. Environmental Protection Agency ("EPA").[37] Compliance with these regulations and continued operation of the plant would require GenOn to take steps (and make capital investments) at the PRGS beginning within the next few years. As NAAQS requirements tighten, along with stronger controls over emissions of mercury and other hazardous air pollutants, the treatment of coal ash, and increased protection of aquatic species near power plant intake structures emerge, GenOn will need to determine whether continued operation of the plant makes economic sense given prevailing fuel prices and market dynamics, increased operation and maintenance costs for an aging facility, and the potential for new regulatory requirements related to emissions of CO_2.

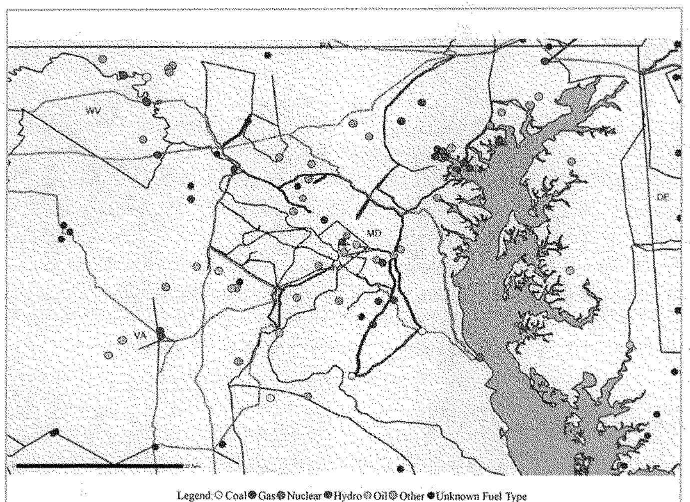
Potential Air Emission Impacts of PRGS Closure

Based on public records, it does not appear that GenOn has decided to retire the PRGS facility. Were it to close permanently, its output would likely be replaced primarily through dispatch of other power plants in the Mid-Atlantic region of PJM in which it sits. Since surrounding generation sources include a mix of fuel and technology types (as shown in Figure 6), it cannot be assumed *a priori* that retirement of the facility would lead to a net decrease or a net increase in regional emissions.

Consequently, we analyzed various generation dispatch and emissions scenarios to determine potential impacts from the point of view of impacts on the emission of air pollutants in the region.

[36] GenOn Energy, Inc. 10-Q Report for Q1 2011, filed May 9, 2011.
[37] These regulations relate to the EPA's implementation of the Clean Air Act (the updated NAAQS, the Clean Air Transport Rule and the Mercury/Air Toxics Rule affecting coal and oil plants), the Clean Water Act (the so-called 316(b) requirements relating to use of water cooling systems for thermal power plants), and the coal-ash handling rules, proposed under the Resource Conservation and Recovery Act.

Figure 6 – Power plants in the area near PRGS



Source: SNL.

To estimate the potential air quality impacts of permanent retirement of the PRGS, we constructed a model to estimate regional emissions with and without operation of the Station, assuming full potential to produce power from each generating unit (including PRGS).[38] Specifically, we modeled total emissions of CO_2, SO_2, and NO_x for 2010 with PRGS in service to meet electrical demand, and then compared those estimates with another depicting the same level of electrical demand without the PRGS available for operation. While we looked at the results from the perspective of the immediate PJM region in which it sits (the PJM Mid-Atlantic-SW transmission zone - which is the region including PEPCO and BGE), we also expanded the analysis to include the full PJM Mid-Atlantic Transmission Area, recognizing that in many hours the absence of PRGS would increase generation from facilities outside PJM Mid-Atlantic-SW.[39]

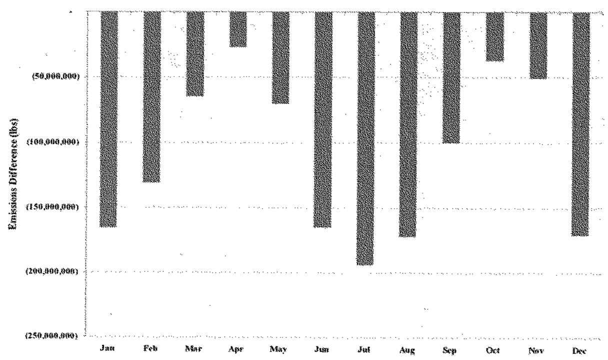
[38] Note that PRGS has operated at significantly less than full power in recent years, as shown in Figure 3 (displaying PRGS' capacity factors in recent years). Removing PRGS from service in 2010 – when the highest capacity factor of the station's units was less than 30 percent – would have required replacement of only the actual level of output, and the emissions from the replacement power would have been compared to PRGS' actual emissions. Going forward, since we did not know the level of dispatch of PRGS or any other power plant, we examined each plant's potential to generate power and potential to emit air pollution.

[39] Our analysis started with the construction of a supply curve for the region of relevance. Using data from Ventyx on unit capacities, emission rates, and marginal costs, we created in effect a dispatch order for generation in the region, ranging

Our purpose in constructing this analysis was to develop a first-order approximation of the likely direction of the impact of PRGS retirement on emissions, in order to determine whether the impact would be positive or negative given the emission profiles of other generation facilities in the region of interest. We therefore made a number of appropriate but simplifying assumptions in making these calculations.[40]

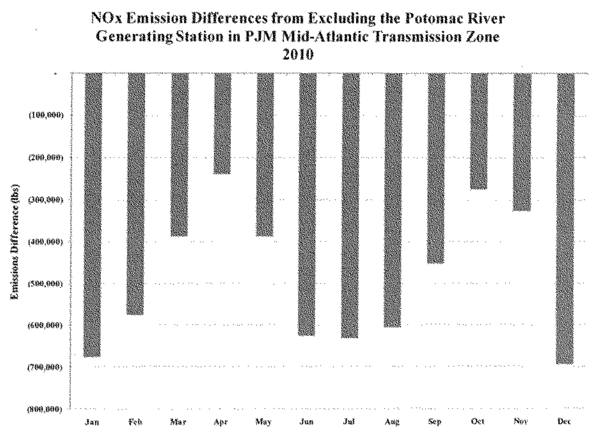
The results show that the retirement of PRGS would likely provide benefits from the perspectives of public health and climate change risks. Specifically, removal of PRGS would lead to reductions in monthly emissions of CO_2 of between approximately 10,000 and 90,000 tons. Total annual CO_2 emissions would be reduced by nearly 600,000 tons. See Figure 7.

Figure 7a and 7b



from lowest to highest marginal cost. We then gathered from PJM data on zonal-specific metered loads for every hour of every day in 2010 (8760 hours). For each hour, we simulated a "dispatch" of generation by moving up the supply curve until reaching the metered load for that hour. We calculated emissions for the hour and for each pollutant as the sum of emissions from all plants operating, based on the generation in the hour from each facility and emission rates. We repeated this process for each hour in the year, and summed emissions for each month. We performed this process again after removing the five PRGS units from the generation mix, and then calculated the differences in emissions of each pollutant across the two scenarios.

40 To derive a precise estimate, one would want to run an actual dispatch model; one that takes into account in more systematic faction the impact of unit outages, individual transmission line limits and constraints, heat rates that vary across the operating range of the generating units (ours are a single full-load heat rate), unit operational characteristics such as minimum and maximum run time, and ramp rates, etc. However, such a modeling was not necessary here, in light of our goal of characterizing the relative impact of retiring the PRGS unit on overall emissions in the region.



Removal of PRGS would also reduce monthly emissions of NO_x by between approximately 250,000 and 700,000 lbs. Total annual NO_x emissions would be reduced by nearly six million pounds, as shown in Figure 7. Reductions of NO_x are particularly strong in summer months, when local and regional air quality concerns associated with ground-level ozone and particulates are most acute.[41]

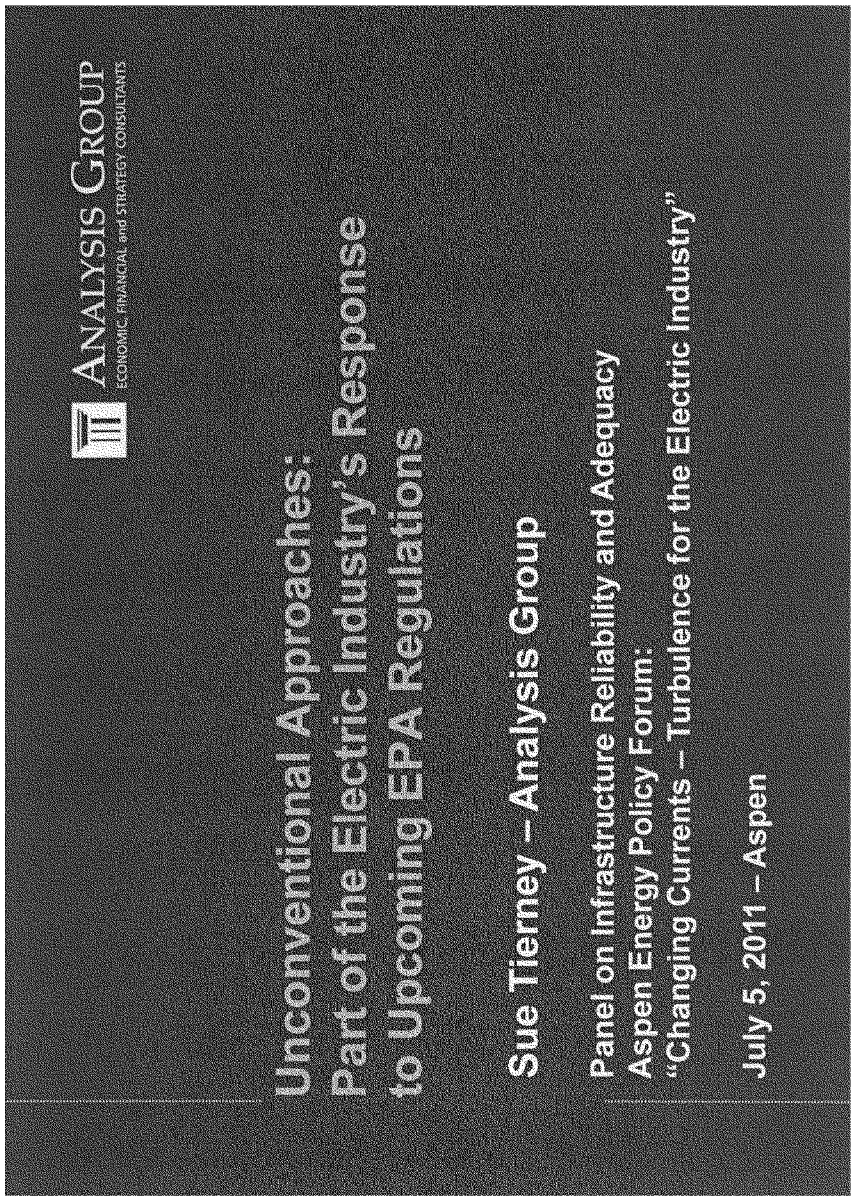
5. CONCLUSIONS

Our review of regulatory, planning, generation output, and other documents in the public domain suggests that the substantial transmission system upgrades that have been put in place in and around the PRGS facility render the plant no longer needed from a reliability point of view. Such a conclusion would need to be confirmed by PJM and PEPCO, in the event that the plant's owner filed a request to deactivate the unit, or regulatory authorities considered it in the public interest to request or require a reliability analysis done in anticipation of plant closure.

Were the PRGS power plant to retire, it would likely lead to overall reductions of pollutants contributing to local/regional air quality and climate change risks, in light of other more efficient and less-polluting plants replacing the power that PRGS would have generated.

[41] Significant reductions of SO2 during summer months are also likely. Specifically, our modeling reveals a reduction in regional SO2 emissions of 325,000 lbs total for the months of June, July, and August.

Attachment 2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ECONOMIC, FINANCIAL and STRATEGY CONSULTANTS
Unconventional Approaches:
Part of the Electric Industry's Response
to Upcoming EPA Regulations
Sue Tierney – Analysis Group
Panel on Infrastructure Reliability and Adequacy
Aspen Energy Policy Forum:
"Changing Currents – Turbulence for the Electric Industry"
July 5, 2011 – Aspen

Overview: Responses to the upcoming EPA Regulations

- The challenge
- Expanding the toolkit of responses
- Examples: viable tools – described here
  - Energy efficiency (mining resources in new places)
  - Demand response (PJM forward capacity auction)
  - Distributed generation (NREL building)
  - Transmission solutions (PEPCO)
- Examples: viable tools – not described here
  - Station modernization (Everett "Air Quality Improvement Plan")
  - Locking in fuel prices (XCEL)
  - Siting policies (NY, CAL)

Unconventional Responses to the Upcoming EPA Regulations

THE CHALLENGE

The challenge: EPA proposals

EPA has moved forward to propose regulations (some under court orders):

- CATR for SO2, NOx
- Air Toxics (MACT) for mercury, benzene, arsenic, and others HAPs
- 316(b) water cooling
- No draft regulations for GHG for existing plants

Other context:

- EPA's regulations allow for more flexibility than originally anticipated (feared)
- Many companies have already invested in env'l equipment
- Many states already have mercury rules stricter than EPA's proposal
- Some big emitters already under consent decrees to "retrofit, retire or repower"
- Many older, inefficient, small, uncontrolled plants already done operate much

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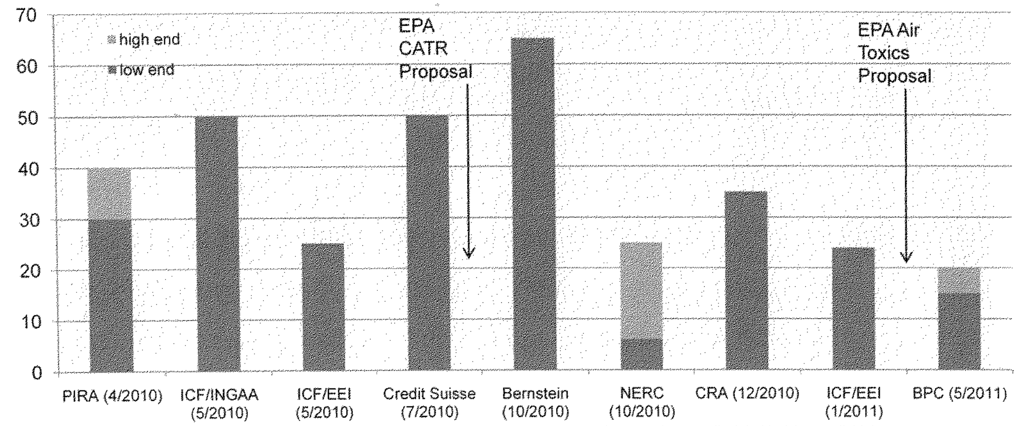
The Challenge:
Estimates of Capacity Retirements Due to EPA Clean Air Rules*



Many studies that have looked at impacts:

- **Most (except BPC) were done prior to issuance of draft rules**
- **Most assumed range of scenarios (e.g., base, "moderate", "strict")**
- **No studies assumed that there would be robust market response including demand-side measures) in combination with the more moderate cases consistent with EPA regulations**

* Notes: ICF / EEI (5/2010) is based on Scenario 1 (CAIR and MACT); NERC (10/2010) low end based on "moderate" CATR and MACT case, and "high end" based on "strict" CATR and MACT cases; ICF/EEI (1/2011) based on scenario with CATR and MACT (high flexibility); and BPC (5/2011) based on estimate of all four non-GHG rules

Unconventional Responses to the Upcoming EPA Regulations

EXPANDING THE TOOLKIT

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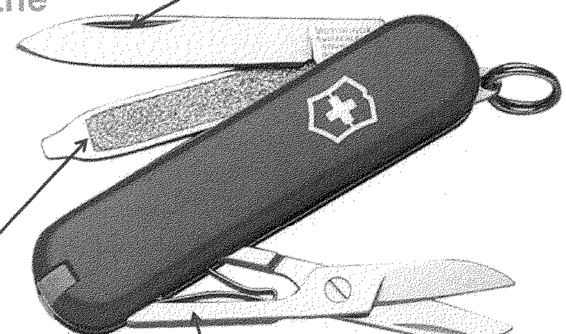
The "Classic": The tool assumed by many of the studies and some in the industry ......



July 5, 2011

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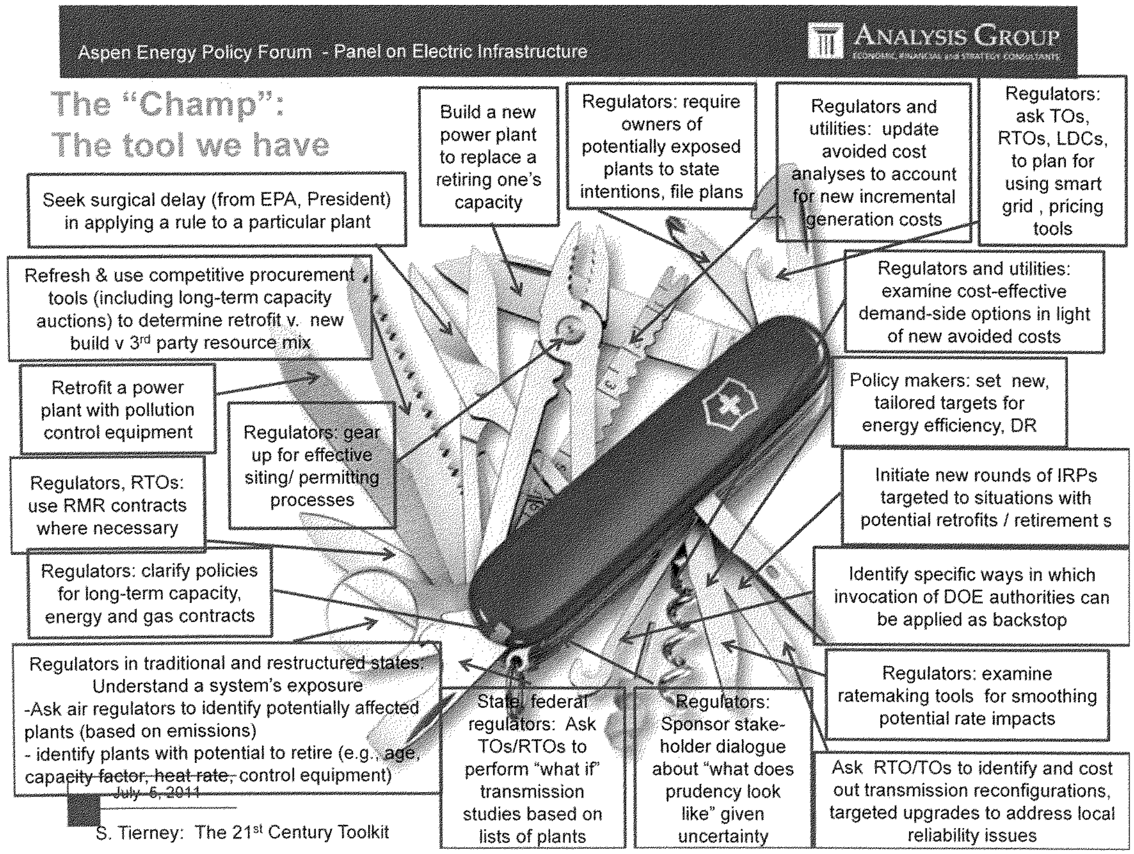
The "Champ":
The tools that are available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The "Champ":
The tool we have
Seek surgical delay (from EPA, President) in applying a rule to a particular plant
Build a new power plant to replace a retiring one's capacity
Regulators: require owners of potentially exposed plants to state intentions, file plans
Regulators and utilities: update avoided cost analyses to account for new incremental generation costs
Regulators: ask TOs, RTOs, LDCs, to plan for using smart grid , pricing tools
Refresh & use competitive procurement tools (including long-term capacity auctions) to determine retrofit v. new build v 3rd party resource mix
Regulators and utilities: examine cost-effective demand-side options in light of new avoided costs
Retrofit a power plant with pollution control equipment
Regulators: gear up for effective siting/ permitting processes
Policy makers: set new, tailored targets for energy efficiency, DR
Regulators, RTOs: use RMR contracts where necessary
Initiate new rounds of IRPs targeted to situations with potential retrofits / retirement s
Regulators: clarify policies for long-term capacity, energy and gas contracts
Identify specific ways in which invocation of DOE authorities can be applied as backstop
Regulators in traditional and restructured states: Understand a system's exposure
-Ask air regulators to identify potentially affected plants (based on emissions)
- identify plants with potential to retire (e.g., age, capacity factor, heat rate, control equipment)
State, federal regulators: Ask TOs/RTOs to perform "what if" transmission studies based on lists of plants
Regulators: Sponsor stake-holder dialogue about "what does prudency look like" given uncertainty
Regulators: examine ratemaking tools for smoothing potential rate impacts
Ask RTO/TOs to identify and cost out transmission reconfigurations, targeted upgrades to address local reliability issues
July 6, 2011
S. Tierney: The 21st Century Toolkit

Unconventional Responses to the Upcoming EPA Regulations

CASE: ENERGY EFFICIENCY

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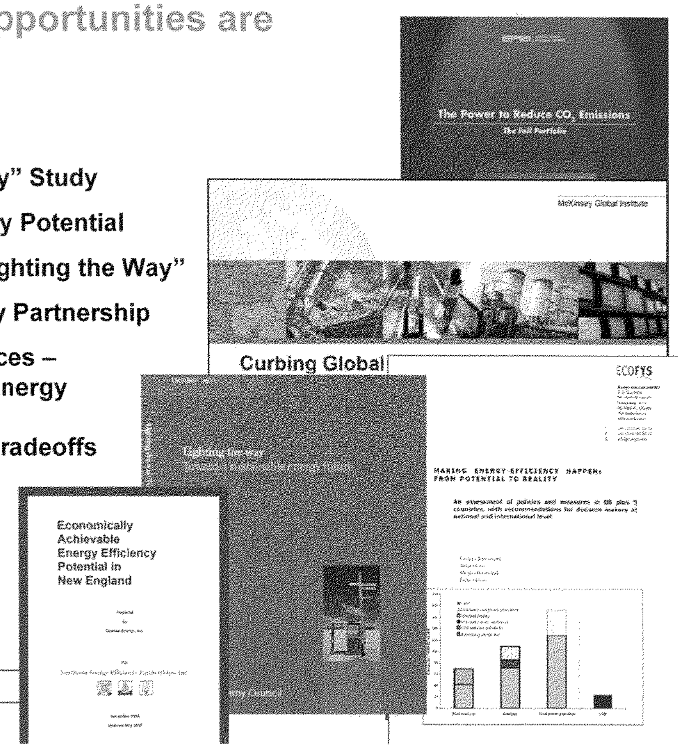
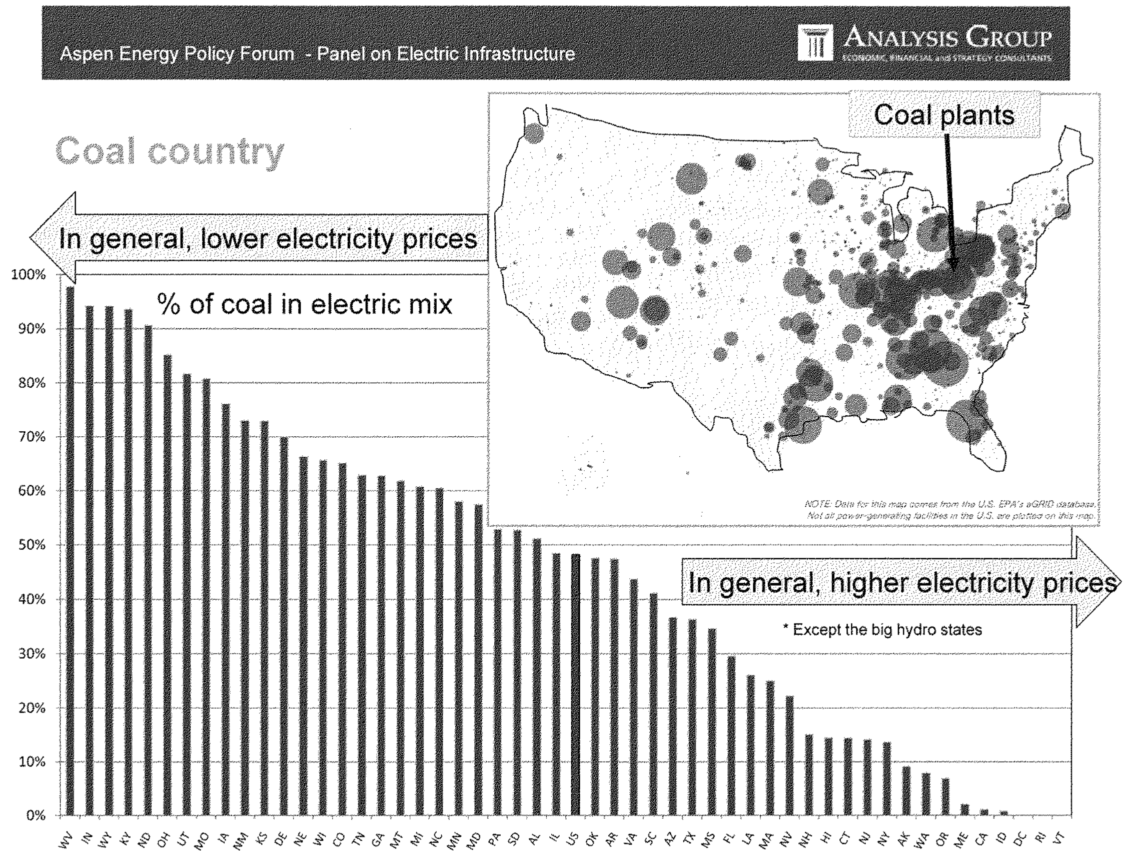
Energy efficiency opportunities are well documented

- **EPRI's "Prism" study**
- **McKinsey's "Wasted Energy" Study**
- **WWF – G8 Energy Efficiency Potential**
- **Interacademy Council – "Lighting the Way"**
- **Northeast Energy Efficiency Partnership**
- **National Academy of Sciences – America's Energy Future: Energy Efficiency Technologies: Opportunities, Risks, and Tradeoffs (underway)**
- **National Action Plans for Energy Efficiency**

But there is still much more to do that is (or will be) cost-effective.





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Coal country
Coal plants
In general, lower electricity prices
% of coal in electric mix
In general, higher electricity prices
* Except the big hydro states
NOTE: Data for this map comes from the U.S. EPA's eGRID database. Not all power-generating facilities in the U.S. are plotted on this map.
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
WV IN WY KY ND OH UT MO IA NM KS DE NE WI CO TN GA MT MI NC MN MD PA SD AL IL US OK AR VA SC AZ TX MS FL LA MA NV NH HI CT NJ NY AK WA OR ME CA ID DC RI VT

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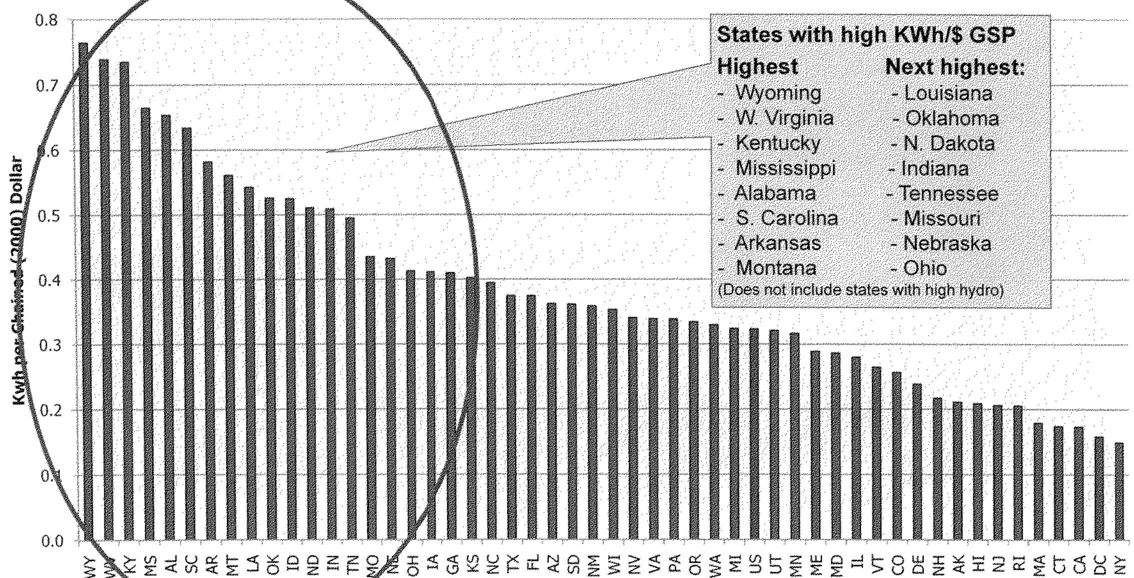
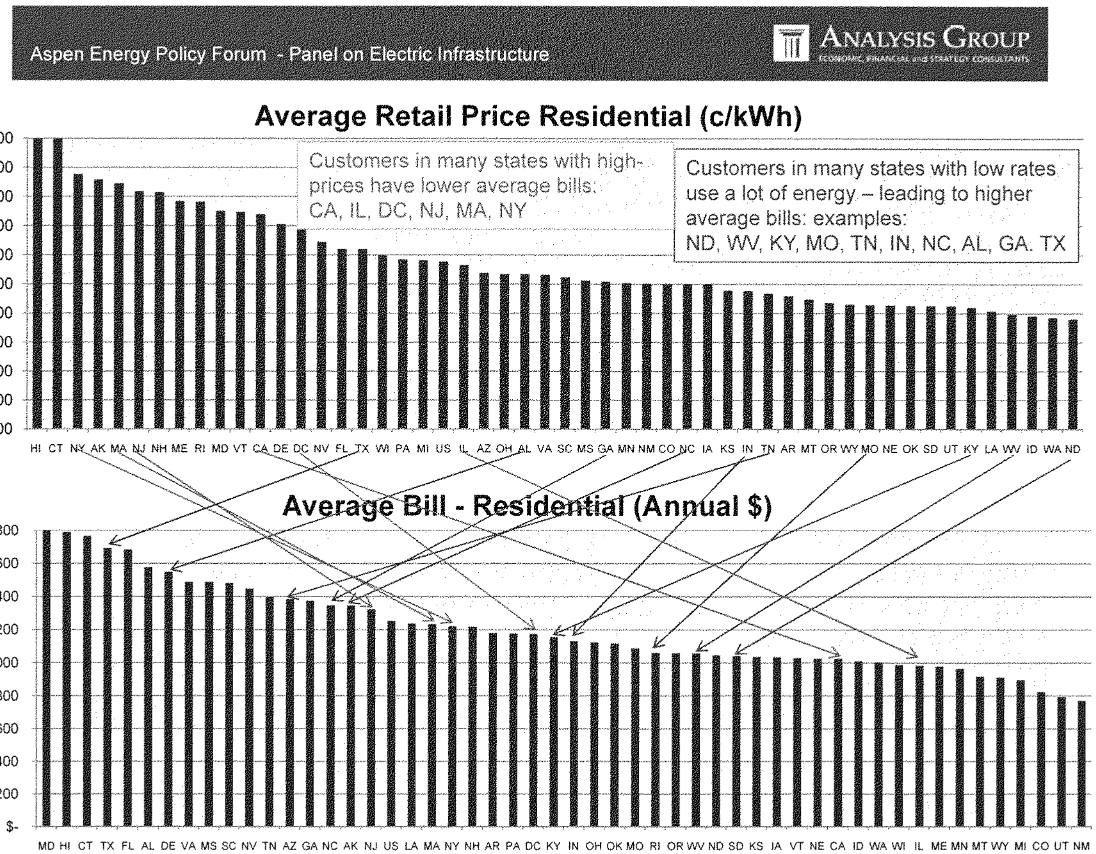
Retail Sales of Electricity per Dollar of GSP



Source: EIA, State Energy Data System (SEDS), Table R3, available at http://www.eia.gov/emeu/states/_seds.html.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Average Retail Price Residential (c/kWh)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
HI CT NY AK MA NJ NH ME RI MD VT CA DE DC NV FL TX WI PA MI US IL AZ OH AL VA SC MS GA MN NM CO NC IA KS IN TN AR MT OR WY MO NE OK SD UT KY LA WV ID WA ND
Customers in many states with high-prices have lower average bills: CA, IL, DC, NJ, MA, NY
Customers in many states with low rates use a lot of energy – leading to higher average bills: examples: ND, WV, KY, MO, TN, IN, NC, AL, GA. TX
Average Bill - Residential (Annual $)
$1,800
$1,600
$1,400
$1,200
$1,000
$800
$600
$400
$200
$-
MD HI CT TX FL AL DE VA MS SC NV TN AZ GA NC AK NJ US LA MA NY NH AR PA DC KY IN OH OK MO RI OR WV ND SD KS IA VT NE CA ID WA WI IL ME MN MT WY MI CO UT NM

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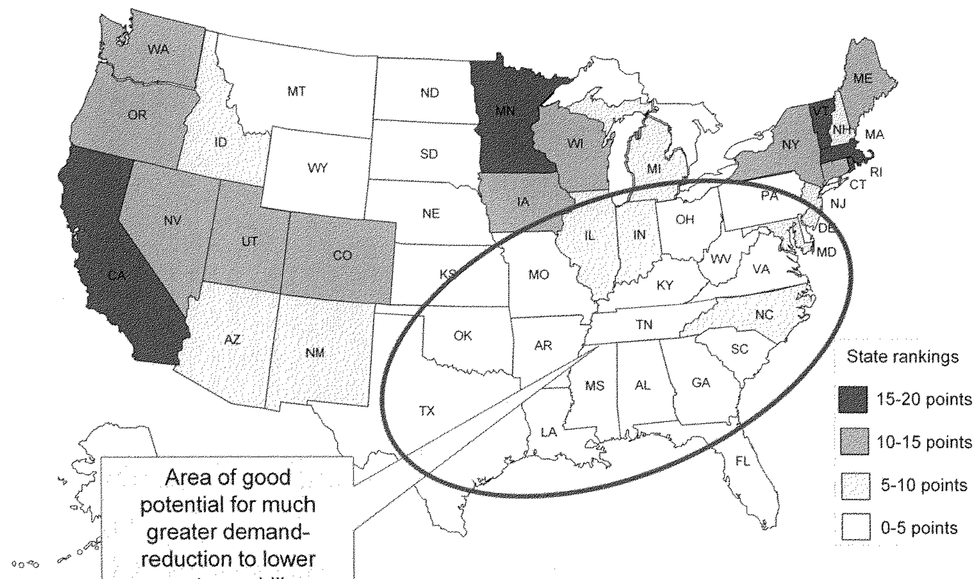
States with strong demand-side management programs



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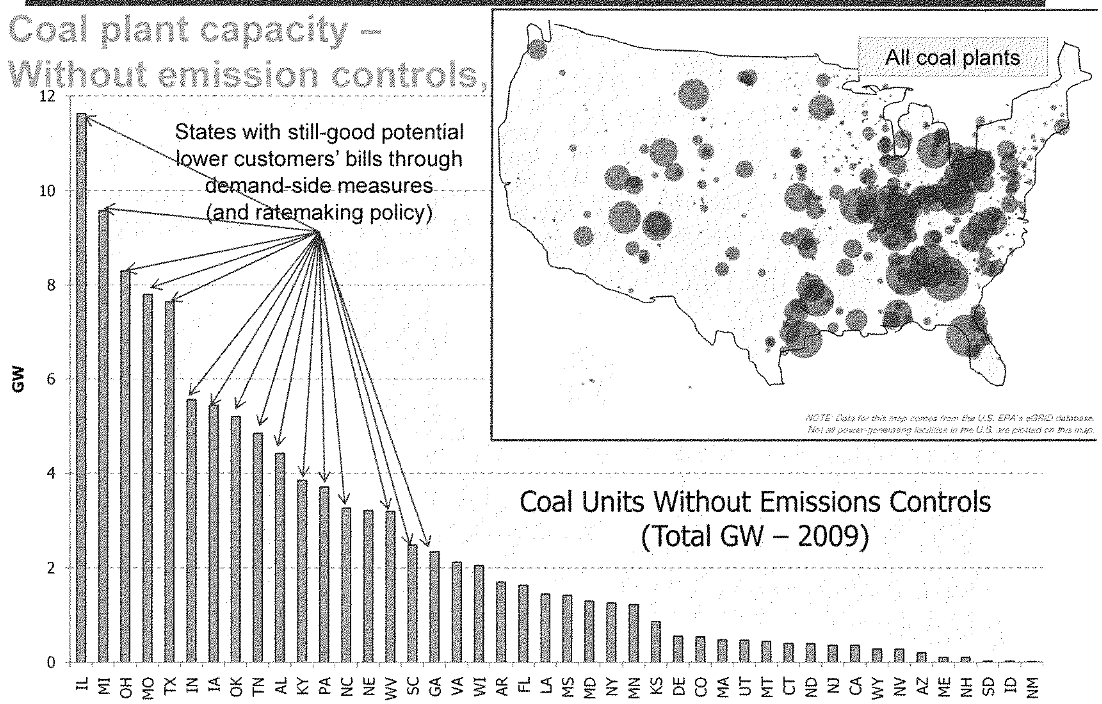
Coal plant capacity – Without emission controls



July 5, 2011

Notes:
[1] Totals do not include Alaska or Hawaii.
[2] Units without emissions are those units without SCR or FGD systems.

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Source: SNL data.

Unconventional Responses to the Upcoming EPA Regulations

CASE: DEMAND RESPONSE

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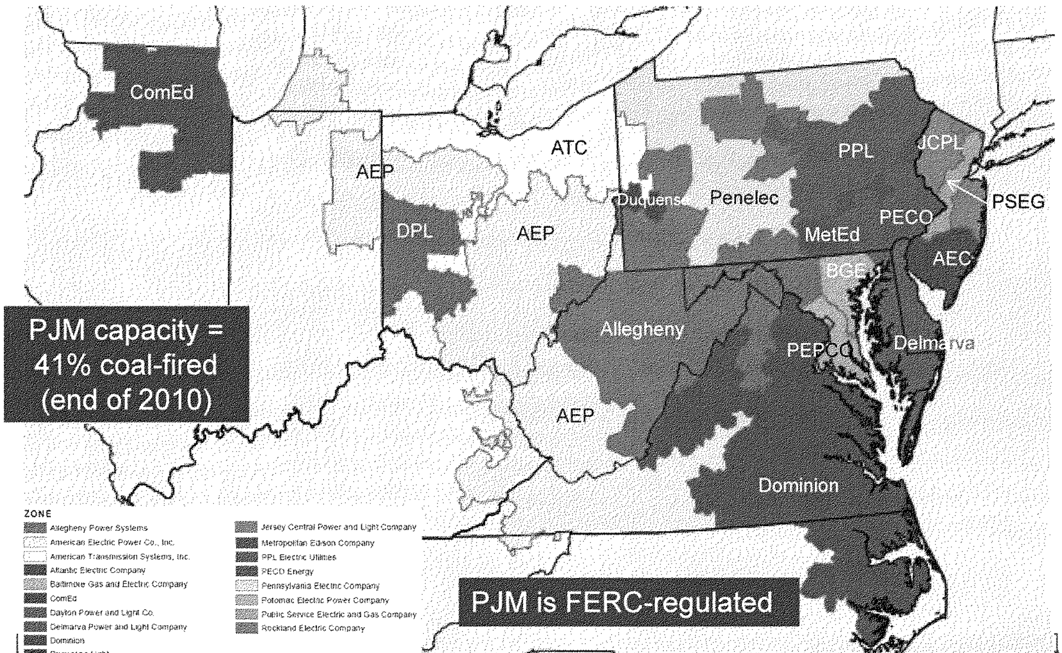
PJM – Boundaries of transmission operators' systems



PJM capacity = 41% coal-fired (end of 2010)

PJM is FERC-regulated

PJM's forward capacity market (FERC regulated)

Mechanism used by PJM to assure sufficient capacity is in place in a future year:

- "Reliability Pricing Model" = forward capacity market
  - **Identification of resource requirements (forecasts of demand) and available supply (market-based mechanism to identify supply to meet demand)**
- The "Base Residual Auction" – annual auction to identify:
  - **Which resources will be available in a future year (through "offers") and**
  - **Which resources are needed (through those that "clear the market" – at the intersection of demand projections and resource offers)**
  - **Which resources will receive compensation in the form of capacity payments (with $/MW payments established by the clearing price) (if a resource doesn't "clear", it does not receive capacity payments)**
- Resources eligible to bid (or offer MW of supply)
  - **Generation (existing and new)**
  - **Demand-response and energy efficiency**

PJM's forward capacity auction (results from 5/2011)

Most recent Base Residual Auction:

- To procure capacity for the period May 31, 2014 through June 1, 2015
- Results announced 5-31-2011
  - **Market-based indications that the region is able to meet its reliability requirements in 2014/2015**
  - **NOTE: this is the time period when the Utility Toxics Rule and the Transport Rule will both be in effect.**
  - **Even though some coal plant offers did not "clear the market" (and may retire), the results show that the region was still able to secure an ample supply of energy resources to maintain reliability.**
  - **Generators had received guidance to offer capacity with prices that reflected compliance with environmental regulations as proposed by EPA.**
  - **Robust response from generators and providers of energy efficiency and demand-response supply.**

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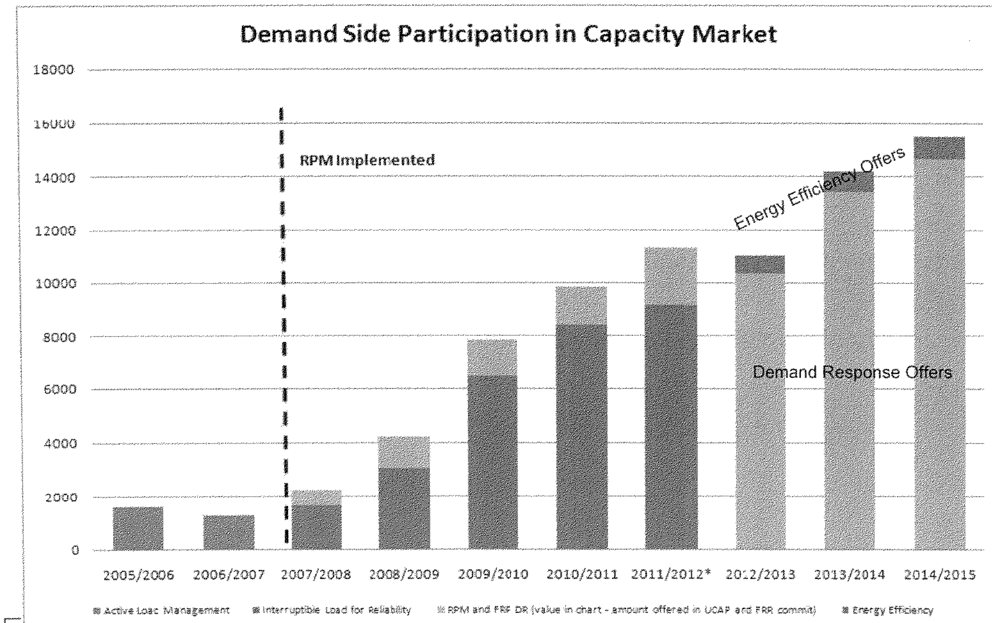
PJM's Base Residual Auction (5/2011) for 2014/2015



PJM, "2014/2015 RPM Base Residual Auction Results"

PJM Base Residual Auctions: Offered and Cleared Resources

Auction Results (all values in UCAP**)	RTO* 2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015
Generation Offered	131,164.8	132,614.2	132,124.8	136,067.9	134,873.0	147,188.6	144,108.8
DR Offered	715.8	936.8	967.9	1,652.4	9,847.6	12,952.7	15,545.6
EE Offered	-	-	-	-	652.7	756.8	831.9
Total Offered	**131,880.6**	**133,551.0**	**133,092.7**	**137,720.3**	**145,373.3**	**160,898.1**	**160,486.3**
Generation Cleared	129,061.4	131,338.9	131,251.5	130,856.6	128,527.4	142,782.0	135,034.2
DR Cleared	536.2	892.9	939.0	1,364.9	7,047.2	9,281.9	14,118.4
EE Cleared	0.0	0.0	0.0	0.0	568.9	679.4	822.1
Total Cleared	**129,597.6**	**132,231.8**	**132,190.5**	**132,221.5**	**136,143.5**	**152,743.3**	**149,974.7**
Uncleared	2,283.0	1,319.2	902.2	5,498.8	9,229.8	8,154.8	10,511.6

* RTO numbers include all LDAs

** UCAP calculated using sell offer EFORd for Generation Resources. DR and EE UCAP values include appropriate FPR and DR Factor.

<u>In 2011/2012 forward market:</u>
Offered resources:
99% = generation
1% = demand response
Of the amounts cleared:
99% = generation
1% = demand response
4% more MW offered than needed

<u>In 2014/2015 forward market:</u>
Offered resources:
90% = generation
10% = demand response and energy efficiency
Of the amounts cleared:
90% = generation
10% = demand response and energy efficiency
7% more MW offered than needed

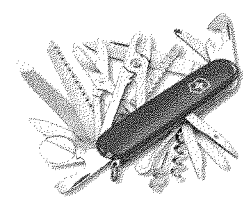
9 MW of generation offered by not cleared: To be retired?

Other results of PJM auction

There are sufficient resources available to federal reliability standards as of the period (2014/2015) when the air rules go into effect.

- More than 5 GW of new capacity came into the market with this auction:
  - **New generation (including gas-fired, wind (695 MW), and solar power (46 MW))**
  - **New demand side resources (EE and DR)**
- Generating capacity that failed to clear the auction:
  - **Included fossil generating units that may eventually retire (i.e., 6.9 GW of coal MW)**
  - **Largely offset by these new resources**
- These results suggest that the tool kit is robust
  - **More robust that the many studies have assumed**

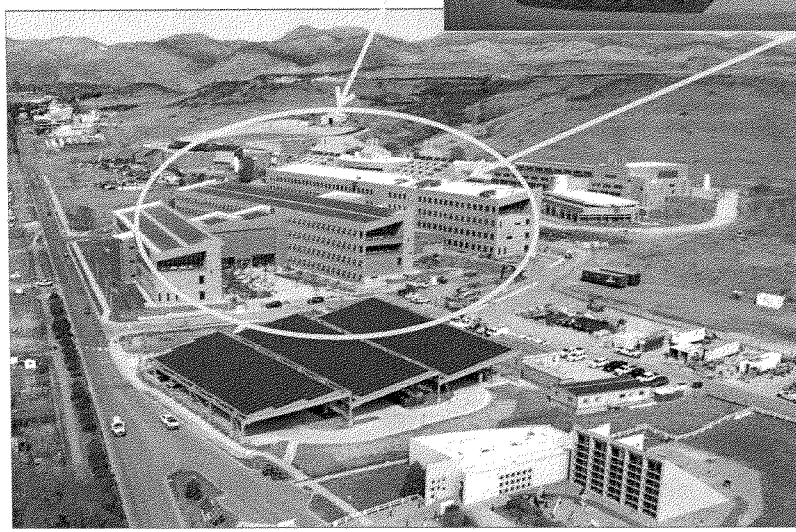
FERC-regulated RTO markets play an important role



Unconventional Responses to the Upcoming EPA Regulations

CASE: DISTRIBUTED GENERATION

NREL:
Lab of the Future – Zero energy use



Research Support Facility, Golden, CO

Construction: 2008-2010

Source: "Lab of the Future," Bill Glover, Deputy Laboratory Director and Chief Operating Officer, NREL, presentation to NREL External Advisory Council, June 29, 2011

NREL RSF: How do you get to zero energy?

Design-Build Process based on performance criteria

- **Focus first on energy efficiency features.**
- **Then focus on adding renewable energy into the equation.**
- **Then use architecture to support those first two goals, rather than the other way around. Design around energy performance requirements.**
- **Extensive energy modeling established the basic building architecture and structure.**

Tier 1: Mission Critical Goals
- Attain Safe Work/Design
- LEED Platinum
- Energy Star "Plus"

Tier 2: Highly Desirable Goals
- 800 Staff Capacity
- 25k BTU/sf/year
- Architectural Integrity
- Honor Future Staff Needs
- Measurable ASHRAE 90.1
- Support Culture and Amenities
- Expandable Building
- Ergonomics
- Flexible Workspace
- Support Future Technologies
- Documentation to Produce "How To" Manual
- Allow Secure Collaboration with Visitors
- Completion by 2010

Tier 3: If Possible Goals
- Net Zero Energy
- Most Energy Efficient Building in the World
- LEED Platinum Plus
- 50% Better than ASHRAE 90.1
- Visual Displays of Current Energy Efficiency
- Support Public Tours
- Achieve National and Global Recognition and Awards

Source: "Lab of the Future," Bill Glover, Deputy Laboratory Director and Chief Operating Officer, NREL, presentation to NREL External Advisory Council, June 29, 2011

What happened:

What NREL wanted:

- Net zero energy goal – with as many of the performance goals as possible
- LEED Platinum
- Competitive cost for fs
- 800 employees

What NREL got:

- Net zero energy including PVs – under budget and 130 days early, with every performance goal achieved
- LEED Platinum
- 220,000 sf at $250/sf
- 825 employees

Source: "Lab of the Future," Bill Glover, Deputy Laboratory Director and Chief Operating Officer, NREL, presentation to NREL External Advisory Council, June 29, 2011

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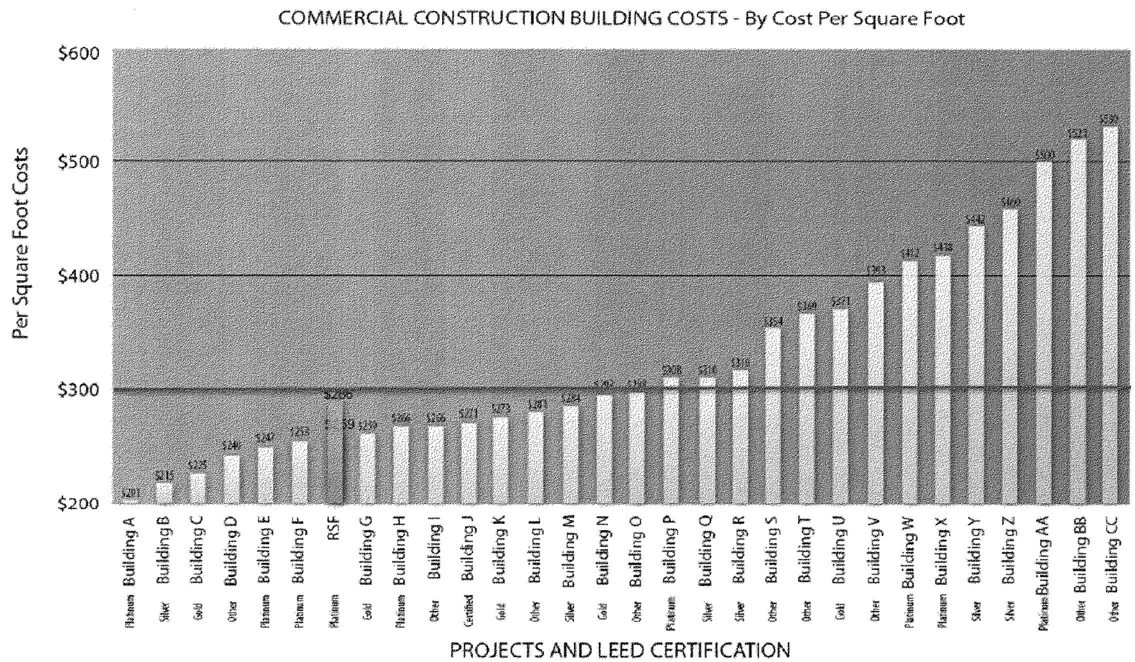

July 5, 2011

Source: "Lab of the Future," Bill Glover, Deputy Laboratory Director and Chief Operating Officer, NREL, presentation to NREL External Advisory Council, June 29, 2011

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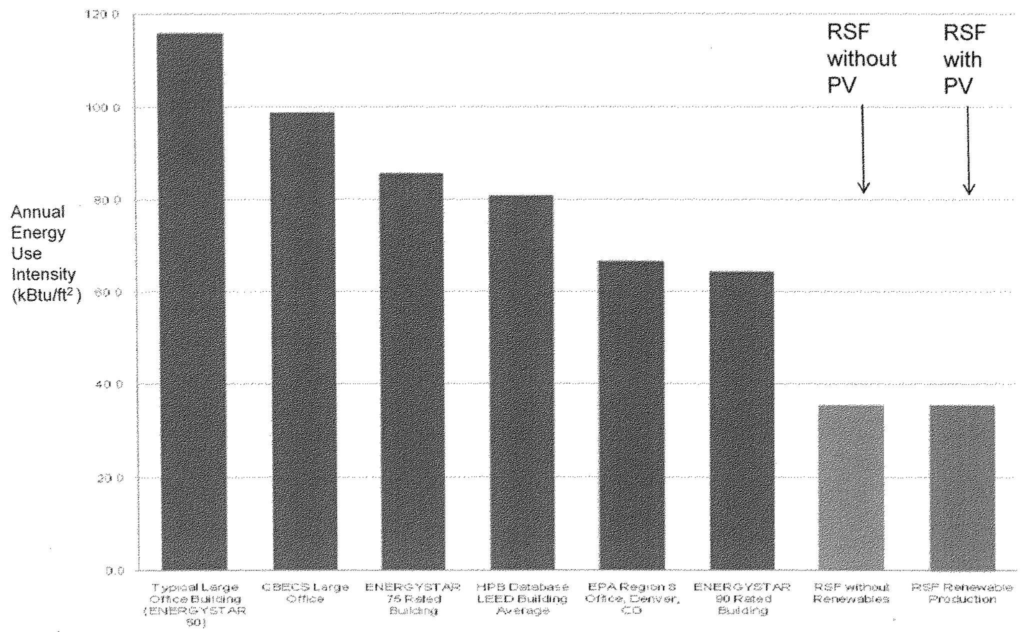
Comparing the energy use (per sf):



July 5, 2011

Source: "Lab of the Future," Bill Glover, Deputy Laboratory Director and Chief Operating Officer, NREL, presentation to NREL External Advisory Council, June 29, 2011

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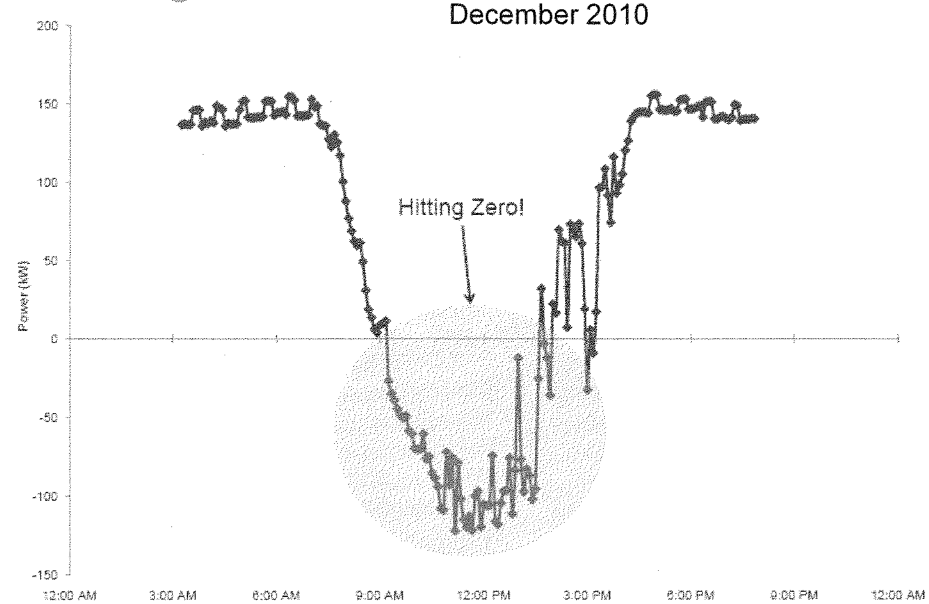
Distributed generation:

450-kW Roof-Mounted PV Performance
December 2010



July 5, 2011 Source: "Lab of the Future," Bill Glover, Deputy Laboratory Director and Chief Operating Officer, NREL, presentation to NREL External Advisory Council, June 29, 2011

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Unconventional Responses to the Upcoming EPA Regulations

CASE: TRANSMISSION

Options when facilities are needed for local reliability

Many authorities exist to ensure that there is no situation in which local or system reliability will be threatened with a plant closure for environmental, economic or other reasons:

- **EPA's authority:**
  - to allow 1-year extension for good cause in the Utility Toxics rule (case-by-case basis)
- **DOE and EPA authority:**
  - to enter into administrative orders of consent or consent decrees with power plant owners, governing terms and conditions of operations for reliability purposes, pending compliance with environmental regulations

Example:

- **GenOn (Mirant) plant (Alexandria, VA) – outside of Washington, DC**

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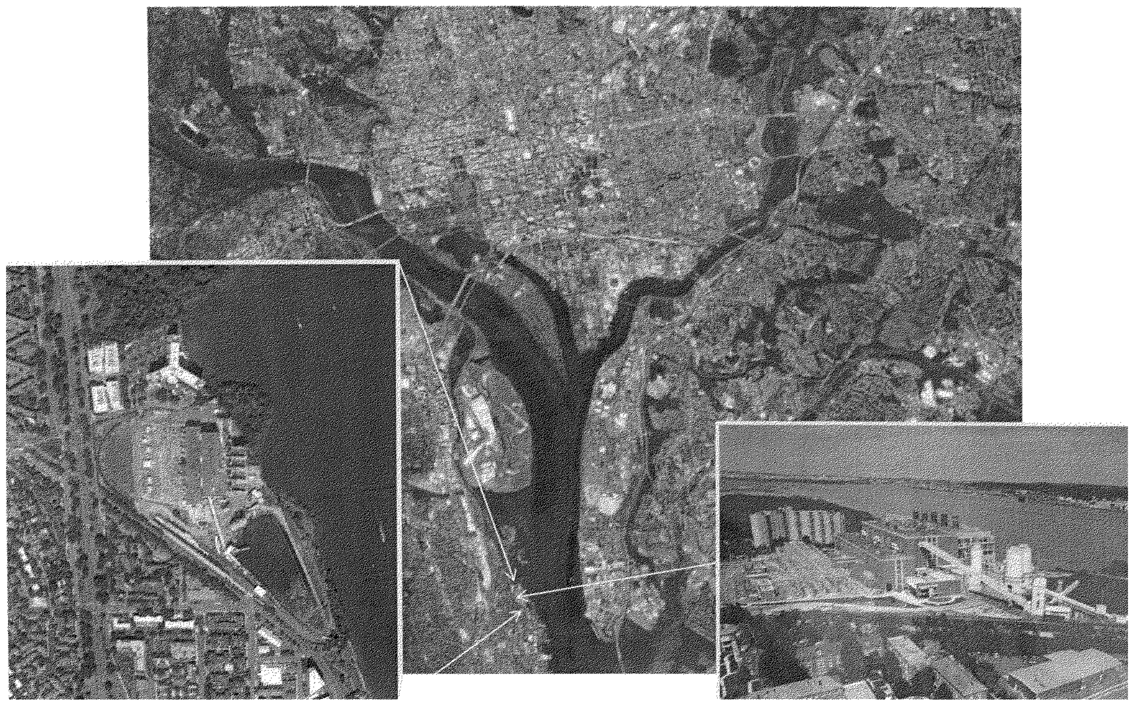
Potomac River Gen Station – Alexandria, VA



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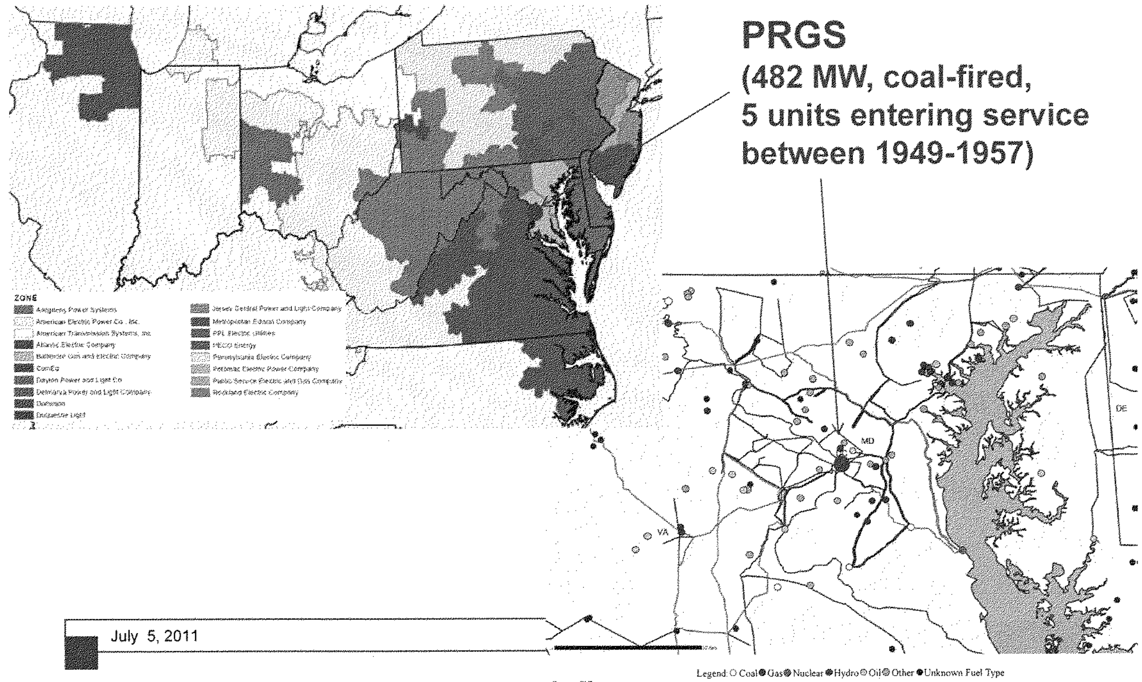
Potomac River Gen Station – in PJM and local grid

PRGS
(482 MW, coal-fired,
5 units entering service
between 1949-1957)



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Environmental and reliability issues

Aug. 2005:	VA DEQ says PRGS violates local air issues: "fix or retire"; PRGS owner announces intention to retire
	DC (PSC, Off of People's council) petitions to FERC to keep plant open to assure reliability in DC
Nov. 2005:	DOE declares reliability 'emergency' & orders PRGS to operate
Dec. 2005:	ORNL study to DOE on local reliability issues if PRGS retired
Jan. 2006:	PJM and PEPCO file reliability plan with FERC; identifies plan including two new 230 kv transmission lines
June 2007:	Construction of two lines (and other facilities) is complete
July 2007:	FERC finds PRGS shutdown poses no reliability issue

The "Champ": The tools that are available

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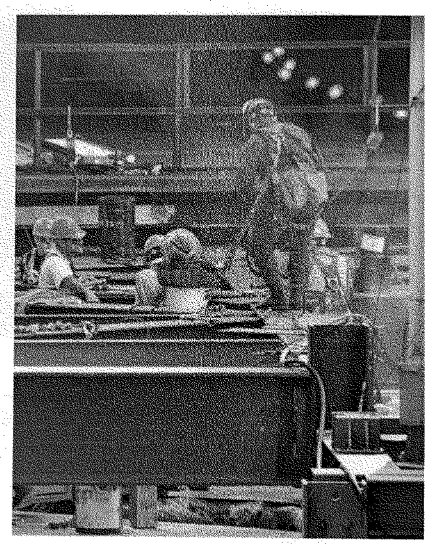
Boston, MA 20199
stierney@analysisgroup.com
617-425-8114

Attachment 3

NEW JOBS — CLEANER AIR

Employment Effects Under Planned Changes to the EPA's Air Pollution Rules



February 2011
A Ceres Report

Ceres

PERI

Authored by
University of Massachusetts
Political Economy Research Institute
James Heintz
Heidi Garrett-Peltier
Ben Zipperer

Ceres is a national coalition of investors, environmental groups, and other public interest organizations working with companies to address sustainability challenges such as climate change and water scarcity. Ceres directs the Investor Network on Climate Risk, a group of 95 institutional investors and financial firms from the U.S. and Europe managing nearly $10 trillion in assets.

The **Political Economy Research Institute (PERI)** is an economic policy research organization affiliated with the University of Massachusetts, Amherst. PERI conducts academic research that is directly engaged with crucial economic policy issues. PERI has broad, and intersecting, areas of specialty: macroeconomics, financial markets and globalization; labor markets (especially low-wage work, both in the U.S. and globally); economic development (with a particular focus on Africa); the economics of peace; and environmental economics.

Acknowledgments

PERI would like to acknowledge the contributions of Ying Chen who worked as a research assistant on this project.

Cover Photo Credits

Smokestack with the American flag: PSNH
Workers in hard hats: PSEG

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NEW JOBS—CLEANER AIR
Employment Effects Under Planned Changes to the EPA's Air Pollution Rules

Table of Contents

FOREWORD

The U.S. electric power sector is changing and modernizing in response to societal and market forces. Power companies face a business imperative to meet increasing pressures for cleaner, more efficient energy that will safeguard public health and protect the world's climate.

These forces are already transforming the industry. Significant capital investment has been flowing in recent years to cleaner technologies such as renewable energy, energy efficiency and natural gas-fired generation. Investment to clean up and modernize the nation's existing fossil fuel generation fleet has already begun to contribute to a cleaner energy future.

New air pollution rules expected this year from the U.S. Environmental Protection Agency will further accelerate these trends. And – as this new Ceres report shows - they will have a major added benefit: significant job creation.

Meeting new standards that limit sulfur dioxide, nitrogen oxides, mercury and other pollutants will create, in the report's own words, "a wide array of skilled construction and professional jobs" – from the electricians, plumbers, laborers and engineers who will build and retrofit power plants all across the eastern U.S., to operation and maintenance (O&M) employees who will keep the modernized facilities running.

The report finds that investments driven by the EPA's two new air quality rules will create nearly 1.5 million jobs, or nearly 300,000 jobs a year on average over the next five years – and at a critical moment for a struggling economy. The end product will be an upgraded, cleaner American industry, along with good paying jobs and better health for the nation's most vulnerable citizens.

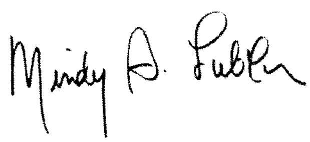
For this report, researchers at the University of Massachusetts' Political Economy Research Institute carefully gauged the job impacts of pending and proposed EPA rules, using independent models and conservative assumptions. Its findings are especially good news for the many states, such as Ohio, Michigan, Pennsylvania, Virginia and Missouri, that are most dependent on traditional fossil fuel energy and most worried about traditional industrial jobs losses.

America's status as one of history's great economic powerhouses has long depended on our willingness and ability to reinvest and innovate when changing times tell us it's time to retool. We've seen throughout our history that clean technology investments – whether to clean our rivers, improve our air quality or compete in the emerging low-carbon global economy – have long-term benefits that far outweigh the upfront costs.

Since 1970, investments to comply with the Clean Air Act have provided $4 to $8 in economic benefits for every $1 spent on compliance, according to the nonpartisan Office of Management and Budget. Since the passage of the Clean Air Act Amendments in 1990, U.S. average electricity rates (real) have remained flat even as electric utilities have invested hundreds of billions of dollars to cut their air pollution emissions. During the same period, America's overall GDP increased by 60 percent in inflation-adjusted terms. The bottom line: clean air is a worthwhile investment.

Significant change is often unsettling, never without short-term costs and some dislocation. But failing to change, especially now, offers much grimmer prospects. We are entering – in fact have already entered – a great global industrial and economic realignment toward clean energy. The greatest benefits, for both today's families and future generations, will flow to those who anticipate these changes, and take proactive steps to respond.

For our electric power sector and the workers tied to it, this report outlines why this path makes sense.



Mindy S. Lubber
President of Ceres

EXECUTIVE SUMMARY

Clean air safeguards have benefitted the United States tremendously. Enacted in 1970, and amended in 1990, the Clean Air Act ("CAA") has delivered cleaner air, better public health, new jobs and an impressive return on investment—providing $4 to $8 in benefits for every $1 spent on compliance.[1]

History has proven that clean air and strong economic growth are mutually reinforcing. Since 1990, the CAA has reduced emissions of the most common air pollutants 41 percent while Gross Domestic Product increased 64 percent.[2] Clean air regulations have also spurred important technological innovations, such as catalytic converters, that helped make the United States a world leader in exporting environmental control technologies.

This study, prepared by the University of Massachusetts' Political Economy Research Institute (PERI), demonstrates how new air pollution rules proposed for the electric power sector by the Environmental Protection Agency ("EPA") will provide long-term economic benefits across much of the United States in the form of highly skilled, well paying jobs through infrastructure investment in the nation's generation fleet. Significantly, many of these jobs will be created over the next five years as the United States recovers from its severe economic downturn.

Focusing on 36 states[3] in the eastern half of the United States, this report evaluates the employment impacts of the electric sector's transformation to a cleaner, modern fleet through investment in pollution controls and new generation capacity and through retirement of older, less efficient generating facilities. In particular, we assess the impacts from two CAA regulations expected to be issued in 2011: the Clean Air Transport Rule ("Transport Rule") governing sulfur dioxide (SO_2) and nitrogen oxide (NOx) emissions from targeted states in the eastern half of the U.S.; and the National Emissions Standards for Hazardous Air Pollutants for Utility Boilers ("Utility MACT") rule which will, for the first time, set federal limits for hazardous air pollutants such as mercury, lead, dioxin, and arsenic. Although our analysis considers only employment-related impacts under the new air regulations, the reality is these new standards will yield numerous other concrete economic benefits, including better public health from cleaner air, increased competitiveness from developing innovative technologies and mitigation of climate change. Moreover, increased employment during this critical five year period will also benefit severely stressed state budgets through increased payroll taxes and reduced unemployment benefit costs.

1. Office of Management and Budget (OMB). Informing Regulatory Decisions: 2003 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities. Office of Information and Regulatory Affairs, Office of Management and Budget, Washington DC. 2003.
2. U.S. Environmental Protection Agency, Our Nation's Air - Status and Trends through 2008, February 2010.
3. As depicted on the map in Figure 2, the Eastern Interconnection also includes the District of Columbia and small portions of Wyoming, Montana, New Mexico, and Texas. A small portion of South Dakota is within the Western Interconnection.

To estimate the job impacts, this study used a forecast of future pollution control installations, construction of new generation capacity, and coal plant retirements from a December 2010 study prepared by two researchers at Charles River Associates ("CRA").[4] Applying stringent EPA compliance requirements, including an assumption that the Utility MACT rule will require pollution controls on all coal-fired power plants by 2015, that study projected that between 2010 and 2015 the power sector will invest almost $200 billion on capital improvements, including almost $94 billion on pollution controls and over $100 billion on about 68,000 megawatts of new generation capacity. Constructing such new capacity and installing pollution controls will create a wide array of skilled, high-paying jobs, including engineers, project managers, electricians, boilermakers, pipefitters, millwrights and iron workers.

Key findings:

- As detailed in Table ES.1 below, between 2010 and 2015, **these capital investments in pollution controls and new generation will create an estimated 1.46 million jobs or about 291,577 year-round jobs on average for each of those five years.**

Table ES.1. Aggregate Employment Estimates from Capital Improvements: Construction, Installation, and Professional Jobs (between 2010 and 2015)

	DIRECT	DIRECT + INDIRECT
Pollution controls	325,305	683,734
New generation capacity	312,617	774,151
TOTAL	637,922	1,457,885

Note: All values reported in "job-years". One job-year equals one year of full-time employment.

- As described in Table ES.2, transforming to a cleaner, modern fleet through retirement of older, less efficient plants, installation of pollution controls and construction of new capacity **will result in a net gain of over 4,254 operation and maintenance (O&M) jobs across the Eastern Interconnection**. Distribution of these O&M jobs will vary from state-to-state, depending on where coal plants are retired (O&M job reduction) and where new generation capacity is installed (O&M job gains).

4. "A Reliability Assessment of EPA's Proposed Transport Rule and Forthcoming Utility MACT", Shavel and Gibbs, CRA, December 16, 2010.

Table ES.2. Employment Estimates of Net O&M Jobs Associated with Capital Improvements and Retirement of Coal Generation

	DIRECT	DIRECT + INDIRECT
Pollution controls	**7,170**	**14,077**
New generation capacity	**4,106**	**8,061**
Retirement of coal generation	**(9,109)**	**(17,884)**
NET TOTAL	**2,167**	**4,254**

- Over the five years, investments in pollution controls and new generation capacity will create significant numbers of new jobs in each of the states within the Eastern Interconnection, more than offsetting any job reductions from projected coal plant closures.
  - The largest estimated job gains are in Illinois, (122,695), Virginia, (123,014), Tennessee, (113,138), North Carolina (76,966) and Ohio (76,240).[5]
  - In states with net O&M job reductions, projected gains in capital improvement jobs will provide enough work to fully offset the O&M job reductions.
  - The construction of pollution controls will create a significant, near-term increase in new jobs. O&M job reductions are likely to occur later in the period.

5. All values reported in "job-years". One job-year equals one year of full-time employment.

I. INTRODUCTION

The CAA and its 1990 amendments have significantly reduced power sector air pollution. In 2011, EPA plans to implement regulations that will further reduce targeted emissions. Last July, the EPA proposed the Transport Rule to introduce new standards governing SO_2 and NO_x emissions from 31 states and the District of Columbia, emissions that hinder the ability of downwind states to comply with national ambient air quality standards. In addition, EPA is required under court order to issue final Utility MACT regulations to limit electric generators' hazardous air pollutant emissions, including, for example, mercury, arsenic, chromium, nickel, lead, and hydrochloric acid.

Merrimack Station

The Merrimack Station, New Hampshire's largest coal-fired power plant, constructed a scrubber to control SO_2 and mercury emissions. According to PSNH, the owner of the facility, the project provided more than 300 construction jobs for the three-year construction period.

Source: PSNH

Focusing on the Eastern and Midwestern regions of the U.S., this study evaluates the employment impacts between 2010 and 2015 of these proposed and planned changes to EPA air regulations resulting from the power sector's investment in pollution controls and new generation, and from retirement of existing coal generation. For the purposes of this analysis, the study assumes stringent compliance requirements, including an assumption that the Utility MACT rule will require scrubbers and advanced particulate controls on all coal units by 2015.[6]

6. According to a study by Dr. Ira Shavel and Mr. Barclay Gibbs of Charles River Associates, "[o]thers...believe that MACT compliance may allow lower cost and relatively inexpensive dry scrubbing options using sorbents to capture acid gases and metals (e.g., trona with activated carbon injection)." A Reliability Assessment of EPA's Proposed Transport Rule and Forthcoming Utility MACT, Shavel and Gibbs, CRA, December 16, 2010, at p. 9.

Deer Creek Station

Basin Electric began construction on the Deer Creek power plant, a 300-megawatt natural gas combined-cycle generation facility in South Dakota, in July 2010. The project will require about 350 workers at the peak of construction and 70 gas pipeline construction workers. The power plant is scheduled for commercial operation in June 2012 and will have about 30 full-time employees.

Source: Basin Electric

The modeling projections focus on the years between 2010 and 2015, as that is the period during which companies will prepare to comply with the Utility MACT and Transport rules. For purposes of this analysis, we therefore assume the expenditures are spread over these years, and limit the employment effects from these capital investments to that period.

As detailed further in Appendix B, to estimate the employment impacts associated with the projected capital spending and coal plant retirements in the 36 states analyzed, we use the IMPLAN 3.0 input-output model, which is based on data from the U.S. Commerce Department's Bureau of Economic Analysis that has been finely disaggregated by sector and state.[7] Capital investments in pollution controls and new generation capacity and coal plant retirements[8] affect employment not only in the power generation sector, but also in sectors linked to electric generation, such as engineering services, coal, natural gas, metal fabrication, construction and business services. Based on the relationships between different economic sectors in the production of goods and services, the input-output model estimates the effects on employment resulting from an increase in spending on the products and services of a given industry. For example, the model estimates the number of jobs directly created in the design, engineering, and construction industries for each $1 million spent on pollution control retrofits and the construction of new generation capacity. As we explain below, the

7. The data used to construct the IMPLAN 3.0 model is based on 2008 figures – the most up-to-date picture of the sectoral relationships in the U.S. economy currently available.

8. Notably, not all the capital investments or coal plant retirements result directly from the new EPA air regulations, as reduced electricity demand, lower sustained fuel prices resulting from recent discoveries of abundant, domestic natural gas supplies, and state renewable energy programs also influence investment and retirement decisions.

model can also estimate the jobs indirectly created in other industries through that same $1 million in spending—for example, in industries such as steel components and hardware manufacturing.

Mercer Station Pollution Control Retrofits

The Mercer station and Hudson station coal plants in New Jersey recently completed the installation of air pollution control systems. More than 1,600 construction workers were on the Mercer and Hudson facility job sites at the peak of construction.

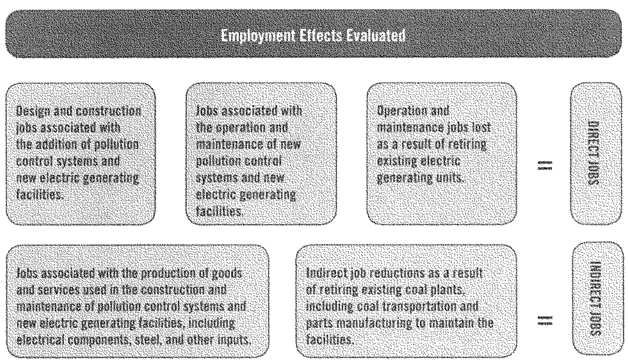
Source: PSEG Corporation

As described in Figure 1 below, our employment estimates include both direct and indirect job creation. First, it examines employment directly generated by capital investments in pollution controls and new generation capacity. Here the focus is on a wide array of skilled jobs associated with designing, procuring and installing pollution controls, and building new generation, including engineers, project managers, electricians, boilermakers, pipefitters, millwrights, iron-workers and security personnel.[9] As

9. For a more detailed discussion of occupational and skills requirements, see the National Commission on Energy Policy report, Task Force on America's Future Energy Jobs, available at www.bipartisanpolicy .org/sites/default/files/NCEP%20Task%20Force%20on%20America's%20Future%20Energy%20Jobs%20-%20Final%20Report.pdf.

these jobs are directly linked to these investment expenditures, they are created and maintained throughout the five year investment period. The direct effect represents jobs created by spending in the respective sector. For example, building new capacity involves expenditures to construct and install that capacity, including payments to new employees. Firms that install the new capacity will also have to purchase goods and services from other sectors, which in turn will create jobs in those other sectors: this "second round" of employment creation constitutes the indirect job effect.

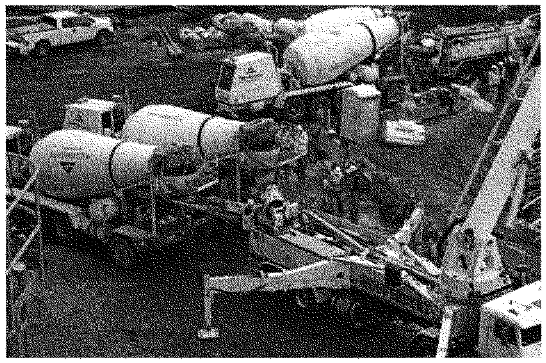
Figure 1. Scope of Employment Analysis



Note: The income associated with both direct and indirect employment will stimulate spending on goods and services that will result in additional job creation. These induced effects are not explicitly considered in this analysis.

We do not explicitly consider a third source of job creation: "induced" jobs. Induced jobs are those created when individuals spend the money they earn from the direct and indirect employment. The size of the induced effects varies for a number of reasons, but will correlate with the number of direct and indirect jobs.[10] As this study calculates only the direct and indirect job impacts and excludes induced jobs, it provides a conservative estimate of the total employment impact.

10. Induced employment refers to the jobs generated when individuals in the direct and indirect jobs spend their income on goods and services. The size of the induced effects vary depending on the state of the economy. For example, if already employed individuals move from one job to another, the induced effects will be smaller (and could even be zero if there is no change in income). But if unemployed individuals move into the newly created jobs, as would be more likely given our current high unemployment rate, induced effects would likely be large.



Merrimack Station

The scrubber retrofit at PSNH's Merrimack Station includes a concrete stack that stands at more than 445 feet. Concrete for the stack was delivered around-the-clock by the Redimix Company based in New Hampshire. By mid-July, when the shell of the stack was completed, a rotating shift of six Redimix drivers had delivered an estimated 1,060 cubic yards of concrete.

Source: PSNH

The study also calculates estimated net changes in O&M jobs which, unlike construction and installation and related professional jobs, exist as long as the plants continue to generate electricity or the pollution control systems continue to operate. We project that although retiring older, less efficient capacity will lead to some O&M job reduction, installing pollution controls and building new generation will lead to a net increase in O&M jobs.

Estimating the employment impacts under EPA's air pollution regulations requires forecasts of future pollution control installations, new power plant construction and coal plant retirements. The forecasts used in this report are based on a detailed CRA modeling assessment entitled, "A Reliability Assessment of EPA's Proposed Transport Rule and Forthcoming Utility MACT," published in December 2010 by Dr. Ira Shavel and Mr. Barclay Gibbs of Charles River Associates (the "CRA Study").[11] The CRA Study used CRA's North American Electricity and Environment Model (NEEM) to estimate coal unit retirements, new capacity additions, and pollution control retrofits, taking into account the operating characteristics of existing capacity and the capital and operating costs of potential new capacity. As highlighted in Table 1 below, the CRA Study's predicted coal plant retirements are consistent with other similar assessments.

The CRA Study limited its analysis to the Eastern Interconnection where most of the nation's coal-fired generating capacity is located and where most of the capital investment associated with EPA's air pollution regulations is expected to occur. The Eastern Interconnection, one of four major power grids in the U.S. and Canada, comprises about 36 states (in part or whole) and the District of Columbia as shown in the map in Figure 2 below, accounts for much of the transmission system east of the Continental Divide[12] and contains approximately 73 percent of U.S. electricity generation. Moreover, as the Transport Rule only applies to states in the Eastern U.S., the estimated power sector changes projected below are concentrated in that part of the country.

11. Available at http://www.crai.com/Publications/listingdetails.aspx?id=13473

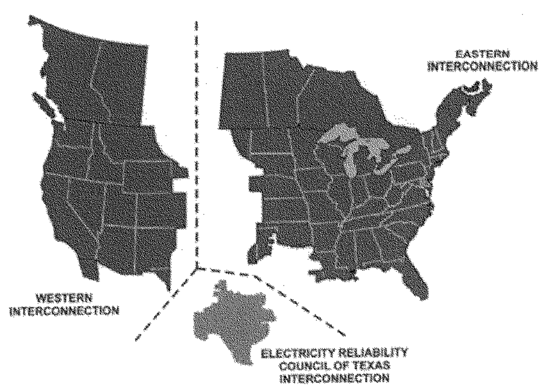
12. One notable exception is Texas, the majority of which is linked into a separate interconnected system.

Table 1. Recent Projections of Coal Plant Retirements and Power Industry Investment

	Author, Date	Projected Retirements	Notes
A Reliability Assessment of EPA's Proposed Transport Rule and Forthcoming Utility MACT	Shavel and Gibbs, Charles River Associates, December 2010	35 GW of coal plant retirements by 2015 (Eastern Interconnection)	Models utility MACT and Transport Rule
Potential Coal Plant Retirements Under Emerging Environmental Regulations	The Brattle Group, December 2010	28-39 GW of coal retirements by 2020 (Eastern Interconnection)	Models utility MACT and Transport Rule (scrubbers and SCR mandate)
Integrated Energy Outlook	ICF Consulting, January 2011	60 GW of coal plant retirements by 2018 (nationwide figure)	Models utility MACT, Transport Rule, coal ash, and cooling water regulations

The CRA Study assumed stringent requirements to comply with the forthcoming Utility MACT regulations and proposed Transport Rule, including an assumption that by 2015 the Utility MACT rule will require scrubbers, activated carbon injection, and advanced particulate controls on all coal units. Furthermore, the CRA Study provided plant-level estimates of pollution control retrofits and retirements which could then be evaluated under the IMPLAN model.

Figure 2. The Eastern Interconnection and Other North American Electric System Interconnections

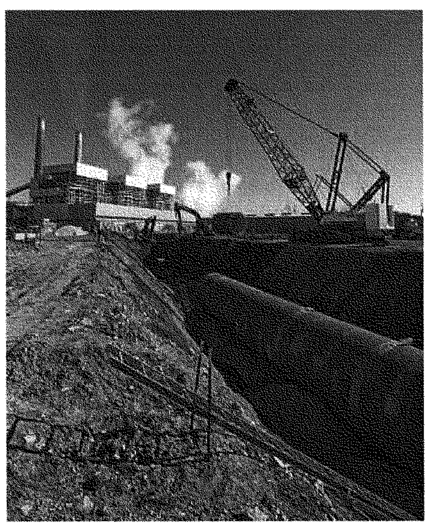


II. EASTERN INTERCONNECTION EMPLOYMENT IMPACTS UNDER PLANNED EPA RULES

This report calculates estimated employment effects in the Eastern Interconnection in two broad categories: (1) construction, installation and professional jobs from capital investment in pollution controls and new generation capacity; and (2) net O&M jobs directly and indirectly associated with those capital improvements and O&M job reductions from retiring older, less efficient coal capacity.

Capital Improvements Spending on Pollution Controls and New Generation Capacity

The CRA Study projects that between 2010 and 2015 the electricity power sector will spend an estimated $196 billion on capital improvements under EPA's new utility MACT and Transport rules: $93.6 billion on pollution controls and $102.4 billion on about 68,000 megawatts of new generation capacity. Expenditures on pollution controls are assumed to include four technologies: (1) activated carbon injection ("ACI") to control mercury emissions; (2) activated carbon injection with fabric filters ("ACI+") to control mercury and other hazardous air pollutant emissions; (3) flue gas desulfurization ("FGD") or "scrubbers" to control SO_2 and hazardous air pollutant emissions; and (4) selective catalytic reduction ("SCR") to control NO_x emissions.



Jeffrey Energy Center

The Jeffrey Energy Center, the largest coal-fired power plant in Kansas, upgraded the scrubbers at the facility to achieve greater than 95 percent SO_2 control. The project started in 2007 and was completed in 2009. The project required over 1,300 tons of structural steel and more than 850 construction workers were on-site at the peak of construction.

Source: Westar

Using the widely endorsed and proven IMPLAN 3.0 input-output model, we estimate the direct and indirect employment effects of substantial pollution control expenditures and resulting job impacts. In addition to investments in pollution controls, we also estimate the employment impacts of investment in new generation capacity involving nine different technologies: (1) advanced coal technologies; (2) integrated gasification combined cycle, ("IGCC") (coal); (3) combined cycle (natural gas); (4) combustion turbine (natural gas); (5) nuclear; (6) municipal waste/landfill gas; (7) biomass; (8) solar (photovoltaic); and (9) wind.

As with pollution controls, the design and construction of new generation capacity requires substantial expenditures for a variety of goods and services. Our employment estimates consider how these expenditures vary by technology. For example, landfill gas capacity involves expenditures on turbines, air and gas compressors, pipes and pipefitting, iron and steel milling, environmental control machinery, and construction services.

The capital investments will generate direct and indirect jobs in a range of sectors involving skilled and professional occupations. Direct jobs would include, for example, new non-residential construction, metal fabrication, and engineering. Indirect jobs would include steel manufacturing, catalyst system manufacturing, control system manufacturing, and transportation services.

Table 2 presents estimates of the aggregate jobs created over five years through investments on capital improvements and new capacity. Between 2010 and 2015, the almost $94 billion of investment in pollution controls would generate an estimated 325,305 direct jobs and an estimated 683,734 direct and indirect jobs. The $102.4 billion of investment in new generation would create a total of 312,617 direct jobs and 774,151 direct and indirect jobs. Taken together, projected investments in capital improvements under the new EPA regulations would create an estimated 1,457,885 jobs over the next five years, or over 290,000 full-time jobs on average per year over the five year period.

Table 2. Aggregate Employment Estimates from Capital Improvements: Construction, Installation, and Professional Jobs (between 2010 and 2015)

	DIRECT	DIRECT + INDIRECT
Pollution controls	325,305	683,734
New generation capacity	312,617	774,151
TOTAL	637,922	1,457,885

Note: All values reported as "job-years". One job-year equals one year full-time employment.

To reflect the reality that construction, installation and professional jobs will be realized over the period during which the investments occur, the 1,457,885 figure represents total jobs created over the five year period, with each job-year representing a single job that lasts one year.[13] If all the expenditures were to happen in a single year,

13. The characteristics of the jobs – in terms of benefits, hours of work, and wages – would reflect the current composition of jobs in the industries impacted by the construction and installation expenditures.

1,457,885 jobs would be created that year. However, a more realistic assumption would be that the pollution control and new generation expenditures would be spread out over time. For purposes of illustration, assuming that 10 percent of the expenditures will occur in the first year, 15 percent in the second year, and 25 percent in each of the three subsequent years, the job creation in three peak years would be 25 percent of 1,457,885, or 364,471 jobs per year.

O&M Jobs

In addition to jobs associated with the design, construction and installation of pollution controls and new generation, the model also projects more permanent O&M jobs. Pollution controls, for example, need workers to maintain systems and handle waste. Similarly, power plants require workers to operate and maintain their equipment. We estimate the O&M jobs associated with these capital investments above by first estimating the O&M costs associated with the capital investment and then use the input-output framework to estimate the employment impacts.

In the case of older, less efficient existing capacity, much of which is already challenged by sustained low natural gas prices and reduced demand, companies may choose to retire existing capacity rather than installing pollution control systems, causing some O&M job reductions.[14] The CRA Study projects 35 gigawatts of coal plant retirements by 2015 in the Eastern Interconnection. To estimate the direct employment impact of predicted retirements, we did not use the input-output framework, but instead used detailed finance and operation data which the Federal Energy Regulatory Commission ("FERC") requires utilities to submit annually. Current employment levels from the FERC forms were matched to retired plants whenever possible. For retired plants with no matched employment data, we used state averages of employment per MW derived from plants in the same state with such employment data. We did, however, apply the input-output model to estimate indirect job losses from capacity retirements.

Table 3 shows the net Eastern Interconnection O&M employment impacts. Pollution control investments would create 7,170 O&M direct jobs and the new capacity investments would create 4,106 direct O&M jobs, offset by a reduction of 9,109 direct O&M jobs through capacity retirements, for a net gain of 2,167 direct O&M jobs. Combining both direct and indirect jobs results in a net gain of 4,254 jobs for the states analyzed.

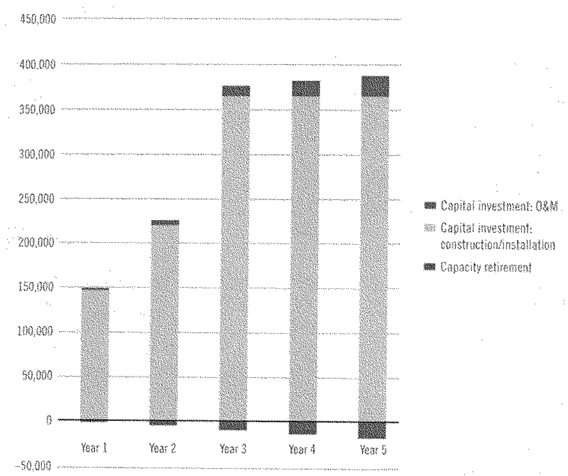
14. Some retirements may also generate short-lived gains in employment through necessary expenditures to shut down a facility (e.g. demolition, waste removal, etc). Also, companies may redeploy workers to other plants or offer early retirement opportunities. We do not, however, consider these possibilities.

Table 3. Estimates of Net O&M Jobs Associated with Capital Improvements and Retirement of Capacity

	DIRECT	DIRECT + INDIRECT
Pollution controls	7,170	14,077
New generation capacity	4,106	8,061
Retirement of existing capacity	(9,109)	(17,884)
NET TOTAL	2,167	4,254

Figure 2 summarizes Eastern Interconnection direct and indirect employment effects in the three main categories of job creation and reductions: (1) construction, installation and professional jobs created through new capital investment, (2) O&M jobs created through new capital investment, and (3) job reductions due to capacity retirements. Again, we assume that 10 percent of the adjustments under the new EPA standards will occur in the first year, 15 percent in the second year, and 25 percent in each of the three subsequent years. Clearly, construction, installation and professional jobs dominate the picture. However, more O&M jobs are created as power companies adapt to the new standards.

Figure 3. Estimates of Direct and Indirect Employment Effects Over Time (between 2010 and 2015)



III. STATE-LEVEL ANALYSIS OF EMPLOYMENT IMPACTS

Using job impact estimates from projected pollution controls and new generation investments and capacity retirements, we also calculated state-level impacts for the states in the Eastern Interconnection.

State-level Spending on Pollution Controls and New Generation

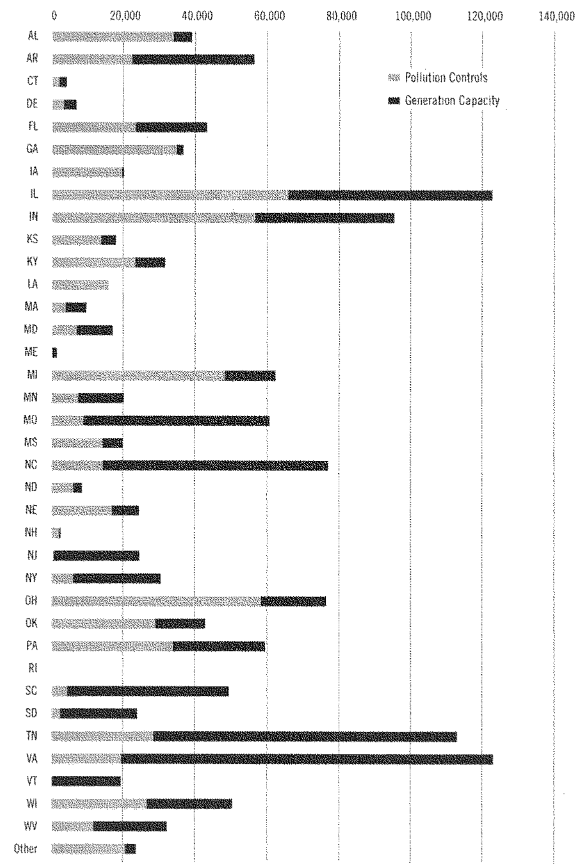
Table A1 in the appendix summarizes state-level capital improvements in terms of: (1) total spending on pollution controls; (2) total increase in energy capacity expressed as megawatts; and (3) capital expenditures needed to increase capacity by the relevant number of megawatts.

To estimate state-specific employment impacts, we used the same methodology as with the Eastern Interconnection analysis except that we relied on individual state input-output models. Figure 4 below shows estimated direct and indirect jobs created through both the pollution control and new generation investments detailed in Table A1. (Table A2 in the appendix summarizes the data used in Figure 4.) Not surprisingly, the number of jobs created tracks closely with the estimated spending. For example, Illinois, which has the highest projected spending on pollution controls over the five year investment period, has the greatest number of related jobs: 65,600 direct and indirect jobs. Similarly, Virginia with the highest projected investment in new capacity, experiences the largest number of related jobs: 103,365 direct and indirect jobs.

State-level Estimates of O&M Jobs from Capital Improvements

Table A3 in the appendix presents state-level estimates of the O&M jobs associated with the capital investments detailed in Table A1. Permanent O&M jobs increase with the amount of the capital investments and vary with the composition of technologies utilized. Although states with zero spending gain no O&M jobs, most states gain substantial numbers of such jobs. For example, Ohio gains over 1,100 O&M jobs (direct and indirect) from pollution control investments, and Virginia gains over 920 O&M jobs (direct and indirect) from new capacity investments.

Figure 4. Estimated Construction, Installation, and Other Professional Jobs Gains from Investment in Capital Improvements



Note: All values reported in "job-years". One job-year equals one year of full-time employment.

Table 4. Summary of Direct and Indirect State-Level Job Impacts from Capital Improvements and Coal Plant Retirements

	Capital Improvements		Retirements
	Construction, Installation, & Professional Job Gains over 5 years (in job years)	O&M Job Gains	O&M Job Reductions
AL	38,755	764	(1,184)
AR	56,110	690	0
CT	3,858	41	0
DE	6,542	114	(219)
FL	43,106	699	(970)
GA	36,465	584	(1,700)
IA	19,899	386	(475)
IL	122,695	1,429	(549)
IN	95,193	1,413	(563)
KS	17,812	342	(179)
KY	31,477	875	(982)
LA	15,842	297	(145)
MA	9,545	66	(157)
MD	16,922	226	(180)
ME	1,279	19	0
MI	62,346	987	(1,124)
MN	20,141	309	(542)
MO	60,512	1,727	(271)
MS	19,803	360	(183)
NC	76,966	973	(1,014)
ND	8,207	193	(58)
NE	24,331	208	(217)
NH	2,420	40	(155)
NJ	24,255	316	(123)
NY	30,496	303	(187)
OH	76,240	1,365	(1,772)
OK	42,651	623	0
PA	59,243	794	(1,272)
RI	359	323	0
SC	49,311	757	(968)
SD	23,909	379	0
TN	113,138	1,379	(869)
VA	123,014	1,225	(369)
VT	19,107	197	0
WI	50,233	784	(874)
WV	32,253	675	(583)
Other	23,453	277	(2)
TOTAL	1,457,885	22,138	(17,884)

Note: Employment estimates taken from Tables A2, A3, and A4.

State-level Estimates of Job Reductions from Retirements

Using FERC data for direct job reductions and state specific input-output models for indirect job losses, Table A4 in the appendix presents state-level estimates of job reductions from coal plant retirements. Notably, the CRA Study's projected coal plant retirements are only partly attributable to stricter EPA regulations. According to the CRA Study, substantial retirements are also driven by reduced demand and low priced, abundant natural gas.[15]

Furthermore, the estimated job reductions in Table A4 will be offset by gains in construction, installation, and professional jobs and O&M jobs due to capital investments in pollution controls and new generation capacity. As such, it is important to examine the net change in employment from all of these sources. To reflect the total impact of capital investments and coal plant retirements between 2010 and 2015, Table 4 provides a comprehensive side-by-side comparison using the estimated gains in construction, installation and professional jobs from Table A2, O&M job gains from capital improvements from Table A3 and job reductions due to coal plant retirements from Table A4.

Significantly, when considering both direct and indirect effects and all sources of job creation and job reductions, all of the states show a net gain in employment over the analysis period.

15. "However, given the recent discoveries of abundant, domestic natural gas supplies, a competing fuel for electric generation, as well as reduced electricity demand, coal plant owners may elect to retire some existing plants rather than investing the capital necessary to install pollution controls," *A Reliability Assessment of EPA's Proposed Transport Rule and Forthcoming Utility MACT*, Shavel and Gibbs, CRA, December 16, 2010, at p. 3.

CONCLUSION

After evaluating the employment impacts of the electric power sector's transformation to a cleaner, modern fleet, we conclude that the installation of air pollution controls and construction of new generation under the proposed and planned EPA air rules will lead to a net job gain in the Eastern Interconnection states.

The installation, design and construction of pollution controls and additional generation capacity will create the greatest number of new jobs. Although some O&M jobs will be lost because of projected coal plant retirements, these losses will be offset by new O&M jobs from pollution control and new generation capacity investments, resulting in net job gains across all the states studied.

Notably as well, this report only considered the net employment impacts from capital investments in pollution controls and new generation and from coal plant retirements. When evaluating the overall impact of new EPA air regulations, one must also recognize that the positive job impacts detailed in this study do not provide the entire picture, as the air regulations will also provide substantial economic benefits from cleaner air, improved public health and increased competitiveness through innovative technologies.

APPENDIX A

Table A1. Pollution Controls and New Generation Capacity Investments from the CRA Study

State	Pollution Controls	Additional Installed Capacity (MW)	Investment in New Capacity
AL	$4.1 billion	766	$691 million
AR	$2.4 billion	1,472	$4.2 billion
CT	$229 million	220	$381 million
DE	$414 million	585	$687 million
FL	$2.7 billion	1,793	$2.3 billion
GA	$4.3 billion	89	$228 million
IA	$2.5 billion	17	$46 million
IL	$7.6 billion	2,946	$7.3 billion
IN	$7.2 billion	2,613	$4.8 billion
KS	$1.8 billion	225	$539 million
KY	$3.8 billion	898	$1.1 billion
LA	$2.1 billion	—	—
MA	$504 million	108	$653 million
MD	$1.0 billion	2,558	$3.3 billion
ME	—	86	$201 million
MI	$6.3 billion	1,033	$1.7 billion
MN	$1.1 billion	652	$1.4 billion
MO	$6.6 billion	4,103	$6.8 billion
MS	$1.5 billion	773	$754 million
NC	$2.0 billion	6,488	$7.9 billion
ND	$1.1 billion	175	$454 million
NE	$2.2 billion	403	$1.0 billion
NH	$266 million	20	$57 million
NJ	$51 million	3,100	$3.8 billion
NY	$944 million	1,826	$3.5 billion
OH	$7.1 billion	1,792	$2.2 billion
OK	$3.5 billion	993	$1.6 billion
PA	$4.7 billion	2,321	$3.3 billion
RI	—	20	$57 million
SC	$695 million	5,554	$5.8 billion
SD	$269 million	3,083	$3.0 billion
TN	$3.6 billion	4,868	$9.9 billion
VA	$2.6 billion	12,531	$13.8 billion
VT	—	1,359	$3.0 billion
WI	$3.4 billion	1,285	$2.9 billion
WV	$2.6 billion	960	$2.7 billion
Other	$2.6 billion	333	$403 million
TOTAL	$93.6 billion	68,047	$102.4 billion

Table A2. Estimated Construction, Installation, and Other Professional Job Gains from Investment in Capital Improvements

	Pollution Controls		Generation Capacity		Total
State	Direct	Direct + Indirect	Direct	Direct + Indirect	Direct + Indirect
AL	16,298	33,495	1,955	5,260	38,755
AR	11,334	22,409	14,325	33,701	56,110
CT	799	1,617	844	2,240	3,858
DE	1,649	3,191	1,626	3,350	6,542
FL	9,856	23,271	6,552	19,834	43,106
GA	15,642	34,836	503	1,629	36,465
IA	10,282	19,602	112	297	19,899
IL	30,594	65,600	21,928	57,096	122,695
IN	27,763	56,648	15,788	38,545	95,193
KS	7,067	13,706	1,720	4,106	17,812
KY	11,892	23,222	3,155	8,255	31,477
LA	8,004	15,842	0	0	15,842
MA	1,735	3,678	2,445	5,867	9,545
MD	3,236	6,967	4,797	9,955	16,922
ME	0	0	570	1,279	1,279
MI	21,534	48,097	5,425	14,249	62,346
MN	3,557	7,590	5,067	12,551	20,141
MO	4,237	8,902	20,668	51,610	60,512
MS	7,514	14,202	2,323	5,601	19,803
NC	6,485	14,275	24,689	62,691	76,966
ND	3,190	5,971	1,073	2,237	8,207
NE	8,261	16,968	3,196	7,363	24,331
NH	1,031	2,068	122	352	2,420
NJ	134	308	9,157	23,946	24,255
NY	2,960	6,155	9,998	24,341	30,496
OH	26,299	58,175	6,407	18,065	76,240
OK	14,380	28,898	5,709	13,753	42,651
PA	15,157	33,833	9,096	25,411	59,243
RI	0	0	118	359	359
SC	2,038	4,421	17,625	44,889	49,311
SD	1,247	2,382	9,060	21,527	23,909
TN	13,455	28,445	35,956	84,693	113,138
VA	9,450	19,648	41,835	103,365	123,014
VT	0	0	9,323	19,107	19,107
WI	12,555	26,801	8,837	23,431	50,233
WV	6,455	11,746	9,692	20,507	32,253
Other	9,214	20,764	919	2,688	23,453
TOTAL	325,305	683,734	312,617	774,151	1,457,885

Note: All values reported in "job-years". One job-year equals one year of full-time employment.

Table A3. Estimated Operating and Maintenance Job Gains from Investments in Capital Improvements

State	Pollution Controls		Generation Capacity		Total
	Direct	Direct + Indirect	Direct	Direct + Indirect	Direct + Indirect
AL	359	684	42	80	764
AR	229	417	150	273	690
CT	11	24	8	17	41
DE	34	60	30	54	114
FL	202	461	105	238	699
GA	274	563	10	20	584
IA	212	381	3	5	386
IL	481	1,007	202	422	1,429
IN	564	1,060	188	352	1,413
KS	160	289	30	53	342
KY	398	738	74	137	875
LA	146	297	0	0	297
MA	28	59	4	8	66
MD	31	81	55	145	226
ME	0	0	10	19	19
MI	405	850	65	137	987
MN	89	172	71	137	309
MO	615	1,157	304	570	1,727
MS	155	273	50	87	360
NC	162	306	355	667	973
ND	89	162	17	31	193
NE	60	171	13	37	208
NH	18	35	2	5	40
NJ	50	105	102	212	316
NY	58	114	97	188	303
OH	599	1,161	106	204	1,365
OK	241	489	66	134	623
PA	255	571	100	223	794
RI	0	0	132	323	323
SC	68	124	352	634	757
SD	24	44	184	336	379
TN	350	634	412	745	1,379
VA	136	297	428	928	1,225
VT	0	0	101	197	197
WI	302	560	121	224	784
WV	275	485	108	190	675
Other	89	248	12	30	277
TOTAL	7,170	14,077	4,106	8,061	22,138

Table A4. Estimated Job Reductions from Coal Plant Retirements

State	Capacity (MW) Retired	Job Reductions	
		Direct	Direct + Indirect
AL	2,197	623	1,184
AR	0	0	0
CT	0	0	0
DE	447	123	219
FL	1,583	427	970
GA	3,018	831	1,700
IA	1,066	265	475
IL	901	263	549
IN	1,440	300	563
KS	287	99	179
KY	1,917	531	982
LA	259	71	145
MA	271	75	157
MD	250	69	180
ME	0	0	0
MI	1,926	537	1,124
MN	1,040	282	542
MO	479	144	271
MS	378	104	183
NC	3,009	540	1,014
ND	116	32	58
NE	276	76	217
NH	208	80	155
NJ	216	59	123
NY	348	96	187
OH	3,851	917	1,772
OK	0	0	0
PA	2,070	570	1,272
RI	0	0	0
SC	2,003	537	968
SD	0	0	0
TN	1,746	481	869
VA	683	170	369
VT	0	0	0
WI	1,437	474	874
WV	1,606	331	583
Other	2	1	2
TOTAL	35,029	9,109	17,884

APPENDIX B

Methodology and Assumptions

a. Response of the Electric Sector to Proposed and Planned EPA Air Regulations

The December 2010 CRA Study developed forecasts of the electricity generation sector's responses to EPA's proposed and planned air regulations. For these forecasts, CRA researchers used a model of the energy sector, the North American Electricity and Environment Model (NEEM), to predict changes in capacity and investment expenditures[16]. We used the modeled responses to estimate employment impacts. The specific responses include: (1) expenditures on pollution control technologies (ACI, ACI+, FGD, and SCR), (2) additions to generating capacity involving nine technologies: advanced coal, IGCC, combined cycle, combustion turbine, nuclear, municipal waste, biomass, solar PV, and wind, and (3) coal plant retirements.

The CRA Study included information on pollution controls, new generation capacity and coal plant retirements was provided at the plant level. We aggregated this information to state-level and Eastern Interconnection-wide estimates of retirements and investment in pollution controls and new generation capacity.

b. Linking Expenditures on Pollution Controls and Generation Capacity Additions to Sectors in the Input-Output Model

Jim Staudt of Andover Technology Partners, provided details of the precise categories of expenditures associated with each of the four pollution control technologies. Dr. Staudt is President of Andover Technology Partners and a nationally recognized expert on air pollution control, with a Ph.D in Engineering from the Massachusetts Institute of Technology. These expenditure breakdowns were linked to PERI's IMPLAN 3.0 input-output model to generate employment multipliers. Select examples of the types of expenditures/activities used to generate the employment estimates include:

ACI and ACI+: equipment (e.g. sorbent injector and disposal systems), engineering services, duct work, and electrical installation services.

FGD scrubbers: water treatment systems, chimney construction, fans & ductwork, engineering services, contractor services.

SCR: reactor housing construction and installation, ammonia handling systems, ductwork & fans, engineering services.

We matched each of these spending areas with an industrial sector in the input-output model. backing out some retrofits that were known to have been completed in 2010.

16. "Appendix B: Modeling and Methodology," *A Reliability Assessment of EPA's Proposed Transport Rule and Forthcoming Utility MACT*, Shavel and Gibbs, CRA, December 16, 2010, at p. 35-37.

We then combined individual spending categories into a single aggregate category for each of the four technologies (ACI, ACI+, FGD, and SCR), using individual expenditure shares as weights. We then generated employment estimates associated with expenditures on each of the four pollution control technologies using the input-output model.

We estimated employment creation from expenditures on generation capacity for each of the nine technologies using a similar procedure. Activities involved in the installation of new generation capacity are identified from industry sources. These activities are then matched with the relevant sectors in the input-output model to produce employment multipliers.

The sum of the indirect employment effects across the Eastern interconnection states based on the state-level input-output models will fall short of the aggregate estimates presented in Table 1, which are based on a national input-output model. The reason for the discrepancy is that indirect effects will be lower at the state level than at the Eastern Interconnection level. For example, based on the CRA Study's estimate, Ohio is expected to spend about $7.1 billion on pollution control technologies. However, firms installing these capital improvements may purchase goods and services from other states. These indirect purchases will create jobs in other states—not Ohio. In contrast, the aggregate estimates include all indirect effects from all the states combined. The state-level input-output models produce estimates of employment effects in one state only. They do not allow us to allocate the indirect effects that occur outside the state to other specific states (e.g., we do not know how much of the spending by Ohio's construction industry is on inputs from Missouri, for instance).

To account for this discrepancy, we allocate the difference between the total employment estimates (direct and indirect) from the national input-output model and the sum of the state-level estimates according to each state's share of the aggregate employment effects across all states.

d. Estimating operating and maintenance expenditures associated with capital investments.

Estimates of O&M expenditures associated with investments in pollution controls are based on estimates compiled by Industrial Economics, Inc. of Cambridge, MA, for FGD scrubbers used in electric generation applications. The O&M estimates are derived from the EPA's Coal Utility Environmental Cost (CUE Cost) spreadsheet. The cost estimates produced by Industrial Economics include a 30 percent premium for administrative employment. To restrict the analysis to O&M jobs, we do not include this premium in the employment estimates, in order to restrict the analysis to O&M jobs. O&M expenditures total an estimated 6.6 cents for each dollar invested in FGD technologies. We assume that this same ratio of O&M costs to investment applies to the other pollution control technologies: ACI, ACI+, and SCR. We then estimate total O&M expenditures from the total dollar value of investments in pollution controls. The input-output model generates employment estimates based on these expenditures.

Estimates of O&M expenditures linked to new generation capacity are based on O&M expenditures used by the U.S. Energy Information Administration (EIA). Fixed and variable O&M costs associated with each of the nine technologies are taken from the EIA publication, *Assumptions to the 2010 Annual Energy Outlook* (Table 8.2). For purposes of estimating O&M employment, O&M costs per kilowatt of installed capacity are computed assuming peak summer capacity. The O&M cost per KW can then be used to calculate total O&M expenditures, in response to changes in emissions regulations, associated with the predicted state-level and Eastern Interconnection investments in new generation capacity.

e. Estimates of direct employment reductions from coal plant retirements

Current employment levels were obtained from FERC forms for some of these retired plants. FERC employment numbers are matched to retired plants whenever possible. For retired plants with no matched employment data, we used state averages of employment per MW derived from plants in the same state that do have such employment data. For states with planned retirements and no employment data whatsoever, national averages of employment per MW are used.

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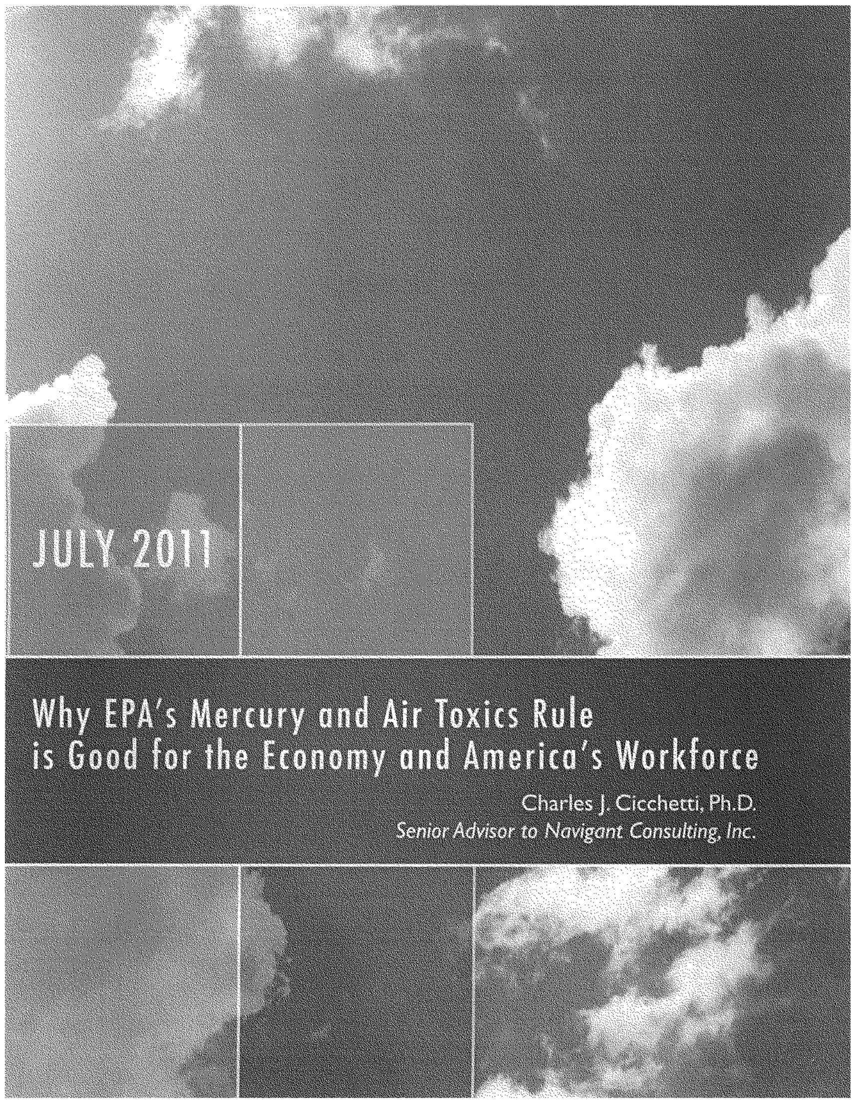
Attachment 4



JULY 2011

Why EPA's Mercury and Air Toxics Rule is Good for the Economy and America's Workforce

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WHY EPA'S MERCURY AND AIR TOXICS RULE IS GOOD FOR THE ECONOMY AND AMERICA'S WORKFORCE

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Cover Photo: Robert Michie

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Executive Summary

EPA's proposed Mercury and Air Toxics Rule would limit emissions of hazardous air pollutants including mercury; non-mercury metals such as lead, arsenic, cadmium, chromium, manganese, selenium and nickel; and acid gases such as hydrogen chloride, hydrogen fluoride and hydrogen cyanide from electric generating units. Emissions of these toxic substances severely harm human health and can result in premature death, birth defects, respiratory illness and heart attacks. Our Nation and most others have determined that these toxic pollutants should be eliminated from the atmosphere and the food supply to the greatest extent reasonably possible. To do so, the electric industry will need to respond, either by installing emissions control technology, switching to lower polluting fuels, retiring older, less efficient and more polluting plants, switching dispatch to reduce emissions and/or implementing measures to improve energy efficiency. In addition to reducing emissions of hazardous air pollutants, these actions would result in significant reductions of other harmful air pollutants, including SO_2, NO_X, particulate matter (PM), and greenhouse gas (GHG) emissions. This, in turn, would produce substantial opportunity benefits (co-benefits) in the form of additional avoidance of low probability premature death, and other health and welfare improvements.

Rather than moving forward with these actions, however, coal plant owners continue to seek delay in the implementation of EPA's emissions standards for hazardous air pollutants and resist EPA every step of the way. Political allies of coal seek to delay implementation of the Toxics Rule and EPA's recently promulgated Cross-State Air Pollution Rule by at least a year and a half through legislation, commonly referred to as the Train Act, as well as other similar legislative efforts to delay rules that already are years late. Companies that have gotten away with and even benefitted from avoiding the consequences of the pollution that they emit challenge EPA's benefit-cost analyses for its proposed Toxics Rule. This report evaluates EPA's benefit-cost analysis as well as quantifies additional benefits that EPA chose not to monetize or include in their final benefit-cost results. EPA's analysis is both comprehensive and conservative, and the proposed Toxics Rule would result in an additional $10.5 billion in annual benefits that EPA did not quantify or include in its analysis.

EPA, nevertheless, concluded that the annual benefits of the proposed Toxics Rule would dwarf the compliance costs, yielding net benefits (benefits minus costs) of about $42 billion to $129 billion per year. Some have argued that EPA's benefit-cost analysis is faulty because it includes co-benefits from SO_2, NO_X, particulate matter (PM), and greenhouse gas (GHG) emissions, which are not directly regulated by the proposed Toxics Rule. Those who suggest that it is improper for EPA to calculate co-benefits from reductions of non-hazardous pollutants, which are regulated under other sections of the Clean Air Act, have a fundamental lack of knowledge of the core economic concept of opportunity benefits and a poor understanding of how to conduct an benefit-cost or economic impact analysis.[1] EPA's benefit-cost analysis is comprehensive and relies upon sound and proven scientific methods and data.

Moreover, EPA's benefit-cost analysis was extremely conservative. EPA ignores the likely overestimate of compliance costs and likely underestimate of realized benefits of the proposed Toxics Rule and fails to substitute a reasonable degree of new energy efficiency and demand-side management. Because it already had enough information to conclude that the benefits of the proposed Rule far outweigh the costs, EPA also chose not to quantify many additional benefits. In this Report, we identify an additional $8.2 billion in annual benefits plus $2.3 billion in likely energy efficiency savings resulting from EPA's proposed Toxics Rule. These include the combined employer business savings for lost workdays, employee recruiting, training, integration, and replacement, and avoided restricted outdoor activities; reduced health

[1] As discussed in Section I, it is contrary to both sound principles of benefit-cost analysis and common sense to suggest that "co-benefits" arising from the Rule should not be considered.

care and insurance costs, and increased employment at a time when the economy is stressed. (See Table 8). This study also examines some of the second and third order effects that EPA did not calculate. The additional analysis in this Report shows that the proposed Toxics Rule would add 115,520 jobs, GDP growth of $7.170 billion, and additional tax receipts of $2.689 billion. These results are summarized in the following table:[2]

	EPA Calculations in RIA	Adding Energy Efficiency ($2.3 million in 2015)	Adding Additional Analysis in this Report
Net Benefits	$42-$129 billion	$44.3-$131.3 billion	$52.5-$139.5 billion
Job Increases	35,970	n/a	115,520
Healthcare Savings	$3.445 billion	n/a	$4.513 billion
GDP Increases	n/a	n/a	$7.170 billion
Increased Tax Revenues	n/a	n/a	$2.689 billion

The damage caused by hazardous air pollutants cannot easily be measured in dollars and cents. But the benefits of reducing exposure to toxic pollutants can be quantified, as EPA has done in its RIA and we have added upon here. The Toxics Rule will reduce public exposure to hazardous pollutants and save lives at no cost to Americans, but, quite the contrary, will produce significant economic benefits. It therefore should be promptly adopted and enforced. Delay is not an option for America's economy or its workforce.

2 Moreover, the proposed Toxics Rule will produce even greater benefits that have not been fully monetized in either the EPA analyses or this Report. For instance, additional benefits will result from structural shifts in the electric generation industry as a result of the replacement of antiquated coal-fired plants with new, more efficient gas-fired plants located in the areas of the shale gas boom. For example, up to nine coal-fired plants that are located in Pennsylvania, Ohio, West Virginia, and New York and projected by the RIA to retire as a result of the Toxics Rule are located above the Marcellus Shale Gas Formation, the Utica Shale Gas Formation, or both. New combined cycle gas fired power plants at these sites could take advantage of existing transmission lines and locally produced natural gas.

Introduction: The Compelling Case for the EPA's Toxics Rule

The Environmental Protection Agency (EPA) has issued a proposed rule establishing national emission standards for hazardous air pollutants (HAPs) from coal- and oil-fired electric utility steam generating units (EGUs) under Clean Air Act (CAA) section 112 and new source performance standards for non-greenhouse gas pollutants from fossil fuel-fired EGUs under CAA section 111(b). These are, collectively, referred to as the Toxics Rule.

The appropriate economic test to determine policies that eliminate toxic substances is the least-cost test. The societal goal should be to avoid the release of HAPs using the lowest reasonable cost options. EPA's approach to regulating HAP emissions and performing the required RIA conceptually should be quantitatively and qualitatively different from its analysis of other air pollutants. This difference is reflected in the special statutory provisions in the CAA governing HAPs. It is also consistent with other statutory provisions directed at many of the substances affected by the Toxics Rule. For example, the Mercury Export Ban Act and the Mercury Containing and Dischargeable Battery Management Act of 1996 both place strict limits on the proliferation of mercury and reflect a legislative judgment that these limits are a high priority. Similarly, the Consumer Product Safety Act Amendments of 2008 place very strict limits on lead coatings and other potential vectors of exposure to lead and other dangerous metals.

Other federal agencies have applied strict scrutiny to the substances at issue here and have imposed stringent regulations. For example, the Food and Drug Administration has a currently effective advisory admonishing pregnant women and young children to avoid consuming certain species of fish entirely because of the potential for mercury exposure. The Occupational Health and Safety Administration has extremely strict workplace rules governing the substances controlled by the Toxics Rule. The Consumer Product Safety Administration has imposed enormous expense on the paint and coatings industry and upon the toy industry and retailers due to product recalls, testing and certification requirements, and other regulations all designed to minimize or eliminate exposure to lead and other dangerous substances. Finally, state and local governments have also enacted stringent restrictions on many of these toxic substances. In many of these cases, the cost per unit of reduced exposure is likely much higher than in the Toxics Rule, but society has made a judgment through the political process that eliminating this danger is well worth the price. These statutes and regulations reflect the implicit value that society places upon reducing human exposure to hazardous substances.

Society's judgment that reducing human exposure to hazardous substances is of high value is not the product of a whimsical or poorly reasoned decision. History tells us that some of the HAPs regulated by the Toxics Rule can produce truly catastrophic human health disasters. In Japan, a notorious outbreak of mercury poisoning was so severe that it was classified as a distinct disease – the Chisso-Minamata disease, named after the primary polluting company and the area primarily affected. It is estimated that there were nearly 2,000 fatalities and many, many more cases of severe neurological damage. A second outbreak also affected a large number of victims. Lead poisoning has been a notorious and vicious source of human health damage, especially in urban areas.

Toxic pollutants should not be and are generally not controlled by effluent taxes or by cap and trade mechanisms more appropriate to other substances for which calculating an economically optimal level can be undertaken. Instead, emissions of hazardous substances that can create severe human health hazards should be eliminated from the atmosphere and the food supply to the greatest extent reasonably possible.

Public policy can reasonably seek to achieve a balance between costs and benefits for some environmental pollutants. Environmental economics evokes a conceptual tradeoff between marginal abatement costs and marginal damages to establish conceptually the economically efficient pollution reduction target or standard and various means to accomplish the goal. While these analyses and policy objectives can be subject to legitimate debate concerning the "optimal" result, this is clearly not the case here. The measures EPA is required to take under the CAA do not lend themselves to such balancing because hazardous substances represent clear and direct dangers to the exposed population. The public policy objective for toxics is to find the least cost means to prevent the release of these toxic substances into the environment.

In this case, EPA has shown that removing these toxic poisons would produce enormous net benefits in excess of costs. This means compliance with the Toxics Rule costs society a negative amount to restrict the release of the hazardous substances the Toxics Rule addresses. Therefore, EPA has proposed a method of reducing hazardous air pollutants at the least cost. Completely aside from the benefits associated with the actual reduction of HAP exposure itself, technologies are available to achieve compliance with the Rule at reasonable costs. In addition, deploying these technologies would reduce $PM_{2.5}$ significantly (even after full compliance with the Transport Rule) and the benefits associated with that reduction significantly exceed the total costs of deploying the technology. Thus, the issue could appropriately be framed as whether Americans would like to be paid (the net benefits of deploying the technology) in order to have less mercury and other heavy metals in their food and less of these metals and dangerous acids in the air they breathe. In a very important sense, this is a free lunch!

Even this compelling analysis understates the Rule's net benefits. While EPA's analysis of the human health benefits of the Toxics Rule is sound, EPA does not include other significant resulting economic benefits. This study shows these additional benefits include reducing employers' labor costs, increasing local and state tax revenues, and reducing employers' health insurance costs and total approximately $8 billion per year. In addition, the RIA understates the potential importance of new energy efficiency and demand-side management alternatives and related cost-savings, and includes no consideration of likely technological innovations.

EPA has provided an example of the IQ-related benefits for children born to mothers with particularly high exposure to mercury in their food chain. This analysis is important, but merely scratches the surface of the myriad of concentrated damages that exposure to mercury and non-mercury heavy metals cause for the poisoned individuals and their children in utero. For some unfortunate population groups, exposure to hazardous substances can be poisonous in a direct manner, and not in just a probabilistic fashion as with other air pollutants. Thus, the enormous net benefits that EPA has calculated for the Toxics Rule are, in fact, substantially understated.

Section I. The Monetized Benefits of EPA's Toxic Rule Far Outweigh the Costs

EPA's core mission is protecting human life, health, and the environment. Many of the conventional pollutants that EPA regulates can be treated in terms of comparing the direct benefits and costs of reducing their concentration in the environment. For this category of pollutants, it is quite reasonable to ask questions such as: How much pollution control or permitted emissions are optimal? Other pollutants, however, are hazardous in the important sense that they poison and directly harm people and other species that are exposed to these toxic materials. For this category of pollutants, the question becomes: "What is the least cost of removing the toxic material from the threatened population?"

In the RIA of the Toxics Rule, EPA did two things. First, EPA recognized accurately that the proper question to ask when toxic poisons are entering the environment is: "What is the least cost means for preventing these toxic pollutants from entering the environment and exposing people and other species from direct harm?" EPA also poses a second critical question in its RIA tied to the fact that there are additional benefits that would offset the necessary costs for avoiding the release of toxic poisons: "Do health-related savings from curbing pollution emissions exceed compliance costs?" The EPA analysis answers this with a very strong and unambiguous "yes", even when focusing only on the morbidity and mortality effects of increased concentrations of $PM_{2.5}$ and ground level ozone. This is most important because it means that the net costs to the nation from curbing the release of toxic substances from the nation's coal-fired power plants is very much an additional benefit.

EPA's benefit-cost analysis of the Toxics Rule is consistent with EPA's Guidelines for Preparing Economic Analyses (Guidelines).[3] The Guidelines (Section 8.1) conclude: "The most comprehensive measure of the costs of regulation – and thus the appropriate measure to use in a

[3] Guidelines for Preparing Economic Analyses, United States Environmental Protection Agency, Office of the Administrator, EPA 240-R-10-001, December 2010.

benefit-cost analysis – is 'social cost'…it may be defined as the sum of all opportunity costs incurred as a result of the regulation." The term opportunity cost in benefit-cost applications can be positive (benefit) or negative (cost). Section 5.71 concludes "In some cases, however, compliance implies a reduction in costs from the baseline." This would be an additional co-benefit or opportunity benefit that would be added to the direct program benefits or subtracted from the costs. Either would yield an identical net benefit calculation. The Guidelines also explain (in Section 5.8) that "Developing a baseline plays a critical role in analyzing policy scenarios, because it is the basis for benefit-cost analysis and options selection." The definition of baseline (Section 5.5 of the Guidelines) is that it "is a reference point that reflects the world without the proposed regulation…" The baseline for the Toxics Rule is the implemented Transport Rule.

Any additional benefits related to cleaner air as a result of the Toxics Rule would be co-benefits or opportunity benefits. These are included in a properly formulated benefit-cost analysis. EPA got this correct in the RIA.

In the analyses of the Toxics Rule, three factors are important in the benefits-cost analysis. These are: (1) benefits of reduced toxic materials; (2) cost of toxics reduction; and (3) other direct opportunity effects or changes, such as co-benefits, in baseline related to the reduction in toxic materials. The RIA reflects these economic principles by defining baseline as a fully implemented Transport Rule; and adding the additional opportunity benefits or co-benefits under the Toxics Rule related to reduced air pollutants, particularly $PM_{2.5}$ and ozone.[4]

Put simply, EPA proves with sound science and clear economic reasoning that levels of toxic emissions in this nation can be sharply reduced with no net costs. EPA and others correctly

[4] As discussed further below, comments suggesting that the opportunity benefits (which EPA calls "co-benefits") of reducing pollutants that are not HAPs should not be considered in evaluating the proposed Rule are completely inconsistent with sound principles of benefit-cost analysis.

show there is a strong and undeniable link between the policies that reduce toxic substances in the environment and the further reduction in harmful particulates and ozone in the air we breathe. In its RIA, EPA properly and logically established a baseline. The RIA cites extensive evidence that demonstrates conclusively there would be significant reductions in concentrations of the harmful particulate and ozone-related air pollutants beyond the baseline of EPA's new Transport Rule. The added opportunity benefits significantly increase health and related economic benefits beyond the Transport Rule. When netted against the direct costs for the electric generating units, the least cost for reducing toxic poisons is negative. This should end the debate without even attempting to monetize the benefits of eliminating toxic poisons placed in our environment. As detailed below, using peer-reviewed scientific and economic evidence, EPA concludes in its Toxic Rule RIA that the annual benefits of reducing premature deaths and illnesses beyond the Transport Rule exceed compliance costs many times, making implementing the Toxics Rule effectively a free pass.

Based on an independent review of EPA's detailed and extensive economic analysis in the Toxics Rule RIA, this Report concludes that EPA's models, methods, sensitivity analyses, and data meet and surpass the professional and scientific requirements of independent peer review. Further, independent sensitivity analysis of several critical components of EPA's benefit-cost analysis confirms that EPA's analysis is reasonable and conservative; that likely the Toxics Rule's benefits are understated and its compliance costs overestimated; and that the benefits of the Toxics Rule far outweigh the compliance costs, which are net negative under any reasonable set of assumptions.

A. EPA's Net Benefit Assessment Methodology Meets or Exceeds the Standard for Peer Review.

The purpose of the Toxics Rule is to reduce the national emissions of HAPs from coal- and oil-fired electric generating plants. This includes reducing emissions of mercury, lead, arsenic, cadmium, chromium, selenium, cobalt, nickel, hydrochloric acid, hydrofluoric acid and hydrogen cyanide. The Toxic Rule would also, as a secondary or direct opportunity benefit, reduce SO_2 and NO_X emissions, which react in the atmosphere to form fine particle pollution ($PM_{2.5}$)[5] and ground level ozone (smog). $PM_{2.5}$ can be deeply inhaled, absorbed, and passed through the blood stream to susceptible organs in the body causing premature deaths, serious illnesses such as chronic bronchitis and heart attacks, and numerous respiratory problems. $PM_{2.5}$ can also travel in the air stream hundreds of miles. Similarly, because the chemical reactions that create ground level ozone take place when wind blows the pollutants through the air, ground level ozone can be even worse miles away than at the source of the emissions. The first air pollution and mortality studies that conclusively established links between air pollutants and human health[6] in the 1970's were primarily based upon statistical correlation. Recently, the focus has shifted to causation, a more scientific approach that analyzes the harm to humans through deep inhalation of such fine particles in the air.

In its RIA, following extensive evaluation of the vast body of authoritative scientific research, EPA estimated that in 2014 the Toxics Rule would protect public health and avoid: 6,800 – 17,000[7] premature deaths; 11,000[8] cases of acute bronchitis; 11,000[9] non-fatal heart attacks; 12,200[10] hospital admissions and ER visits; 850,000[11] days when people miss work or school; 110,000[12] cases of aggravated asthma; and 225,000[13] cases of upper and lower respiratory symptoms. EPA used this information to calculate that the Toxics Rule would

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5 $PM_{2.5}$ refers to fine particles with a diameter of 2.5 microns or less. A micron is one-millionth the size of a meter, which is about 1% of the width of a human hair.

6 Lester Lave and Eugene Seskin with support from Resources for the Future (RFF) established the statistical links between air pollutants and human health in a variety of studies summarized in their 1977 book: Air Pollution and Human Health, Baltimore: the Johns Hopkins University Press for Resources of the Future.

7 RIA page 1-1.

8 RIA, page 6-83, Table 6-17.

9 RIA, page 6-83, Table 6-17

10 RIA page 6-93, Table 6-17.

11 RIA page 6-83, Table 6-17.

12 RIA, page 6-83, Table 6-17.

13 RIA, page 6-83, Table 6-17

provide mortality and morbidity annual health and welfare benefits of between $58 and $140 billion more than the baseline Transport Rule.[14] These are summarized in the RIA's Table 6-18, (as corrected by the EPA's Errata of March 23, 2011) which is reproduced below.

[14] RIA, page 1-1.

Table 6-18. Estimated Economic Value of Health and Welfare Benefits (95% confidence intervals, billions of 2007$)[a]

Health Effect		*Eastern U.S.[b]*	*Western U.S.*	*Total*
Adult premature death (Pope et al. 2002 PM mortality estimate)				
3% discount rate	$PM_{2.5}$	$53 ($4.2—$160)	$0.9 ($0.1—$2.8)	$54 ($4.3—$160)
7% discount rate	$PM_{2.5}$	$48 ($3.8—$140)	$0.8 ($0. 1—$2.5)	$48 [9?] ($3.8—$150)
Adult premature death (Laden et al. 2006 PM mortality estimate)				
3% discount rate	$PM_{2.5}$	$140 ($12—$390)	$2.4 ($0.2—$6.9)	$140 ($12—$400)
7% discount rate	$PM_{2.5}$	$120 ($11—$350)	$2.2 ($0.2—$6.3)	$120 ($11—$360)
Infant premature death [was this done at 3 and 7% rates?]	$PM_{2.5}$	$0.3 ($-0.3—$1.2)	<$0.01	$0.3 ($-0.3—$1.2)
Chronic Bronchitis	$PM_{2.5}$	$2.1 ($0.1—$9.6)	$0.05 (<$0.01—$0.2)	$2.1 ($0.1—$9.8)
Non-fatal heart attacks				
3% discount rate	$PM_{2.5}$	$1.2 ($0.2—$2.9)	$1.2 ($0.2—$2.9)	$1.2 ($0.2—$2.8)
7% discount rate	$PM_{2.5}$	$1.1 ($0.2—$2.8)	$1.2 ($0.2—$2.9)	$1.1 ($0.2—$2.8)
Hospital admissions—respiratory	$PM_{2.5}$	<$0.01	<$0.01	$0.02 ($0. 01—$0.03)
Hospital admissions—cardiovascular	$PM_{2.5}$	<$0.01	<$0.01	$0.1 ($0.05—$0.14)
Emergency room visits for asthma	$PM_{2.5}$	<$0.01	<$0.01	<$0.01
Acute bronchitis	$PM_{2.5}$	<$0.01	<$0.01	<$0.01
Lower respiratory symptoms	$PM_{2.5}$	<$0.01	<$0.01	<$0.01
Upper respiratory symptoms	$PM_{2.5}$	<$0.01	<$0.01	<$0.01
Asthma exacerbation	$PM_{2.5}$	<$0.01	<$0.01	<$0.01
Lost work days	$PM_{2.5}$	$0.1 ($0.1—$0.1)	<$0.01	$0.1 ($0.1—$0.1)
Minor restricted-activity days	$PM_{2.5}$	$0.3 ($0.2—$0.5)	<$0.01	$0.3 ($0.2—$0.5)
CO_2-related benefits (3% discount rate)	CO_2			$0.57
Monetized total Benefits (Pope et al. 2002 $PM_{2.5}$ mortality estimate)				
3% discount rate		$57 ($4.6—$170)	$1 ($0.1—$3.1)	$58 ($4.6—$180)
7% discount rate		$52 ($4.1—$160)	$0.9 ($0.1—$2.8)	$53 ($4.2—$160)
7% discount rate		$52	$0.9	$53

	($4.1—$160)	($0.1—$2.8)	($4.2—$160)

Table 6-18. Estimated Economic Value of Health and Welfare Benefits (95% confidence intervals, billions of 2007$)[a] (continued)

Health Benefit	*Eastern U.S.[b]*	*Western U.S.*	*Total*
Monetized total Benefits			
(Laden et al. 2006 $PM_{2.5}$ mortality and Levy et al. 2005 ozone mortality estimates)			
3% discount rate	$140 ($12—$410)	$2.5 ($0.2—$7.2)	$140 ($12—$410)
7% discount rate	$130 ($11—$370)	$2.2 ($0.2—$6.6)	$130 ($11—$370)

[a] Economic value adjusted to 2007$ using GDP deflator. Estimates rounded to two significant figures. The negative estimates for certain endpoints are the result of the weak statistical power of the study used to calculate these health impacts and do not suggest that increases in air pollution exposure result in decreased health impacts. Confidence intervals reflect random sampling error and not the additional uncertainty associated with benefits scaling described above. The net present value of reduced CO2 emissions are calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SCC at 5, 3, 2.5 percent) is used to calculate net present value of SCC for internal consistency. This table shows monetized CO2 co-benefits at discount rates at 3 and 7 percent that were calculated using the global average SCC estimate at a 3% discount rate because the interagency workgroup on this topic deemed this marginal value to be the central value. In section 6.6 we also report the monetized CO2 co-benefits using discount rates of 5 percent (average), 2.5 percent (average), and 3 percent (95th percentile).

[b] Monetary value of endpoints marked with dashes are < $100,000

EPA uses only peer-reviewed scientific models and methods to estimate how changes in ambient air concentrations of air pollutants result in health benefits. EPA's quantitative and qualitative models, sensitivity analyses, and data meet and surpass professional and scientific requirements of independent peer review. In determining the impact of increasing concentrations of harmful pollutants by adding transported upwind emissions to locally produced downwind emissions, the EPA followed the widely-accepted science of concentration-response ("C-R"). Under the C-R approach, the "odds," or relative risk, of premature death or illnesses increase exponentially.

EPA's Health Impact Analysis uses an air quality model called CAM_X (Comprehensive Air Quality Model with Extensions) that projects "$PM_{2.5}$ and ozone air quality" and estimates "the change in the spatial distribution of the ambient air quality." This approach determines the change in exposure to populations, and calculates the health effects.[15] The estimated concentrations of both primary and secondary particles in the atmosphere reflect geographically dispersed meteorological inputs such as wind speed and direction, temperature, moisture, vertical diffusion, and rainfall.

The CAM_X results are combined with the AIRS (Aeromatic Information Retrieval System) model to estimate ground level ozone concentrations. EPA's peer-reviewed quantitative benefits model (BenMAP) determines the different health and social consequences of implementing the Toxics Rule based upon estimated differences in concentrations of $PM_{2.5}$ and ground level ozone using the conservative assumption that the Transport Rule has been fully implemented.

Table 1, which reproduces portions of EPA's RIA Tables 8-4 and 3-12, shows the significant power plant reductions in SO_2 and NO_X emissions from implementing the Toxics Rule as calculated by EPA using these conservative, tested, and sound scientific methods.

[15] RIA at pages 6-6 through 6-7.

TABLE 1
Summary of Emissions Changes for the Toxics Rule in Lower 48 States

	Pollutant	
Item	**NO_X**	**SO_2**
2015 EGU Emissions		
Base Case After Implementing Transport Rule	2,000,000	3,900,000
Further Reductions for Toxics Rule	100,000	1,100,000
Further Percentage Reductions with Toxics Rule	5.0%	28.2%
Total 2014 Man-made Emissions*		
Base Case with Transport Rule	Not Reported	6,288,530
Control Case with Toxics Rule	Not Reported	3,931,211
Percentage Reduction with Toxics Rule	N/A	37.5%

* In this table, man-made emissions includes average fires

Based on these substantial SO_2 and NO_X emission reductions, and using sound scientific and proven methodology discussed at length in Section I (B) of this report, EPA also calculated that implementing the Toxics Rule could prevent 6,800 to 17,000 premature deaths per year, as shown in the following Table 2[16]. EPA applied similar peer reviewed and widely accepted scientific techniques to determine the incidence and health care costs for increased illness and

[16] EPA uses two significant digit rounding. Therefore the combined premature deaths estimated for ozone and $PM_{2.5}$ equal the number of premature deaths for adults and children combined and attributable to ozone and $PM_{2.5}$ combined. Annual ozone-related premature deaths and infant $PM_{2.5}$ are both less than 500 deaths per year, so that those numbers round down to zero when combined with the adult $PM_{2.5}$ numbers.

morbidity. These are included in the opportunity benefits discussed above that EPA often refers to as co-benefits.

TABLE 2
Toxic Rule Reductions in Annual Premature Mortality *

Fine Particles

	Source	Range	Midpoint
(1)	Pope, et al 2002 >30	1,900 - 12,000	6,800
(2)	Laden, et al 2006 >25	8,100 - 27,000	17,000
(3)	Infant	30	30

* Source for PM and Ozone premature mortality estimates is Table 6-17, page 6.83 of the RIA.

In the public comment sessions, the Electric Reliability Coordinating Council ("ERCC"),[17] echoing other opponents of the Toxics Rule, suggested it was somehow improper for EPA to calculate co-benefits or opportunity costs to the extent the co-benefits that arise from reductions of pollutants might be regulated under other sections of the Clean Air Act. This comment reflects a lack of knowledge of the core economic concept of opportunity benefits and a poor understanding of how to conduct an economic impact analysis. In fact, it would be improper to fail to account for these co-benefits because they amount to net negative costs of implementing the regulation. This is known as joint products in the economic literature. It is

[17] This group does not represent the utility industry but, based on its website, is a coalition of unnamed parties formed with the express purpose of challenging EPA regulation of the industry.

exemplified by considering the calculation that a lead smelting company might make in deciding whether or not to develop a new mine rich in lead, where the new vein also included silver and other valuable metals. Although the company would be developing the mine to supply its lead smelter, it would base its investment decision on the total return, which would require considering the present value of all costs and revenues, which would necessarily consider revenues from the sale of the silver and other non-lead minerals. Even assuming that the non-HAP and HAP benefits could be segregated, it would make little sense for society to ignore the benefits of reducing $PM_{2.5}$ and NO_X, just as it would make little sense for the lead company to ignore the value of the jointly producible silver.

B. Independent Review of Several Critical Issues Confirms that EPA's Methodology is Reasonable and Conservative.

A comprehensive review of EPA's analysis confirms its net benefit methodology for valuing annual mortality and morbidity health and welfare benefits is reasonable and conservative. In particular, an independent review of EPA's: (1) baseline conditions; (2) explicit value of human life that drives its numbers; (3) quantitative omission of some benefits; and (4) conservatively high compliance costs, verifies that the health co-benefits associated with reducing $PM_{2.5}$ alone from the Toxics Rule far exceed compliance costs under any set of reasonable assumptions, and that the Agency's approach is conservative because it tends to understate benefits and overstate costs. Under highly probable conditions, the analysis indicates that refining EPA's estimates would likely mean that Toxics Rule benefits would exceed compliance costs by about 5 to 13 times.

1. Baseline Conditions

EPA's baseline assumes that the Transport Rule is in effect and includes reductions in ground level ozone and $PM_{2.5}$ pollution from all other federal and state requirements in place as of 2010. Thus, the baseline case takes into account the emissions reductions associated with the

Transport Rule and the co-benefits EPA calculates for the Toxics Rule are in addition to the benefits achieved through implementing the Transport Rule. Similarly, the costs associated with the reductions required by the Transport Rule are not included in calculating the costs of the Toxics Rule.[18]

2. EPA Used a Reasonable Value of Statistical Life (VSL)

The value of statistical life ("VSL") EPA used in calculating the value of fewer premature deaths represents the largest share of the Toxics Rule's opportunity or co-benefits. Accordingly, we conducted an independent sensitivity analysis on this key variable. This analysis concludes that EPA's VSL methodology represents current state-of-the-science.

Although important work continues in refining monetization of the value of premature loss of life, the EPA's VSL analysis was vetted fully, subjected to robust peer review in the scientific community, and applies the most scientifically objective methodology for valuing human life currently available. Even if EPA had selected an unreasonably low VSL value, the Toxics Rule benefits still far outweigh the compliance costs. When the monetized opportunity benefits related to cleaner air are subtracted from the additional conservatively estimated compliance cost, the net costs are extremely negative, even without monetizing the effect of poisonous HAPs that bio-accumulate and persist in the environment and food chain.

EPA's VSL relies conceptually on two critical issues: (1) reducing the risks of premature death (*i.e.*, the effect of a "small reduction in risk on a large number of people"); and (2) the "willingness of people to pay" (WTP) to reduce such risks. It is important to understand that the VSL evaluation represents payments (*i.e.*, a relatively small individual WTP[19] across all the

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18 As we noted in our report on the Transport Rule, Charles J. Cicchetti, *Expensive Neighbors: The Hidden Cost of Harmful Pollution to Downwind Employers and Businesses*, (Dec. 2010), EPA properly determined that the benefits of the Transport Rule far outweighed its benefits. Because the costs and benefits of the Toxics Rule are marginal, if one considered the combined impacts of the two rules, the benefits would far outweigh the costs.

19 The three approaches to determine WTP are: (1) Wage-Risk Studies, which compare relative salary differences to different fatal injuries, adjusting for confounding factors in the regression analysis; (2) Continent

(continued...)

potentially affected populations) to reduce the risk of premature death, rather than an attempt to determine the value of a specific human life.

Consider an example. Suppose one million people are each willing to pay $100 per year to reduce the risk of deaths from twenty per million people to ten per million people. The sum of WTP equals $100 million per year and the reduction in expected deaths is 10 per year, so the VSL would be $10 million per person ($100 million divided by 10 people per year).

The EPA relied on its Guidelines for Preparing Economic Analyses (U.S. EPA 2000) (Guidelines) to determine the Toxics Rule VSL.[20] EPA's Scientific Advisory Board ("SAB") vetted and endorsed the VSL in the Guidelines for Preparing Economic Analyses.[21] These Guidelines have been peer-reviewed and fully vetted. They represent state-of-the-science values and methods for the performance of economic analysis, and the EPA has properly applied them.

The EPA used sound scientific methods to determine the VSL estimates including a "meta analysis" of 26 "high-quality" studies conducted between 1974 and 1991, which estimated a value of mortality risk reduction.[22] Each study was peer-reviewed, tested, and endorsed by the SAB. The EPA Guidelines recommend updating the $4.8 million (1990$) figure for VSL for inflation to the base year of the benefit analysis yields a VSL of $6.3 million in 2000$.[23] EPA reasonably derived a VSL of $7.8 million after adjusting a VSL of $6.3 million in 2000 dollars to 2006 dollars.[24]

(...continued)
Valuation Studies, which pose hypothetical questions related to risk, hypothetical insurance premiums, changes in monetary remuneration, etc.; and (3) Consumer Market Studies, which examine the actual economic trade-offs people make between risks and benefits in their product consumption and insurance decisions.

20 RIA at page 6-36.

21 RIA at page 6-36.

22 See Guidelines for Preparing Economic Analyses, Exhibit 7-3 Value of Statistical Life Estimates (mean values in 1997 dollars), page 89 (September 2000). RIA page 6-36.

23 RIA at page 6-36.

24 RIA at page 6-36, footnote 2.

(i) EPA Uses a Reasonable Approach to Calculate the Number of Avoided Premature Deaths

The value of the VSL is a critical variable in EPA's cost/benefit calculations because health-related and, in particular, mortality-related benefits, dominate the estimated benefits for the Toxics Rule. The Toxics Rule RIA estimated that in 2016 approximately 6,800 to 17,000 premature deaths would be avoided nationwide. Avoiding these premature deaths represents about $53 billion[25] of the $59 billion, or nearly 90% of the low case's estimated benefits for the 3% discount case. The corresponding estimates for the high case are $133 billion[26] for premature mortality out of $140 billion in annual benefits, or about 95% for the 7% discount case.[27]

EPA's approach to estimate the number of avoided premature deaths is called a Concentration-Response ("C-R") method. This widely endorsed method, which has been used extensively in the epidemiology, public health, and economics fields, uses a log-linear function. Such an approach is consistent with a low incidence of low exposure that increases exponentially until a threshold is approached and incidence again slows. The EPA's low case (6,800 deaths per year) relies upon American Cancer Society data and a 2002 peer-reviewed study published in the Journal of the American Medical Association ("Pope Study").[28] The EPA's high case (17,000 deaths per year) is based on data from a 2006 Harvard study published in The American

25 This equals 6,800 premature deaths per year times $7.8 million in VSL.

26 This equals 17,000 premature deaths per year times $7.8 million in VSL.

27 See Table 6-18 of the Toxics Rule, RIA at page 6-84.

28 See Pope, C.A., III, R. T. Burnett, M.J. Thun, E.E. Calle, D. Krewski, K. Ito, and G.D. Thurston. 2002. Lung Cancer, Cardiopulmonary Mortality, and Long-term Exposure to Fine Particulate Air Pollution. Journal of the American Medical Association 287:1132-1141; Pope, C.A., III, R.T. Burnett, G.D. Thurston, M.J. Thun, E.E. Calle, D. Krewski, and J.J. Godleski. 2004. Cardiovascular Mortality and Long-term Exposure to Particulate Air Pollution. Circulation 109:71-77; Pope, C.A. III, E. Majid, D. Dockery. 2009. Fine Particle Air Pollution and Life Expectancy in the United States. New England Journal of Medicine 360:376-386; Pope, C.A. III, M.J. Thun, M.M. Namboodiri, D.W. Dockery, J.S. Evans, F.E. Speizer, and C.W. Heath, Jr. 1995. Particulate Air Pollution as a Predictor of Mortality in a Prospective Study of U.S. Adults. American Journal of Respiratory Critical Care Medicine 151:669-674; and Pope, C.A. III, D.W. Dockery, J.D. Spengler, and M.E. Raizenne. 1991. Respiratory Health and PM_{10} Pollution: A Daily Time Series Analysis. American Review of Respiratory Diseases 144:668-674.

Journal of Respiratory and Critical Care Medicine, which covered six cities and was peer-reviewed ("Laden Study").[29]

The Toxics Rule RIA uses two ranges for mortality estimates: the low range uses the 2002 Pope Study for $PM_{2.5}$ mortality and Bell[30] for ozone; and the high range uses the 2006 Laden Study for $PM_{2.5}$ mortality and Levy[31] for ground level ozone. EPA did two things to address the overall uncertainty in the analysis: (1) it performed analysis using the widely accepted Monte Carlo method for "characterizing random sampling error associated with the concentration response functions from epidemiological studies and economic valuation function;"[32] and (2) it utilized an expert elicitation on the relationship between premature mortality and ambient $PM_{2.5}$ concentration.[33] Since issuing the CAIR RIA in 2005, EPA adopted the following technical enhancements in this RIA of the Toxics Rule:

1. The Toxics Rule RIA supplements CAIR's analysis, which quantified PM-related mortality using the C-R function from the 2002 Pope Study, with the 2006 Laden Study's C-R function estimate. Thus, the EPA presents two core $PM_{2.5}$ estimates; one based on the Pope Study and the second based on the Laden Study.
2. The Toxics Rule RIA also includes the twelve $PM_{2.5}$-mortality estimates based on EPA's expert elicitation study used in the CAIR study, and presents "$PM_{2.5}$-related premature mortalities avoided drawn from the expert elicitation."[34]

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29 See Laden, F., J. Schwartz, F.E. Speizer, and D.W. Dockery. 2006. Reduction in Fine Particulate Air Pollution and Mortality. American Journal of Respiratory and Critical Care Medicine 173:667-672.

30 Michelle L. Bell, Aidan McDermott, Scott L. Zeger, Jonathan M. Samet, Francesca Dominici (2004) "Ozone and Short Term Mortality in 95 US Urban Communities, 1987-2000". Journal of American Medical Assoc. 292, 2372-2378.

31 Levy JI, Chemerynski SM, Sarnat JA. July 2005. Ozone Exposure and Mortality: an Empiric Bayes Metaregression Analysis, Epidemiology 14(4):458-68.

32 RIA at page 6.2.

33 RIA at page 6.2.

34 RIA at page 6-22.

As SO_x and NO_X emissions increase, $PM_{2.5}$ concentrations in the air also increase and, as NO_X emissions rise, ozone concentrations in the air also increase. Based on the widely accepted C-R method, peer-reviewed scientific evidence finds conclusively, with great statistical confidence, that higher concentrations in the air of these hazardous substances increase the incidence of premature mortality. Numerous variables in the proven C-R model remove confounding factors and purge missing variable bias. EPA's two state-of-the-science approaches considered a wide range of variables in a complex sensitivity analysis to estimate the likely range of premature deaths. Table 3 below, which reproduces EPA's Table 6-4 in the RIA,[35] describes EPA's comprehensive and robust approach. For example, EPA prefers to use the most recent peer-reviewed research available, and prefers cohort studies that, unlike ecological studies, can be controlled for important confounding variables. EPA quite reasonably prefers using domestic, multi-city studies covering the broadest population to best ascertain total national level health impacts.

[35] RIA at 6-18.

TABLE 3

Table 6-4. Criteria Used when Selecting C-R functions

Consideration	*Comments*
Peer-Reviewed Research	Peer-reviewed research is preferred to research that has not undergone the peer-review process.
Study Type	Among studies that consider chronic exposure (e.g. over a year or longer) prospective cohort studies are preferred over ecological studies because they control for important individual-level confounding variables that cannot be controlled for in ecological studies.
Study Period	Studies examining a relatively longer period of time (and therefore having more data) are preferred, because they have greater statistical power to detect effects. More recent studies are also preferred because of possible changes in pollution mixes, medical care, and lifestyle over time. However, when there are only a few studies available, studies from all years will be included.
Population Attributes	The most technically appropriate measures of benefits would be based on impact functions that cover the entire sensitive population but allow for heterogeneity across age or other relevant demographic factors. In the absence of effect estimates specific to age, sex, preexisitng condition status, or other relevant factors, it may be appropriate to select effect estimates that cover the broadest population to match with he desired outcome of the analysis, which is total national-level health impacts. When available, multi-city studies are preferred to single city studies because they provide a more generalizable representation of the C-R function.
Study Size	Studies examining a relatively large sample are preferred because they generally have more power to detect small magnitude effects. A large sample can be obtained in several ways, either through a large population or through repeated observations on a smaller population (e.g. through a symptom diary recorded for a panel of asthmatic children).
Study Location	U.S. studies are more desirable than non-U.S. studies because of potential differences in pollution characteristics, exposure patterns, medical care system, population behavior, and lifestyle.
Pollutants Included in Model	When modeling the effects of ozone and PM (or other pollutant combinations) jointly, it is important to use properly specified impact functions that include both pollutants. Using single-pollutant models in cases where both pollutants are expected to affect a health outcome can lead to double-counting when pollutants are correlated.
Measure of PM	For this analysis, impact functions based on $PM_{2.5}$ are preferred to PM_{10} because of the focus on reducing emissions of $PM_{2.5}$ precursors, and because air quality modeling was conducted for this size fraction of PM. When $PM_{2.5}$ functions are not available, PM_{10} functions are used as surrogates, recognizing that there will be potential downward (upward) biases if the fine fraction of PM_{10} is more (less) toxic than the coarse fraction.
Economically Valuable Health Effects	Some health effects, such as forced expiratory volume and other technical measurements of lung functions, are difficult to value in monetary terms. These health effects are not quantified in this analysis.
Non-overlapping Endpoints	Although the benefits associated with each individual health endpoint may be analyzed separately, care must be exercised in selecting health endpoints to include in the overall benefits analysis because of the possibility of double-counting of benefits.

EPA scientifically estimated the range of premature deaths from $PM_{2.5}$ and ozone using "with and without" comparisons that effectively shift the C-R function for air emissions under the Toxics Rule from the assumed baseline that conservatively presumes full Transport Rule compliance. Based on the expected shift under the Toxics Rule from the Transport Rule's baseline in C-R, the midpoint of the range of 6,800 to 17,000 deaths is 11,900 premature deaths per year. Using the midpoint of 11,900 avoided premature deaths per year and a $7.8 million per death VSL, the Toxics Rule annual health benefits alone would equal $92.8 billion per year. Compared to direct incremental annual compliance costs of about $10.9 billion per year to that midpoint benefits amount, for just avoided premature deaths, Toxics Rule net benefits would exceed costs by about $81.9 billion per year. Therefore, the reduction in mercury and heavy metal HAPs can be achieved with no net costs because the conservatively estimated compliance costs have been paid for with the additional annual savings that are about 8.5 times greater than the Toxics Rule compliance costs. The peer-reviewed and scientifically estimated values and methods EPA used in the Toxics Rule RIA unequivocally demonstrate the Toxics Rule's expected benefits far exceed estimated costs.

3. Other Reasons Why EPA's Net Benefit Analysis is Very Conservative

Additional reasons for concluding that EPA's Toxics Rule RIA net benefit analysis is very conservative and likely understates net benefits include: (1) it understates the serious effects for at-risk populations; (2) it has comprehensively identified and fully accounted for possible uncertainties; (3) it does not account for *all* benefits and, therefore, understates benefits; (4) it overstates estimated compliance costs; and (5) it underestimates the energy efficiency and demand-side management potential.

(i) At-Risk Populations

EPA reasonably did not attempt to monetize the benefits from avoiding the release of poisonous and carcinogenic HAPs because there has been less comprehensive peer review of these matters. Furthermore, the undisputed benefits, including opportunity benefits, necessary for the least-cost test significantly exceed compliance costs. Instead of introducing less than fully vetted analyses, EPA used an example of the monetized benefits related to avoiding the IQ losses for exposed populations that self-catch fish. These effects are worth considering because they demonstrate the difference between the release of HAPs into the environment and their directly observable pathways to at-risk individuals.

There is a stark difference between mothers eating mercury-laden fish and how this affects their children in utero. These pathways are direct and have very high probability of severe harm. In contrast, many major airborne pollutants, such as particulates, have lower probability consequences, causing lung disease for a small percentage spread across a large population of exposed individuals. Toxics tend to harm smaller concentrated populations with a high probability of severe harm. This raises the risk avoidance aspect of this source of pollution. EPA's RIA analyses did not need to quantify this risk effect because the benefits that EPA monetized easily exceed the compliance costs. Regardless, the risk and damage for the exposed individuals from HAPs exposure is all too real and very severe.

(ii) Comprehensive Identification of Uncertainties

EPA performed a careful and comprehensive review of the uncertainties inherent in all net benefit analyses. EPA recognized that there are limitations in its ability to model the health damages caused by power plant emissions and to quantify the benefits of emission reductions. As for the implications of these uncertainties, EPA noted: "There are costs and important benefits that EPA could not monetize, such as those for the HAP being reduced by this proposed rule other than mercury. Upon considering these limitations and uncertainties, it remains clear the benefits of the proposed Toxics Rule are substantial and far outweigh the costs."[36] The

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36 RIA at page 1-1.

transparency of EPA's exhaustive discussion of uncertainties, as detailed below in Table 4, and resulting quantitative omission of some benefits, represents the best in scientific methods and underscores that EPA benefits are likely understated. More to the point, this rule would reduce poisons, including many persistent bio-accumulating poisons, in the environment, and the goal should be how to do that cost effectively (*i.e.* the least costs test). This is not the same as insisting monetized benefits must exceed costs (*i.e.* the net benefit test). Regardless, when taking into account direct benefits, including opportunity benefits, the total easily surpasses the conservatively estimated compliance costs, so that the proposed Rule meets the net benefits test as well as the least cost test. Both public policy and economic principles strongly show that EPA has correctly performed the RIA, and the Toxics Rule should be implemented sooner rather than delayed.

TABLE 4

Table 6-3. Primary Sources of Uncertainty in the Benefits Analysis

1. Uncertainties Associated with Impact Functions - The value of the ozone or PM effect estimate in each impact function - Application of a single impact function to pollutant changes and populations in all locations. - Similarity of future-year impact functions to current impact functions. - Correct functional form of each impact function. - Extrapolation of effect estimates beyond the range of ozone or PM concentration observed in the source epidemiological study. - Application of impact functions only to those subpopulations matching the original study population.
2 Uncertainties Associated with CAMx-Modeled Ozone and PM Concentrations - Responsiveness of the models to changes in precursor emissions from the control policy. - Projections of future levels of precursor emissions, especially ammonia and crustal materials. - Lack of ozone and $PM_{2.5}$ monitors in all rural areas requires extrapolation of observed ozone date from urban to rural areas.
3 Uncertainties Associated with PM Mortality Risk - Limited scientific literature supporting a direct biological mechanism for observed epidemiological evidence. - Direct causal agents within the complex mixture of PM have not been identified. - The extent to which adverse health effects are associated with low-level exposures that occur many times of the year versus peak exposures. - The extent to which effects reported in the long-term exposure studies are associated with historically higher levels of PM rather than the levels occurring during the period of study. - Reliability of the $PM_{2.5}$ monitoring data in reflecting actual $PM_{2.5}$ exposures.
4 Uncertainties Associated with Possible Lagged Effects - The portion of the PM-related long-term exposure mortality effects associate with changes in annual PM levels that would occur in a single year is uncertain as well as the portion that might occur in subsequent years.
5 Uncertainties Associated with Baseline Incidence Rates - Some baseline incidence rates are not location specific (e.g. those taken from studies) and therefore may not accurately represent the actual location-specific rates. - Current baseline incidence rates may not approximate well baseline incidence rates in 2014. - Projected population and demographics may not represent well future-year population and demographics.
6 Uncertainties Associated with Economic Valuation - Unit dollar values associated with health and welfare endpoints are only estimates of mean WTP and therefore have uncertainty surrounding them. - Mean WTP (in constant dollars) for each type of risk reduction may differ from current estimates because of differences in income or other factors.
7 Uncertainties Associated with Aggregation of Monetized Benefits - Health and welfare benefits estimates are limited other available impact functions. Thus, unquantified and unmonetized benefits are not included. Source: RIA at 6-15

(iii) EPA Has Understated Benefits by Excluding Certain Non-Health Related Benefits.

EPA's RIA is also very conservative because its co-benefits analysis focused almost exclusively on the health-related benefits of protecting the population from the adverse effects of ground level ozone and $PM_{2.5}$, and did not include welfare-related benefits. EPA's RIA attributed more than 90% of the estimated co-benefits to premature deaths. Decreased sickness, health costs, and morbidity were relatively important components of the remaining ten percent of EPA's co-benefits estimates. Yet even when limiting Toxics Rule co-benefits to the health-related ones noted above, EPA found Toxics Rule co-benefits exceed social costs by at least 5 to 1.[37]

Given these staggering health benefits, EPA had little scientific reason to look beyond mortality and morbidity. Although EPA states that it thinks the benefits are substantial, it does not quantify the overall value associated with HAP reductions arising from increased agricultural crop and commercial forest yields, visibility improvements, and reductions in nitrogen and acid deposition and the resulting changes in ecosystem functions.[38] It also fails to account for the costs associated with behavior to avoid the adverse health effects of HAP emissions. For example, many young women forego the pleasures and health benefits of eating the fish subject to mercury advisories by avoiding them, and the costs of this avoidance behavior is not captured in the cost benefit analysis. As EPA explained in the RIA, substantial quantitative benefit omissions or underestimates include:

(1) Enhanced *Ecosystem Services,*[39] which include use and non-use values individuals and organizations derive from ecosystems.

[37] See RIA, page 1-1, Chapter 1 (Key Findings), where the EPA says "The benefits outweigh costs by about 5 to 1 or 13 to 1 depending on the benefit estimate and discount rate used." See also Table 1-1 on page 1-2.
[38] RIA at page 1-8. See also Table 1-4 on pages 1-9 through 1-10.
[39] RIA at page 6-57.

(2) *Ecosystem Benefits of Reduced Nitrogen and Sulfur Deposition,*[40] which include reducing acidification that can negatively affect both terrestrial and aquatic ecosystems.

(3) Reduced *Ecological Effects Associated with Gaseous Sulfur Dioxide,*[41] which are damages avoided for animal and plant life due to alterations in biogeochemistry. The Eastern United States is particularly sensitive to air-borne related losses in this category, including, for example, acidification of lakes due to transformation of SO_2 to sulfuric acid.

(4) *Nitrogen Enrichment*[42], which includes eutrophication in estuaries. Eutrophication includes low dissolved oxygen levels in water that causes stress to fish and shellfish, loss of submerged aquatic vegetation, harmful algal blooms, and low water clarity.

(5) *Benefits of Reducing Ozone effects on Vegetation and Ecosystems,*[43] which includes increasing the diversity, health, and vigor of various species.

(6) *Unquantified SO2 and NO2-Related Human Health Benefits,*[44] which include primarily respiratory effects that result in increased hospital and emergency room visits, respiratory symptoms, airway hyper-responsiveness, airway inflammation, and lung function.

One of the reasons for these omissions could be the same level of scientific advisory review has not been completed for the various HAPs as have been completed for SO2, NOX and PM2.5. As in the case of the other benefits that EPA did not quantify in its RIA, the additional time and cost associated with the additional quantification would only have gilded the lily. Incurring this

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[40] RIA at page 6-59.
[41] RIA at page 6-68.
[42] RIA at page 6-69.
[43] RIA at page 6-71.
[44] RIA at page 6-78.

additional delay and cost when the benefits have already been clearly demonstrated would not have met either the least cost or net benefit test.

(iv) Overestimation of Compliance Costs

Fairly consistently, previous estimates of various environmental compliance costs have been substantially lower than originally projected. M.J. Bradley Associates reported that SO_2 and VOC emission *ex ante* compliance cost estimates significantly overestimated costs.[45] In the case of the Toxics Rule, EPA determined estimated compliance costs using the widely endorsed Integrated Planning Model (IPM), but acknowledges that its estimated costs may well be too high. Specifically, as the EPA concedes, its IPM analysis of the Toxics Rule does not take into account the "potential for advancements in the capabilities of pollution control technologies for SO_2 and NO_X removal, as well as reductions in their costs over time."[46] The EPA explained that cost estimates for the Clean Air Act Title IV acid rain SO_2 program made by Resources for the Future and MIT could be as much as 83% lower than EPA's original projections, which were made using "an optimization model like IPM." *Ex ante*, EPA's acid rain cost estimates were $2.7 to $6.2 billion, whereas *ex post* these costs were estimated to be only $1.0 to $1.4 billion.[47]

There are two very important additional reasons why the IPM compliance cost estimates very likely are too high. First, the electricity industry has an uninterrupted, successful history of implementing technical improvements and reducing costs through least cost engineering principles. Numerous entities in the power sector will be focused on reducing costs and achieving savings through fuel switching, enhanced generation utilization and accelerated use of more efficient, state-of-the-art equipment. Second, EPA likely over-estimated costs because it

45 Van Atten, C and L. Hoffman-Andrews of M. J. Bradley Associates, "The Clean Air Act's Economic Benefits Past Present and Future, Small Business Majority and The Main Street Alliance, October 2010, p.7.

46 RIA at page 8-32.

47 RIA at page 8-33, using a comparison of $1 billion to $6.2 billion.

failed to quantify the effect of reasonably anticipated accelerated supply side and demand side responses.

Generators maintain, retire, or replace power plants based on a combination of engineering and economic factors and analyses. This can cause new coal units to replace older coal units sooner. Older coal-fired units have higher heat rates, typically in the range of 11,500 to 12,000, than new coal fired generation with heat rates less than 10,500.[48] The more than ten percent improvement in heat rate efficiency improvement means replacement coal-fired generation will use less coal and emit less air pollution. The gains from new natural gas-fired generation replacing older coal-fired generation are even more significant. For example, new natural gas combined-cycle electricity generating units typically have heat rates of less than 7,000[49] and they emit only about 25 percent of the NO_X per MWH generated than coal.[50] EPA's RIA makes very conservative assumptions related to both greater efficiency and less emissions.

A new pollution rule such as the Toxics Rule alters the relative costs and prices throughout the electric power industry. Although models such as IPM can broadly estimate response costs, retirements, replacements and reliability requirements, in actual real world engineering, the many smaller "parts" of the industry will seek their own customized engineering and economic responses. The sum of these many smaller parts will, therefore, invariably achieve lower overall response costs than a model such as IPM might estimate for the power sector as a whole. Thus, the IPM model conservatively favors the *status quo*. This fact is well known, transparent, and has been thoroughly vetted. This is not a criticism of the IPM estimates, but

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[48] For example, the 695 MW coal-fired Longview Power Plant that opened in West Virginia in May 2011 has a heat rate of approximately 8800. [NB the permit sets a maximum heat input of 6114 MMBTU and states that the consent order gives a capacity of 600 MW, while the announcement states 695 MW – this uses the 695]

[49] For example, GE Power System has 11 models of combined cycle turbines with heart rates below 7,000. Four of those models have heat rates below 6,000. See GE Power Systems; Gas Turbine and Combined Cycle Products.

[50] The EPA reports that the average coal-fired generating plant in the US produces 6 lbs of NO_X per MWH, while a natural gas fired generating plant produces only 1.7 lbs of NO_X per MWH.

further confirms that Toxics Rule benefits will likely exceed costs by significantly more than the ratios calculated both by EPA and in this Report.

Compared to older coal-burning units and with production costs of about $3 per MCF, shale gas represents a cost effective fuel that will support new, cost-effective electric generation with very significant improvements in air quality and GHG reductions. Although the IPM model did include the effect of the stabilization of natural gas prices arising from the shale gas boom, it does not adequately capture the opportunities for new structural shifts in the electricity generation industry. Some of the most productive shale gas areas are located where many of the antiquated coal-fired plants will retire.

Pennsylvania, which formerly referred to itself as the Saudi Arabia of coal, now refers to itself as the Saudi Arabia of gas. This presents the opportunity for new development and finance models. For example, many gas wells are "shut-ins" with no immediate access to natural gas pipelines. Many older coal plants have existing transmission lines but no access to natural gas pipelines. This raises the possibility of supplying new combined cycle plants with unregulated gathering lines, using the new unexploited resource and the existing transmission infrastructure, water supply, and pollution offsets from closing the coal plants. Up to nine coal-fired plants that are located in Pennsylvania, Ohio, West Virginia, and New York and projected by the RIA to retire as a result of the Toxics Rule are located above the Marcellus Shale Gas Formation, the Utica Shale Gas Formation, or both. The IPM model does not capture these types of entrepreneurial opportunities.[51]

(v) EPA has Overstated Costs by Not Including Energy Efficiency and Demand Response in its Analysis

[51] As noted below, the existence of fully depreciated coal plants operating with few or no controls also likely inhibits new development projects by depressing capacity and electricity markets alike.

The nation's electric and natural gas sectors are increasingly supporting new end-use customer investments in demand response, distributed and centralized renewable energy, and energy efficiency. Nationwide, the electricity industry is approaching $5 billion in annual spending on utility-sponsored demand response programs and natural gas distributors are spending nearly $1 billion each year to encourage consumers to conserve natural gas. A recent American Gas Association survey[52] of natural gas utilities reported a 46.7% increase in conservation expenditures between actual expenditures for 2008 and budgeted expenditures for 2009.

The electricity sector has been increasing electricity-related energy efficiency and demand response spending as well. The U.S. Department of Energy's Energy Information Administration (EIA) reports a similar 47% increase between 2007 and 2008.[53] The planned and actual expansions of the "smart grid" also will likely lead to greater end use efficiencies and more load management. Additionally, expanding the use of distributed and centralized renewable energy to replace some older, less efficient fossil-fired, particularly coal-based generation, may lower compliance costs. These efforts to become more efficient on both sides of the meter will combine to further reduce the likely compliance costs related to the Toxics Rule.

EPA recognized energy efficiency investments and demand response could reduce compliance costs for EGUs. EPA also explained its "modeling does not typically incorporate a 'demand response' in its electric generation modeling (Chapter 8)..." Therefore, in the RIA EPA assumed a constant demand.[54] Nevertheless, the EPA did develop "an end-use energy efficiency policy scenario and analyzed the associated effects."[55] This sensitivity analysis was based on the

[52] AGA "Natural Gas Efficiency Report 2008 Program Year", Appendix B.
[53] EIA Form 861.
[54] RIA page 7-18.
[55] RIA page 8-27.

federal government implementing federal appliance standards and an increase in ratepayer-funded energy efficiency programs.[56]

EPA's Energy Efficiency Sensitivity Scenario resulted in less incremental compliance costs for the Toxics Rule. EPA found the overall reduction in annual electricity system compliance costs would be $2.3 billion in 2015, $6.0 billion in 2020, and $11.4 billion in 2030.[57] EPA seemingly apologized for including this energy efficiency analysis when explaining "a possible alternative future where use of energy efficiency policies lead to increased investment in cost-effective energy end-use technologies beyond what is reflected in the reference electricity demand forecast used for EPA's core analysis."[58] The EPA conservatively did not include these potential energy efficiency costs as an offset to annual compliance costs. Furthermore, EPA's assumed level of energy efficiency does not reflect the full implementation of all technical and economic energy efficiency that others have shown to be achievable energy efficiency targets.[59] The EPA admits that its "projected reductions in demand growth are substantially lower than recent estimates of available, cost effective energy efficiency potential."[60]

The results of the most recent PJM capacity auction, which include consideration of the likely impact of the Air Toxics Rule, confirm that cost effective energy efficiency will reduce compliance costs, even without the additional state measures suggested by EPA. While 6.9 GW of ancient coal-fired capacity was either withdrawn from the market or failed to clear the auction,

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56 RIA page 8-27.

57 RIA page 8-28. See also Table 8-16, page 8-29.

58 RIA page 8-27.

59 See for example, Cicchetti, Charles J., Going Green and Getting Regulation Right: A Primer for Energy Efficiency. Public Utilities Reports, Inc. Vienna, VA 2009. See also Real Prospects for Energy Efficiency in the United States, National Academy of Sciences, National Academy of Engineering, National Research Council of the National Academies. The National Academies Press, Washington, D.C. 2010.

60 RIA at page 8-28.

an additional 4.836 GW of demand response resources cleared the auction, mitigating impacts on consumer prices.[61]

The conclusion is clear. Many changes have already been made in the electricity industry to reduce demand and harmful emissions and improve efficiency on both sides of the meters. The natural gas and shale gas boom occurring across the nation also makes it likely that EPA overstates the compliance costs for the Toxics Rule. Accordingly, the actual compliance cost for implementing the Toxics Rule will very likely be less and the expected benefits far greater than EPA has estimated in the RIA.

Section II. The Toxics Rule Stimulates Employment, Businesses, and Government Receipts

EPA's analysis shows that the benefits from implementing the Toxics Rule far outweigh the costs even though EPA did not monetize several benefits of the Rule. This section quantifies some additional benefits related to employment, businesses, and governments that will arise from the Toxics Rule's implementation. The findings here further reinforce that the Toxics Rule will strengthen, not weaken, the economy and add jobs and that the Toxics Rule should be implemented without delay.

As further developed below, some additional benefits that EPA did not quantify include:

(i) Avoided lost work days and labor cost savings;

(ii) Reduced health and insurance costs; and,

(iii) Increased employment at a time when the economy is depressed.

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[61] Ade Dosunmu, *Up in Smoke*, Fortnightly's Spark (June 29, 2011), *available at* http://spark.fortnightly.com/sitepages/pid58.php?ltemplate=intro_archive&pageId=58&lcommtypeid=6&item_id=30.

A. **Lost Work Days and Labor Costs**

EPA estimates the number of lost work days due to $PM_{2.5}$ and ground level ozone emissions under both baseline conditions and the Toxics Rule, calculating that workers 18 to 65 years of age annually lose 850,000 work days across all states. EPA further estimates the economic effect of lost work for average workers using a value for their time of about $130 per day[62] for an annual total of $110,500,000. Notably, however, EPA measures losses only from the perspective of employees. However, employers *also* incur losses as they typically pay for sick days and other benefits in addition to wages for each employee.[63] For example, the Bureau of Labor Statistics reported in June 2010 that total compensation comprised 70.6% for wages and salaries and 29.4% for benefits, with the combined civilian workforce total compensation averaging $29.52 per hour (or $236 per 8 hour day), state and local government workers averaging $39.74 per hour, and private sector workers averaging $27.64 per hour.[64]

Beyond paying employees sick leave and related payroll taxes and benefits, employers incur additional costs due to lost productivity. For example, personnel discontinuity, required replacement workers and temporary staff, redundant training, and missed or postponed opportunity costs, all impose higher costs on businesses. In the spring of 2010, Mercer Consulting[65] surveyed 276 organizations from all major U.S. industry segments, sizes, and regions, including colleges and universities; health care; hospitality; manufacturing, life sciences, and energy; public sector, government and public schools; retail or wholesale trade, services; and transportation, distribution, and telecommunications. The Mercer study estimated that

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62 RIA at page 6-47, Table 6-11. As this is based on a national median wage of $16.25 hourly for 2000, it is a very conservative estimate.

63 "Survey on the Total Financial Impact of Employee Absences", Mercer and Kronos Incorporated, June 2010.

64 BLS News Release, September 8, 2010, USDL-10-1241.

65 Mercer Consulting is a leading consultancy in Human Resources (HR) and related financial products and services. It is a wholly owned subsidiary of Marsh & McLennan Companies, Inc. and has more than 19,000 employees worldwide in over 180 cities and 40 countries and territories. See www.mercer.com/about-mercer.

unplanned absences reduce productivity by about 19%[66], meaning civilian business and government employers would, on average, lose about $35.13 per hour ($29.52 * 1.19), or about $281 per day for each work loss day. Therefore, under the Toxics Rule, business would avoid losses of $239 million per year (850,000*$281= $239 million per year).

Pre-mature deaths also require businesses to pay more for employee recruiting, training, integration, and replacement. In its median case, EPA estimates conservatively that implementing the Toxics Rule would avoid 11,900 premature annual deaths for ages 18-65. Applying US Census Bureau estimates that 80% of the population is in the work force, 9,520[67] of these premature deaths are in the work force. As the typical person works about 48 five-day weeks, or 240 work days per year, the typical civilian employee's total compensation (wages plus benefits) equals $56,640 (240 days * $236/day). Various estimates show the cost to replace an employee is about 40%[68] of total compensation ($56,640), or about $22,650 (0.40 * $56,640)

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66 Mercer, "Survey of the Total Financial Impact of Employee Absences", June 2010, page 8.

67 The U.S. Census Bureau reports that there were approximately 189 million people between the age of 18 and 65 in the U.S. There were approximately 153 million people in the workforce, or about 80% of the population. 11,900 times 80% equals 9,520. See 2006-2008 American Community Service Survey 3-Year Estimate. U.S. Census Bureau. http://factfinder.census.gov.servlet/SSTable. Accessed 9/22/2010

68 Ostro, Bart D. "The Effects of Air Pollution on Work Loss and Morbidity." Journal of Environmental Economics and Management 10, 371-382 (1983); Ostro, Bard D. and Susy Rothschild. "Air Pollution and Acute Respiratory Morbidity: An Observational Study of Multiple Pollutants." Environmental Research 50, 238-247 (1989); Ostro, Bart D. "Air Pollution and Morbidity Revisited: A Specification Test." Journal of Environmental Economics and Management 14, 87-98 (1987); Rumsberger, Jill S., Christopher S. Hollenbeak, and David Kline, "Potential Costs and Benefits of Smoking Cessation: An Overview of the Approach to State Specific Analysis." Penn State. April 30, 2010; Hayday, Beban S., "Costing Sickness Absence in the UK." Institute for Employment Studies, Report 382, October 2001; Bureau of Labor Statistics, "Employer Costs for Employee Compensation – June 2010", USDL-10-1241, September 8, 2010; "Estimating Mortality Risk Reduction and Economic Benefits from Controlling Ozone Air Pollution." The National Academies, Committee on Estimating Mortality Risk Reduction Benefits from Decreasing Tropospheric Ozone Exposure, ISBN 0-309-119995-2 (2008); Scitovsky, Anne A., "Estimating the Direct Costs of Illness." The Milbank Memorial Fund Quarterly. Health and Society, Vol. 60, No. 2 (Summer 1982), pp. 463-491; "Full Cost of Employee Absence Equals 36 Percent of Payroll, According to New Mercer Study Sponsored by Kronos." Boston Business Journal, October 21, 2008; Hadzima, Joe. "How Much Does an Employee Cost?" http://web.mit.edu/e-club/hadzima/how-much-does-an-employee-cost.html; U.S. Bureau of Labor Statistics, "Total Nonfatal Occupational Injury and Illness Cases, by Category of Illness, Private Industry, 2006" (October 2007); U.S. Bureau of Labor Statistics, "Number of Injuries and Illnesses with Days Away from Work, Private Industry, 2003-2006" (November 2007); Berk, Aviva, Lynn Paringer, Selma T. Mushkin, "The Economic Cost of Illness, Fiscal 1975." Medical Care, Vol. 16, No. 9 (Sep. 1978), pp 785-790; Cooper, Barbara S. and Dorothy P. Rice, "The Economic Cost of Illness Revisited" Office of Research and Statistics, Social Security Administration Adapted from a paper presented at the annual American Public Health Association meetings in

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per replaced worker. Employers would save the cost to recruit, train, integrate, and replace 9,520 workers each year under the Toxics Rule. This would save 9,520 workers, multiplied by $22,650, or about $216 million per year.

Air pollution also causes businesses to lose money through restricted activities for outdoor workers. In the RIA, EPA estimates there are 5,100,000 restricted activity person-days for adult workers in the 18 to 65 year old category based on the statistical work of Ostro and Rothschild[69], which limits lost person days to the outdoor workers likely to be restricted because of air pollution. Reduced activity clearly causes a loss in productivity, but is less severe than losing a full work day. As discussed above, Mercer Consulting estimates that unplanned absences reduce productivity about 19%. Assuming that a restricted worker would function at about half his usual level, a conservative estimate of restricted output equals approximately 484,500 lost days (5,100,000 restricted days * 0.19 loss in productivity * ½ level of effort). This effect of the Toxics Rule will save employers $136 million per year in avoided lost productivity (484,500 lost days * $281/day).

The combined employer business savings for lost workdays, employee recruiting, training, integration, and replacement, and avoided restricted outdoor activities equals about $591 million per year.[70] In addition to the substantial employer benefits resulting from the Toxics Rule, a multiplier effect applies across the national economy. Because of the interconnections among industries and between industries and households, higher costs for wages, benefits, and health insurance cause negative ripple effects throughout the economy. Negative ripple effects result in job loss and reductions in economic outputs because of

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(...continued)
Chicago, Ill., November 20, 1973 (Bulletin 1976); Abt Associates Inc., Technical Support Document for the Powerplant Impact Estimator Software Tool, prepared for the Clean Air Task Force, July 2010.

69 Ostro, Bart D. and Susy Rothschild. "Air Pollution and Acute Respiratory Morbidity: An Observational Study of the Multiple Pollutants." Environmental Research 50, 238-247 (1989).

70 $239 million + $216 million + $136 million = $591 million.

decreased disposable income as fewer workers are hired and fewer wages are paid to employees, as well as reduced equipment and supplies purchased from local businesses, and reduced government tax revenues. These ripple effects are called multipliers effects or multipliers. The Department of Commerce publishes a widely used model to determine the employment and economic effects for increased spending.[71] Applying a multiplier of 1.86, the Toxics Rule adds about $1.099 billion per year to Gross Domestic Product (GDP). Assuming federal, state and local tax expenditures equal 37.5% of GDP,[72] tax revenues will increase by about $412 million per year. Further, the GDP increase would cause about 8,330 jobs based on 7.58 jobs per million dollars of GDP.[73]

Table 5 summarizes these economic benefits related to labor costs, taxes and jobs under the Toxics Rule. The job and other economic increases reflect the stimulating effects of increased profits due to reduced business costs when less people become sick or die.

[71] The U.S. Department of Commerce publishes RIMS II Type I multipliers, which represent the additional indirect or upstream jobs generated for each job directly added in the selected industry. The RIMS II Type II multipliers add incidental jobs within the state due to the additional stimulative economic effect of added direct and indirect/upstream employment or, conversely, eliminate jobs as a result of reduced economic activity. The ripple effect can be thought of in terms of three buckets. For example, consider a manufacturing facility that lays off four workers due to air pollution. The first bucket comprises the four direct manufacturing jobs at the plant that are lost as a result of air pollution. These four lost jobs and the concomitant reduced manufacturing output at the manufacturing facility have an indirect effect on those upstream industries that support the manufacturing facility. This indirect effect is the second bucket. The indirect effects of reduced manufacturing output downstream result in a loss of two jobs in the support industries upstream of the manufacturing facility. The six total direct and indirect lost jobs due to air pollution mean that the unemployed former employees have less money available to spend. This reduced available money to be spent in the state results in one lost incidental job, comprising the third bucket. Thus, the combined direct (bucket 1), indirect (bucket 2), and incidental (bucket 3) effects result in a total loss of seven jobs.

[72] In 2008, federal, state and local spending were about 37.5% of GDP. "US Governments Spending," Christopher Chantrill, September, 2010. www.usgovernmentsspending.com, link Federal, State and Local for 2008 tax year.

[73] The Department of Commerce's RIMS Type II multipliers range between 5.029 and 10.124 jobs per million dollars of GDP, with a midpoint of 7.58 jobs per million dollars for the 50 states.

TABLE 5
Economic Benefits Related to Employers' Labor Costs, State and Local Taxes, and Jobs

	All States
Increased GDP	$1.099 billion
Tax Revenues	$412 million
Jobs*	8,330 jobs

*Jobs based on 7.58 jobs per million dollars of GDP.

Reduced Health and Insurance Costs

The higher levels of pollution increase illnesses. Table 6 shows EPA estimates the air pollution to be eliminated by the Toxics Rule causes more than 380,000 additional illnesses each year at a cost, based on lost income and direct health care costs, of about $3.5 billion per year. These were included in the opportunity benefits that EPA estimated. EPA's estimated medical treatment costs do not reflect the administrative costs that accompany these direct medical treatment costs. A 2003 study in the New England Journal of Medicine estimated these additional costs would add 31% to the direct medical costs.[74]

Applying this to EPA's medical treatment costs would increase the estimated costs for illness from $3.445 billion per year by $1.068 billion to $4.513 billion per year.

TABLE 6
EPA's Annual Morbidity Estimates and Costs
Within the United States*

Disease	Illnesses	Cost per Year
Chronic Bronchitis	4,500	$2,100,000,000
Non-Fatal Heart Attacks	11,000	$1,200,000,000
Hospital Admissions and Emergency Rooms	12,200	$125,000,000
Other	356,000	$20,000,000
	383,700	**$3,445,000,000**
	Average $8,978 per illness	

*See Tables 6-17 and 6-18 in the Toxics RIA.

[74] Woolhander, Steffie, M.D., MPH., Terry Campbell, M.H.A., and David U. Himmelstein, M.D. "Costs of Health Care Administration in the United States and Canada.", N. ENGL J. Med 349:8, August 21, 2003.

B. Increased Employment from Implementing the Toxics Rule

The University of Massachusetts recently published a report that shows the employment benefits related to a cleaner fleet of power plants in the U.S.[75] This study netted the lost jobs at existing power plants against the jobs related to compliance and replacement. In the RIA, EPA also estimated the direct employment effects of the Toxics Rule. The RIA reasonably combined the net direct effect of jobs lost from retiring coal plants netted against the jobs gained from pollution control investments and pollution control O&M. EPA did not, however, include all the jobs added because it omitted the upstream indirect and incidental job growth that are standard in a benefit-cost analysis. The University of Massachusetts approach can be used to modify the EPA results to add the omitted jobs in the EPA's more conservative analysis.

Starting with construction jobs, EPA estimates 30,870 new jobs. EPA adds 5,230 jobs for the chemicals and materials needed to operate the pollution controls related to the Toxics Rule, and another 5,500 utility jobs for equipment operations and maintenance. The RIA reports that the combined new jobs added equal 41,600. The RIA estimates 5,630 lost jobs associated with retiring coal plants, for a total net number of direct jobs added of 35,970. These are shown in Table 7.

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75 "Employment Effects Under Planned Changes to the EPA's Air Pollution Rules", University of Massachusetts, Political Economy Research Institute.

TABLE 7
Employment Effects EPA Estimated Due to Pollution Control Equipment and Operations Under the Toxics Rule
(Job Years 2015)

Jobs for Construction	Incremental Employment
1. Boilermakers	13,400
2. Engineers	3,270
3. General construction	13,770
4. Steel Manufacturing	430
Sub Total	30,870
Jobs for Operation (Increased Operating Resource Use)	Incremental Employment
1. Limestone	2,020
2. Ammonia	20
3. Catalyst	100
4. Activated Carbon	90
5. Sodium Bicarbonate	2,940
6. Baghouse Material	60
Sub Total	5,230
Jobs for Pollution Control Operation (O&M)	5,500
Total Gains	41,600
Jobs Lost from Plant Retirements	5,630
Net Gains	35,970

The U.S. Department of Commerce (USDOC) publishes economic input/output multipliers,[76] which can be used to estimate the additional jobs that result indirectly when

[76] The U.S. Department of Commerce publishes RIMS II Type I and II multipliers. The RIM II Type I multipliers add the indirect jobs. The average national Type I multiplier is 1.71 for the electricity industry. The RIMS II Type II multipliers add incidental jobs due to the additional economic effect of added direct and indirect/upstream employment. The RIMS II Type II national average multiplier is 2.98.

equipment manufacturers, transportation, and other services that support new investments are counted as well. If EPA had included these indirect jobs as well as the direct net jobs added, the employment effects using a 1.71 Type I multiplier would more accurately equal 61,355. The RIA does not include any explanation of why it did not estimate these indirect jobs added, even though it is standard to add indirect jobs in a benefit-cost analysis. The total net new jobs related to compliance would be 97,325 based on EPA's 35,970 net jobs and 61,355 indirect jobs.

The RIA also did not include the additional jobs as a result of increased spending caused by new direct and indirect jobs. Instead, the EPA's RIA conservatively avers "Moreover, when the economy is at full employment, we would not expect an environmental regulation to have an impact on overall employment because labor is being shifted from one sector to another." [77] This is not a reasonable assumption because the national recession has structural problems and likely will last a long time. Furthermore, full employment is not a static goal or even a precise level of employment. The USDOC's Type II comprehensive jobs' multipliers are more accurate indicators of the jobs likely to be added to the economy. Accordingly, starting with the net addition of direct jobs (35,970) added from implementing the Toxics Rule and using the Type II federal multiplier of 2.98, the combined direct, indirect, and incidental jobs added would be about 107,190 or nearly three times the net jobs EPA estimated quite conservatively. Using a rather conservative Mercer Consulting compensation estimate of $56,640 per employee discussed above, the 107,190 jobs added would add personal income and benefits of about $6.071 billion to GDP, improve tax receipts by $2.277 billion, and yield significant net social benefits.

The EPA and other jobs analyses related to clean air compliance do not include the structural effects that the Toxics Rule could have on the economy. These are difficult to

[77] RIA page 9-6.

quantify, but by no means unimportant. For example, shifting to bituminous coal would add jobs if this coal replaces the use of lignite and other sub-bituminous coal. At the least, this effect would seem to be jobs neutral. Other major shifts could add even more jobs. The existence of fully depreciated coal plants operating with few or no controls also inhibit new development projects by depressing capacity and electricity markets alike. This, in turn, inhibits investment in new, more efficient and less polluting technologies in all sectors of the electric industry. The closure of these inefficient, polluting plants more than 40 years after the Clean Air Act was enacted will spur a new wave of investment that will cause economic growth and improve the efficiency of both the industry and the economy as a whole.

Renewable energy and energy efficiency would add jobs that very likely exceed any job losses if older inefficient generating stations are replaced with more eco-friendly, employment-intensive, supply and demand side investments in the electricity sector. Uprating existing nuclear facilities and efficiency improvements in existing fossil fuel-fired facilities will become cost effective and give us more electricity with no additional pollution. The shale gas stimulation effect of the Toxics Rule would also add new jobs not quantified in EPA's employment analyses related to the Toxics Rule. The evidence is that EPA's pollution enforcement efforts will add, not destroy, jobs in the US economy. The regional gains from adding jobs where unemployment is particularly high would also likely be very favorable under the Toxics Rule implementation and the concomitant shift to shale gas and energy efficiency in the electricity industry.

Section III. Conclusion

EPA's comprehensive and conservative cost/benefit analyses rely upon sound and proven scientific methods and data. The Toxics Rule prevents the release of toxic HAPs that literally poison people, other species, and their offspring in utero. The effects are often direct and isolated. The policy goal should be to stop their release at least cost. The Toxics Rule not only does this, but creates value many times the direct costs. Some aver that EPA should delay implementing the Toxics Rule because the economy is currently too weak to absorb the implementation costs without extending the recession. They are wrong for two reasons. First, if anything, EPA's analyses understate the Toxics Rule's benefits and overestimate its costs. In fact, many of the Toxics Rule benefits are not monetized. Further, in focusing almost exclusively on reduced premature death and health related benefits, EPA did not consider the additional business savings, federal, state and local tax receipts, direct spending on health care and insurance, and the creation of almost 115,520 new jobs related to compliance (107,190,) and reduced business costs (8,330).

The RIA shows the least cost for reducing HAPs is negative. The annual compliance costs are about $10.9 billion. However, the opportunity benefits in terms of reduced mortality and morbidity related to $PM_{2.5}$ and lower atmosphere ozone range between $53 billion and $140 billion. In addition, Table 8 shows additional benefits that EPA did not monetize related to business, governments, and additional jobs of more than $8.2 billion in one year. If energy efficiency is relied on at the levels EPA contemplates the compliance costs would be $2.3 billion less in 2015 growing to $6 billion in 2020 and $11.4 billion in 2030. The Toxics Rule will yield considerable net benefits, not societal costs.

TABLE 8
Additional Benefits

	Direct Economic	Jobs	Tax Revenue
Increased GDP Related to Labor Cost Savings	$1.099 billion	8,330	$412 million
Annual Savings in Health Case Administrative Costs	$1.068 billion	n/a	n/a
Increased GDP Related to Personal Income and Benefits	$6.071 billion	107,190	$2.277 billion
TOTAL	$8.238 billion	115,520	$2.689 billion

Power plants should not be permitted to use the air stream as a free waste transfer system that pollutes the air for downwind populations, while causing many thousands of premature deaths and illnesses each year, and also causing higher labor and higher health insurance costs, lost jobs, and lost tax revenues. Power plants should not discharge hazardous mercury and heavy metals that bio-accumulate and persist in the food chain. These are poisons that harm people, other species, and their in utero offspring. Some HAPs also cause cancer. A benefit-to-cost comparison is not the essential or even the conceptually correct criteria to use to evaluate policies for avoiding the release of toxic poisons. The primary goal should be to avoid exposure and bio-accumulation at a reasonable least cost. The Toxic Rule addresses this absolute need to control HAPs and the least cost for society is negative under EPA's Toxics Rule.

Ignoring the opportunity benefits, the savings to businesses and government for avoided costs, reduced healthcare, and insurance plus job creation would nearly justify full compliance without adding the direct benefits for the exposed population or the co-benefits that cleaner air above the Transport Rule compliance would achieve. The Nation is seldom offered such a starkly obvious public policy choice as EPA's Toxics Rule.

Senator CARPER. That was exactly, exactly 5 minutes. Normally, when witnesses do that well, we give them an extra 15 minutes to talk about anything they want.

[Laughter.]

Senator CARPER. Since lunch is bearing down on us, we will forgo. That was great.

Barbara Walz, welcome. Good to see you. Thank you for joining us.

STATEMENT OF BARBARA WALZ, SENIOR VICE PRESIDENT POLICY AND ENVIRONMENTAL, TRI-STATE GENERATION AND TRANSMISSION ASSOCIATION, INC.

Ms. WALZ. Thank you. Chairman Carper, Ranking Member Barrasso, it is good to be here with you today, and it is particularly good to be here with you, Senator Barrasso, as you have been a great friend to the co-op world.

My name is Barbara Walz, and I am Tri-State Generation and Transmission Association's Senior Vice President for Policy and Environmental. I hold a bachelor's degree in chemical engineering and a master's in environmental management.

Tri-State is a not-for-profit member owned rural electric cooperative based in Colorado. Tri-State is committed to maintain high environmental standards while providing reliable cost-based wholesale electricity to our 44 not-for-profit member systems that serve 1.5 million rural customers in Wyoming, Nebraska, New Mexico, and Colorado.

To meet our member energy needs, Tri-State generates or purchases power produced by hydropower, solar, wind, coal, and natural gas sources. We recently integrated 50 megawatts of wind and 30 megawatts of solar into our generation mix. Renewables now constitute about 16 percent of our generation needs. The bulk of our power comes from coal-based power plants in Wyoming, Colorado, Arizona, and New Mexico. These plants are an important part of the rural communities in which they reside. For example, the Craig Plant in Colorado and the coal mines that supply it employ 750 people near a town of 10,000 and provides $73 million in wages. The plant is also an important tax base to Moffat County, paying $9 million in taxes each year.

Tri-State's generating facilities all have state-of-the-art emission controls. These plants were primarily built from 1978 through 1983 and were equipped with controls well before the 1990 Clean Air Act came into place. We have scrubbers on our facilities that remove more than 90 percent of the sulfur dioxide and bag houses that remove up to 99 percent of the particulate matter. These controls also result in a co-benefit mercury emission reduction ranging from 65 to 95 percent.

Even with all of these advanced environmental controls, Tri-State cannot meet the proposed Utility MACT emission limits. Significant additional controls will be required and will result in higher electricity costs for our co-op consumers. In addition, the Utility MACT emission limits for new units are set at such low levels that it will be impossible to construct and operate new coal facilities, even with the most technologically advanced controls.

Tri-State currently operates in compliance with mercury regulations in Colorado and New Mexico. These regulations were negotiated in good faith with State agencies and environmental groups.

In the Clean Air Act amendments of 1990, Congress treated electricities different than other industries. The law required EPA to conduct a study of the hazards to public health that were reasonably anticipated to occur as a result of emissions. The study was completed in 1998 and found that mercury emissions were of greatest concern. Given this determination, Tri-State believes that EPA's authority is limited to regulate only mercury at this time.

Particulate matter is already regulated through the National Ambient Air Quality Standards. Added particulate matter standards included in the MACT will require Tri-State to install additional controls at a cost of hundreds of millions of dollars. These costs will be passed on to our rural electric co-op consumers. Particulate matter should not be regulated under this MACT rule.

The EPA cost-benefit analysis found that 90 percent of the benefits of the rule are based on the reduction of particulate matter. If this rule is finalized as proposed, it will be nearly impossible to meet the time lines for installation of controls by 2014. Utilities need time to design, permit, and construct retrofit control equipment. There are a limited number of qualified vendors who have limited skilled labor to take on these technical projects. And because rural electric cooperatives are small business, when the deadlines come, co-ops are not going to be able to get the qualified labor needed to get the job done because vendors will be bidding on the bigger jobs of our friends in the investor-owned utility community.

Tri-State supports and is committed to good environmental regulations, including full implementation of the 1990 Clean Air Act, but we firmly believe that the Utility MACT Rule goes beyond EPA authority and over-regulates coal plants. What Assistant Administrator McCarthy is saying utilities need to do Tri-State did 30 years ago, and we have those controls in place today and they still do not meet the Utility MACT Standard.

Thank you for inviting me to testify here today, and I would be happy to take any questions.

[The prepared statement of Ms. Walz follows:]

TRI-STATE
Generation and Transmission Association, Inc.
A Touchstone Energy® Cooperative

Ms. Barbara Walz
"Oversight: Review of EPA Regulations Replacing the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR)"
Senate Environment and Public Works Committee
Subcommittee on Clean Air and Nuclear Safety
Thursday, June 30 2011

Mr. Chairman, Senator Barrasso and members of the Subcommittee, my name is Barbara Walz. I am the Senior Vice President for Policy and Environmental at Tri-State Generation and Transmission Association, Inc. based in Westminster, Colorado. I appreciate having the opportunity to testify before you regarding the effect that EPA regulations replacing the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR) would have on Tri-State's operations.

BACKGROUND

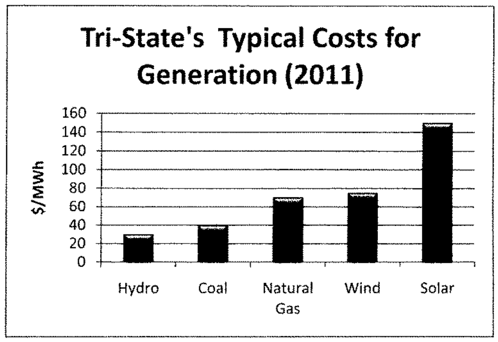
Tri-State is a not-for-profit member-owned electric cooperative. Our mission is to provide reliable cost-based wholesale electricity -- while maintaining high environmental standards -- to our 44 member system electric cooperatives (co-ops) and public power districts (PPDs). These members serve approximately 1.5 million consumers in Wyoming, Nebraska, New Mexico and Colorado.

Tri-State's service territory is spread over more than 200,000 square miles and serves many of the Intermountain West's rural and frontier communities. The average number of consumers served by our member cooperatives and PPDs is five consumers per mile. (In Wyoming and Nebraska, it's 2.82 and 2.41 respectively.) Our friends in the investor owned utility sector serve 37 consumers per mile and the municipally owned utilities serve 43 consumers on average.

Tri-State was organized on May 19, 1952 to meet the growing electricity needs of its 15 founding co-ops and PPDs. This initial group of members charged Tri-State with aggregating each member's allocation of federal hydropower from the Bureau of Reclamation. Through mergers with other co-ops, consumer growth and load growth, Tri-State has evolved over the last 60 years from a co-op that simply provided for its members electricity needs through the aggregated management of a federal hydropower allocation to a co-op that provides for its members' needs through a diverse portfolio of generation sources.

Today Tri-State generates or purchases power produced by hydropower, solar, wind, coal and natural gas turbines. Tri-State is committed to reliable (federal hydropower) and intermittent (wind and solar) sources of renewable energy. Up to 15% of our power needs comes from hydropower marketed by the Western Area Power Administration (WAPA). We have also recently integrated 50 megawatts of wind and 30 megawatts of solar into our generation portfolio through purchase power agreements with Duke Energy and Southern Company respectively. The Cimarron facility located on Ted Turner's ranch in Northern New Mexico and owned by the Southern Company is one of the largest photovoltaic solar facilities in the United States and generates enough power to fulfill the electricity needs of 9,000 homes[1]. Tri-State was recently recognized by the Solar Electric Power Association as the highest ranked cooperative developer of solar power in 2010.[2]

While we are very proud in the strides we have taken to integrate intermittent sources of renewable energy into our generation portfolio -- after the cost-based hydropower marketed by WAPA -- coal based thermal generation continues to be the most economical source of baseload generation to meet our members' needs (see graph). Tri-State currently owns and operates the Craig and Nucla power stations in Western Colorado and the Escalante power station in Western New Mexico. In addition to these facilities, Tri-State owns 24% of the Laramie River Station in Wheatland, Wyoming and 35% of the Springerville Generating Station in Springerville, Arizona. We also have plans to own 700 Megawatts of a planned 900 megawatt coal unit with our partner Sunflower Electric Power Corporation in Holcomb, Kansas. The State of Kansas has already issued the air quality permit needed to proceed with construction.



ECONOMIC IMPACTS OF POWER PLANTS

The Craig, Escalante and Nucla generating stations are not only crucial to Tri-State's baseload operations, but they also play an important role in sustaining and developing rural communities in rural Colorado and rural New Mexico. Tri-State commissioned Development Research Partners (DRP) of Lakewood, Colorado to conduct studies regarding the economic and fiscal impacts of the Craig, Nucla and Escalante stations to the surrounding communities.

DRP produced the following findings for the Craig Generating Station in Moffat County, Colorado:

- The 306 direct power plant employees earn approximately $33.9 million in wages, salaries and benefits each year.

[1] http://www.southerncompany.com/news/Cimarron_fact_sheet.pdf
[2] http://www.solarelectricpower.org/media/194514/sepa-top-10-press-release.pdf

- The on-going operations of the power plant support the employment of 748 workers annually (306 direct employees + 442 indirect employees).

- Craig receives 100% of its coal supply from the Trapper and Colowyo Mines supporting 100% of the employees from both mines and supporting an annual payroll of $38.9 for 446 employees.

- The Craig Stations spends $213.8 million locally each year for goods and services associated with electricity generation.

- Craig generates $8.9 million annually in tax revenue for local governments.

DRP produced the following findings for the Escalante Station:

- Escalante supports the employment of 303 employees (117 direct employees + 186 indirect employees).

- The 117 Escalante employees earn approximately $13.1 million in wages, salaries and benefits each year.

- The Escalante Station spends $44.2 million locally each year for goods and services associated with the electricity it produces.

- Escalante generates $5.2 million annually in tax revenue for local governments.

DRP produced the following findings for the Nucla Station:

- Nucla Station is one of the largest private employers in Montrose County, Colorado. It employs 60 with wages and benefits amounting to $7.2 million annually.

- Nucla purchases 100% of its coal supply from the New Horizon Mine, which supports 28 employees for a direct payroll of $1.7 million.

- Nucla spends $20.3 million locally each year for goods and services associated with the electricity generation.

- Nucla station generates $1.1 million in tax revenue for the various taxing entities in the region.

TRI-STATE OPERATIONS AND IMPACTS FROM UTILITY MACT AND CATR

All our power stations are heavily regulated by state and federal agencies which include: Colorado Department of Public Health & Environment (CDPHE), Wyoming Department of

Environmental Quality, Arizona Department of Environmental Quality, New Mexico Environment Department, Kansas Department of Health and Environment, U.S. Environmental Protection Agency (EPA), Army Corps of Engineers and Office of State Engineers. Tri-State is routinely inspected for environmental requirements and is consistently in compliance with the broad array of rules and regulations that are already placed on coal fired electric generating units (EGUs). For the past decade, Tri-State has implemented an Environmental Management System (EMS) that meets the EPA guidelines for EMS's and International Standards Organization 14001 Standard for EMS's. The Colorado Department of Public Health and Environment has recognized Tri-State as a Silver Achiever under the Colorado Environmental Leadership Program (ELP) for implementation of the EMS and sustaining significant achievements in operating our Nucla Generating Station, airport hanger, and headquarters facilities in compliance with all state environmental regulations.

Tri-State has reviewed the proposed Utility Maximum Available Control Technology (MACT) regulation and has considered the allocation methodologies that are set forth in the proposed Clean Air Transport Rule (CATR).We have submitted comments to the EPA on the alternative allocation methodologies for the CATR and will submit comments to the EPA on the Utility MACT proposed rule. Tri-State has a team of environmental staff that have evaluated the proposed rules but due to the volume of new rules being proposed by EPA, Tri-State is not able to evaluate all the rules on our own and we rely on national organizations such as the utility Air Regulatory Group and the National Rural Electric Cooperative Association to provide analysis of rules as well. This testimony is based on analysis by several of these organizations in addition to Tri-State environmental staff.

Tri-State's power generating stations all have state of the art air pollution controls that work to meet or exceed federal and state clean air and clean water standards. The stations have scrubbers to remove more than 90% of the sulfur dioxide and baghouses that remove up to 99% of the particulate matter. These controls also result in a co-benefit of mercury emission reductions ranging from 65% to 95% at Tri-State stations. The proposed MACT rule will likely require additional controls to meet the particulate matter or metal standards. These additional controls will result in a finishing or second baghouse at the plants. Because we are a not-for-profit cooperative that is ultimately owned by our consumers, these new compliance costs will be passed on directly to cooperative member-owners in the form of higher rates.

Tri-State supports and is committed to good environmental stewardship and the appropriate assessment of environmental regulations to ensure such protections. We support the use of good quality data for decision making and have readily complied with the EPA's Information Collection Request (ICR) data collection requirements. The emissions testing was done on very short notice and represents a snapshot in time, with most constituents having only one data point for the station emissions. It is important to have good data for regulation development. Tri-State not only supports the reasonable application of emission controls to achieve reasonable emission limits that are designed to protect public health and the environment, we also support the installation of emission controls in a reasonable timeframe such that facilities are capable of complying with the requirements of a given rule. Tri-State believes that the proposed rules for the Utility MACT are not reasonable, are not based on sound practices of data quality and are not readily achievable using generally available emission control technologies, especially for new units.

CLEAN AIR ACT AMENDMENTS OF 1990 SHOULD BE IMPLEMENTED PRIOR TO ANY MACT RULE

In amending the Clean Air Act (CAA) in 1990, Congress set utilities apart from other sources in addressing hazardous air pollutants (HAPs) and established special circumstances, set forth in section 112(n)(1), for regulation of electric utility steam generating units. Congress recognized the importance of coal-based electricity generation to our country's electric reliability and economic growth. Congress also recognized that a substantial amount of emission reductions would occur from the utility sector as a result of the **full** implementation of the 1990 Clean Air Act amendments. Congress indicated, in section 112(n)(1) that further regulation was warranted ***only if,***

> "….. a study of the hazards to public health reasonably anticipated to occur as a result of emissions by electric utility steam generating units of pollutants listed under subsection (b) **after imposition of the requirements of this act**."

Congress further expressed this perspective by stating that

> "The Administrator shall regulate electric utility steam generating units under this section, if the Administrator finds such regulation is appropriate and necessary after considering the results of the study ….." **conducted after imposition of the requirements of the act.**

The EPA has not yet implemented the provisions of the act in a timely fashion such that the EPA could consider the benefits of those required programs prior to conducting the study required in section 112(n)(1). It is only after these programs have been implemented that the EPA could appropriately consider the impact of the remaining emissions from electric utility steam generating units as set forth in Section 112(n)(1). The EPA clearly states in the proposed rule preamble that it is not opposed to the generation of electricity using coal, but clearly takes actions that contradict that statement by disregarding the benefit that these other CAA programs that provide to public health and the environment, specifically PM2.5 NAAQS compliance. The EPA has estimated the benefits of the Utility MACT from PM2.5 emission reductions to be approximately $42 – 130 billion, but PM2.5 emission reductions are a NAAQS program benefit that should not be attributable to the Utility MACT.

Specifically, the EPA has failed to consider the benefit of the emission reductions that would have occurred had the EPA appropriately addressed the requirements of §110(a)(2)(D) regarding interstate transport of pollutants for the achievement of the National Ambient Air Quality Standards, the Prevention of Significant Deterioration of air quality, and the protection of visibility. Clearly, the EPA should have considered the emission reductions at electric utility steam generating units that would have resulted from returning nonattainment areas to compliance with the NAAQS. The EPA has also failed to take into consideration the benefit of emission reductions from the implementation of the Visibility Protection Program set forth in section 169A of the Clean Air Act. Here again, the EPA should have taken into consideration the emissions reductions that would likely occur as a result of implementing the requirements of this provision of the Act. The EPA disregards these clear requirements and has charged ahead to unnecessarily and inappropriately impose regulatory burdens on the coal fired electric generation sector. The EPA has also miscalculated the public health benefit of the proposed rule because it has failed to attribute the public health benefits of other required 1990 Clean Air Act amendment programs prior to the proposal of this rule. The public health benefit of these other required programs should be subtracted from the totals that the EPA has presented in the proposed rule and appropriately attributed to the other programs.

EPA'S 2000 LISTING DECISION IS TOO STRICT; OTHER FLEXIBLE OPTIONS EXIST FOR REGULATION

In December 2000 EPA Administrator Browner concluded that mercury emissions from coal-fired electric utility steam generating units posed a public health concern and that regulation of these sources was "appropriate and necessary." Despite earlier statements by EPA about its regulatory flexibility under §112(n)(1)(A), Administrator Browner concluded that the only option EPA had for regulation, once there was a finding that regulation was necessary and appropriate, was to list electric utilities under §112(c) and to proceed in the development of MACT standards under §112(d). This decision to proceed under the MACT provisions of §112(d) narrowly construes §112(n)(1)(A) and unduly constrains EPA's present regulatory options.

Section 112(n)(1)(A) provides EPA broad discretion to address specific public health risks EPA identified as a result of its Utility Study to Congress. Section 112(n)(1)(A) is not specific to the provisions under which EGUs should be regulated. Instead, this section requires EPA to "develop and describe" alternative control strategies for emissions which may warrant regulation. The development of alternative control strategies would be a pointless paperwork exercise if the EPA's only option was to regulate under the MACT provisions of §112(d). When Congress instructed the EPA to identify alternative control strategies, it provided the agency authority to implement the control strategies that it found to be the most appropriate to address any identified health concerns.

In the 1990 CAA Amendments Congress treated electric utility steam generating units differently than all other source categories under §112. Rather than subjecting these units to the §112(c)/§112(d) regulatory scheme, Congress enacted §112(n)(1)(A) to govern any §112 regulation of these units. Section 112(n)(1)(A) requires the EPA to study any hazards to public health reasonably anticipated to occur as a result of hazardous air pollutant emissions from electric utility steam generating units, after considering the impact of the other provisions of the CAA on this source category. As part of that evaluation, Congress directed the EPA to "develop and describe" alternative control strategies for emissions which may warrant regulation. Finally, Congress directed the EPA to determine whether regulation of these units is "appropriate and necessary" after considering the results of a public health hazards study.

The legislative history of §112(n)(1)(A) provides perspective on Congress' approach to address emissions from electric utility steam generating units under §112. S. 1630, which passed the Senate on April 3, 1990, would have required EPA to list electric utility steam generating units under §112(c) and to regulate them under the MACT provisions §112(d). However, when the House passed a modified version of S. 1630 on May 23, 1990, it substantially changed the §112 provisions related to electric utility steam generating units making them virtually identical to the current §112(n)(1)(A) which was later adopted by the conference committee and made law.

Congressman Mike Oxley (R-OH), a sponsor of the House provision and a member of the conference committee, explained the intent of §112(n)(1)(A):

> Pursuant to section 112(n), the Administrator may regulate fossil fuel fired electric utility steam generating units only if the studies described in section 112(n) clearly establish that emissions of any pollutant, or aggregate of pollutants, from such units cause a significant risk of serious adverse effects to the public health. Thus, . . . he may regulate only those units that he determines – after taking into account compliance with all provisions of the act and any other Federal, State, or local regulation and voluntary emission reductions -- have been demonstrated to cause a significant threat of serious adverse effects on the public health.

Thus, Congress directed the EPA to make a regulatory determination regarding fossil-fuel-fired generating units based on consideration of any adverse public health effects identified in the study. Congress did not dictate in §112(n)(1)(A) that the EPA must regulate electric utility steam generating units under §112(d). The EPA first had to conclude that regulation was "appropriate and necessary." Even if the EPA concluded that regulation was appropriate and necessary, Congress did not require the agency to regulate "under subsection (d) of this section" – the language used in CAA §112(c)(5), for most source categories – or, for that matter, any other specific subsection of §112.

Thus, the EPA's December 2000 listing decision is premature and inappropriate because it does not rest on a finding from the study that the EPA was required to conduct indentifying that these non-mercury hazardous air pollutants present a public health threat once the other applicable provisions of the CAA were implemented.

EPA SHOULD NOT REGULATE ANY NON-MERCURY HAPS

Because the regulation of electric utility steam generating units is governed by the provisions of §112(n)(1)(A) the EPA is not required to regulate all HAP emissions from an electric generating unit as required by §112(d). Section 112(n)(1)(A) requires the EPA to "perform a study of the hazards to public health reasonably anticipated to occur as a result of emissions by electric utility steam generating units of pollutants listed under subsection (b) of this section after imposition of the requirements of this chapter." The Administrator is required to consider the results of that study to determine if regulation of electric utility steam generating units is "appropriate and necessary" under §112. Thus, the basis for any regulatory action by the EPA is an initial finding that a HAP presents a public health concern.

In its 1998 Utility Study, the EPA identified all of the HAPs emitted by coal-fired power plants, estimated the emissions of each HAP, and analyzed the risk posed by emissions of each HAP using conservative, screening models and assumptions. As a result of that work, the EPA decided not to make a regulatory determination as part of the Utility Study. Instead, the EPA offered the general conclusion that mercury from coal-fired power plants is the HAP of "greatest potential concern" and that additional research and monitoring is needed. As for all other HAPs, the agency found that a few other HAPs had some remaining potential concerns and uncertainties may need further study.

The December 14, 2000 regulatory decision described the evidence that caused the EPA to conclude that "mercury is both a public health concern and a concern in the environment." With regard to other HAPs, the EPA stated that arsenic and a few other metals (e.g., chromium, nickel, cadmium) were of potential concern for carcinogenic effects and that dioxins, hydrogen chloride, and hydrogen fluoride are of potential concern. The EPA added that "the other HAPs studied in the risk assessment do not appear to be a concern for public health based on available information."

The Electric Power Research Institute (EPRI) also conducted a detailed study of the HAPs emitted by coal-and oil-fired power plants and modeled the risks posed by those HAPs. The EPRI study confirmed the EPA's conclusions that the non-mercury HAPs from electric utility steam generating units did not pose public health threats. As a result, the rulemaking record does not establish a public health concern from power plant emissions of non-mercury HAPs. The proposed MACT rule contains HAP standards for eleven non-mercury HAPs for which EPA has not evaluated and proven a public health concern. Industry should not have to install pollution control devices until it is shown it will address a public health issue. EPA should not regulate HAPs other than mercury until a determination is made that a public health threat does exist based on specific factual analysis.

NO PLAUSIBLE LINK BETWEEN COAL PLANT MERUCRY EMISSIONS AND MERCURY IN FISH TISSUE

The EPA has failed to establish a plausible link between the emissions of mercury from coal fired power plants and the methyl mercury concentrations upon which it has based its decision to regulate mercury from coal fired electric power generation. There is a significant amount of mercury in the global atmosphere that can have an impact on the deposition of mercury onto the land and water surfaces. Total mercury in the atmosphere has been estimated in the range of approximately 6,000 to 8,000 tons. This global pool of mercury is made up of natural and manmade emissions of mercury in various chemical forms. The natural sources of mercury account for about 3,500 tons to the lower end of the total atmospheric projection of about 6,000 tons. Man-made sources of mercury in the atmosphere account for about 2,000 to 2,500 tons and mercury emissions from coal fired power generation in the United States accounts for about 56 tons per year. The net effect of the utility MACT to reduce mercury emission would be approximately 22 tons per year. EPA has never fully demonstrated that the mercury emissions from coal fired electric utilities is emitted and deposited in the lakes and streams for which EPA claims credit for the proposed rule.

EPA INAPPROPRIATELY ESTABLISHED THE MACT STANDARD - ACTUAL OPERATING SOURCES DO NOT ACHIEVE THESE STANDARDS

The EPA has selected the emission standard for each of the constituents it intends to limit on an individual basis from several different facilities and aggregated those limits into a single set of emission limits that will apply to all facilities. Tri-State believes that the EPA significantly underestimates the impacts of this approach on existing and new sources. The EPA does not seem to realize or consider that there is not a linear relationship between the control equipment at a facility, how the facility is operated and the resultant emissions of each individual HAPs. The EPA must consider HAP emissions on a per unit basis and not simply consider each HAP separately taking the 12% best emitting sources of each single HAP, then adding them together to create a wholly new facility profile that is not reproduced anywhere in the existing operating system. MACT standards must be set based on the level of performance achieved by actual sources.

As noted earlier in this testimony, Tri-State stations are highly controlled power plants. In general the plants have scrubbers that remove greater than 90% of the sulfur dioxide and have baghouses that remove up to 99% of the particulate matter. These controls also result in a co-benefit of mercury emission reductions ranging from 65% - 95% at Tri-State Plants. The proposed MACT rule will likely require additional controls to meet the particulate matter or metal standards. These controls will result in the addition of a finishing or second baghouse at the plants, which is not current industry practice that should be reflected in a MACT standard that is set on achievements of actual operating sources.

MACT STANDARD FOR NEW UNITS ARE ARTIFICALLY LOW AND NOT ACHIEVABLE

Although the economy is still recovering, Tri-State member system demand for energy continues to increase about 3-4% per year. Therefore, Tri-State needs to plan for new generation stations and continues to look at all fuel options with a focus on affordable, reliable electricity that is environmentally sound. Under the proposed MACT rule, new coal units can **NOT** be constructed to meet the MACT standards due to the fact that technology does not exist to meet limits, vendors will not give guarantees to meet limits, and financial institutions will not support new projects that are not able to ensure compliance with environmental rules.

Emission estimates from Powder River Basin (PRB) coal used at a new unit with state of the art environmental controls for particulate matter, mercury, sulfur dioxides and nitrogen oxides are well above the proposed emission limits in the MACT rule. Although Powder River basin coal is considered clean coal (low mercury, low sulfur and high thermal value), this MACT rule will prohibit the building of new PRB coal power plants.

SUBCATEGORIZATION FOR CIRCULATING FLUIDIZED BEDS

Tri-State's Nucla facility is a circulating fluidized bed coal fired electric generating unit that has the lowest mercury emissions in the ICR database. The Nucla facility does not have add on controls for reducing mercury emissions. The reduced nature of the mercury emissions at the Nucla facility are due to the combustion process that results in near zero mercury emissions.

Coal fired electric generating units are complex operating systems whose emissions must be considered in a complicated equation of variables that include the chemistry of the fuel, the design of the boiler, the atmospheric pressure, the emission control system currently in use and many other factors. It is not appropriate to include CFB units in the mix of all boiler types to create a MACT standard that reflects the best 12% performing units. There is a fundamental difference in the process that does not allow CFBs to be compared directly to conventional boilers.

MACT FLOOR CALCULATIONS ARE BASED ON FLAWED DATA ANALYSIS

EPA has conducted a significant amount of analyses to determine the MACT floors for each of the hazardous air pollutants (HAPs) and HAP surrogate categories using the 2010 Information Collection Request (ICR) data that was supplied by the industry participants. This analysis was conducted in a relatively short period of time. Tri-State appreciates that the EPA has provided all of the working data and spreadsheets for members of the public to review and provide comment on as well as the proposed rule itself. EPRI has reviewed the data that was supplied by the EPA and has noted that there are many data errors and incorrect MACT Floor calculations. The EPA has acknowledged some of these discrepancies in their May 18, 2011 correction of the proposed mercury emission limit for existing sources revising that emission limit from 1.0 lb/TBtu to 1.2 lbs/TBtu. Tri-State believes that this 20% change in the level of the emission standard for mercury is a significant change and that a mistake of this magnitude warrants an EPA quality assurance review of all the data that the EPA used in the determination of the MACT floors. The EPRI analysis identifies several instances where the EPA used incorrect heat rates, where EPA has made inconsistent MACT floor determinations, used inconsistent Upper Prediction Limit (UPL) calculation procedures and where the EPA has made significant errors in its conversion of the ICR testing data. Tri-State supports the EPRI analysis and believes that the EPA should review the analyses and re-propose the rule with accurate analyses such that the public can have a reasonable opportunity to provide public comment on what should be substantially revised emission limitations.

THE TIMELINE FOR INSTALLATION OF CONTROLS IS NOT ACHIEVEABLE

The MACT deadlines for installation of controls are hard deadlines of three years with an option for one year extension. The current EPA timeline for installation of controls to meet MACT would be by 2014 or 2015. It will be nearly impossible for all affected utilities to install controls in the timeline due to the fact that time is needed for design, permit, construct and start up of retrofit controls. Utilities will be getting bids from a limited number of vendors who have limited skilled labor to take on such projects. Rural Electric Cooperatives are small utilities that have smaller and fewer units than do the for-profit companies that may be retrofitting a multitude of units. In past rulemakings, cooperatives have experienced vendors choosing not to bid our projects due to the fact they are smaller projects, and the vendors can focus on larger companies with multiple unit needs. More time will be needed to comply with any new standards.

BENEFITS OF THE UTILITY MACT PROPOSED RULE

The EPA has portrayed that the benefits of the Utility MACT as a standard which will dramatically outweigh the costs that they (under) predict for the proposed rule. The EPA has estimated the public health benefits of the proposed Utility MACT in the range of $53 – 140 billion dollars. The EPA has also estimated that the costs to society to implement the Utility MACT in 2016 will be approximately $10.9 billion dollars. However, it has also stated that over 90% of the benefits of the proposed rule will be attributable to the emission reductions that will be achieved as co-benefits of the proposed rules implementation. The proposed rule that was signed by the EPA administrator states that the benefits could range between $450,000 to $6 million dollars. The EPA's Regulatory Impact Analysis (RIA) has presented the actual benefits of the proposed rule attributable to mercury will fall in the range of $5,000 - $6 million dollars. The EPA also has portrayed that the Agency cannot monetize the benefits of the non-mercury HAP emissions from coal fired electric generating units. An economic benefit of $53 - $140 billion dollars is a significant economic benefit and not one that can easily be dismissed, but it is inappropriate for the EPA to pursue the public health benefit that the emission reductions from PM2.5 under the auspices of §112 of the Clean Air Act. It would be much more cost effective for the EPA to seek these emission reductions under the premise of the NAAQS compliance other CAA mechanisms. Compliance costs for the implementation of regulations are typically considered on a cost effectiveness basis or on a dollar per ton of emissions reduced basis. In a comparable air quality program, BACT or Best Available Control Technology assessments for new and modified sources, utilities typically see cost effectiveness assessments in the $5,000 to $15,000 dollar per ton of emission reduced. In the Utility MACT, we see the cost effectiveness calculation at approximately $162,000 per ton of emissions reduced for mercury and acid gases.

CLEAN AIR TRANSPORT RULE

The CATR is proposed by the EPA to address air quality in eastern states to achieving compliance with the National Ambient Air quality Standards (NAAQS) due to the transport of pollutants into those areas. Tri-State does not have existing operations on the CATR states, but, has been monitoring the development of the rule and provided comments to EPA on the allocation methodologies since it is likely that a final rule will be used as a precedent for any future rules with allocation programs.

EPA has significant discretion to select allocation methodologies that are reasonable and consistent with the goals of the CAA. It appears that the allocation options proposed by the EPA do not function to distribute allowances in a reasonable, sensible or equitable manner.

It appears that natural gas combined cycle (CC) and turbine units receive more allocations than they can use in all the CATR allocation options, and that in general coal units do not get enough allocations to operate with controls in place. Tri-State has concerns with an allocation option that greatly favors one fuel source over another.

CONCLUSION

Thank you for the opportunity to testify before you today on this important issue that we are facing. Tri-State supports good environmental regulations, but, firmly believes that the MACT rule goes beyond EPA authority and over-regulates coal fired power plants. Existing Tri-State stations generally meet the mercury emission limits in the MACT rule through co-benefits of existing controls. We believe that the proposed rules for the Utility MACT are not reasonable, are not based on sound practices of data quality and are not readily achievable using generally available emission control technologies, especially for new units. The MACT rule will result in adding additional controls at Tri-State facilities to meet particulate matter and metals limits which are non-mercury HAPS. The EPA should not regulate non-mercury HAPS until a study and determination is made that a public health threat exists.

Senator CARPER. Thanks, Ms. Walz. Thanks so much.

Dr. Carpenter, welcome. Please proceed.

STATEMENT OF DAVID O. CARPENTER, M.D., DIRECTOR, INSTITUTE FOR HEALTH AND ENVIRONMENT, UNIVERSITY OF ALBANY

Dr. CARPENTER. Senators Carper and Barrasso, I thank you for the opportunity to testify before this Subcommittee on clean air and nuclear safety. I am a public health physician and the former Dean of the School of Public Health at the University at Albany, and, as you know, public health is that part of the medical profession that is concerned with prevention, rather than treatment, of disease. I strongly support the new regulations and changes in the Clean Air InterState Rule and Clean Air Mercury Rule. These changes, once implemented, will significantly reduce morbidity and mortality of U.S. citizens, especially those living downwind of coal-fired power plants.

There is overwhelming scientific evidence that exposure to current levels of major air pollutants causes serious disease and death of thousands of Americans. The risk of sudden death due to respiratory or cardiovascular failure is dramatically elevated in older persons on days when concentrations of these pollutants are elevated.

Air pollutants cause asthma attacks both in children and adults, and increase the risk of respiratory infections. Particulate air pollution contains cancer-causing polyaeromatic hydrocarbons and metals such as arsenic, chromium, and nickel that are known human carcinogens. Consequently, chronic exposure to particulate air pollution increases the risk of lung and other cancers.

The detailed scientific evidence for these statements is contained in my written testimony.

Let me tell you of studies that I and my colleagues have recently completed. In New York, we have an excellent data base that reports to the State Health Department all of the diseases diagnosed in patients when they are discharged from the hospital. We have this information on hospitalization for about 2.5 million New Yorkers each year from 1993 to 2008, with information on age, sex, race, and zip code of residence.

We have compared rates of hospitalization for various respiratory diseases in New Yorkers who live in a zip code that contains a fossil fuel-fired power plant, not just coal, as compared to those that live in a zip code that does not contain such a power plant. We find that living in a zip code that contains a power plant is associated with 11 percent greater frequency of hospitalization for asthma, a 15 percent greater rate of hospitalization for respiratory infection such as pneumonia, and a 17 percent greater rate of hospitalization for chronic obstructive pulmonary disease.

These increases rates reflect only the contribution of power plants, not the total air pollution contribution, because, unlike emissions from motor vehicles, power plants are stationary. In addition, these data do not reflect illnesses that do not lead to hospitalization, nor the transport of contaminants into Connecticut, Massachusetts, and Vermont.

Implementation of these changed rules will also significantly reduce releases of metals that are known to be carcinogenic and of mercury, a very dangerous metal that is converted into methylmercury in bodies of water. Methylmercury bio accumulates in fish and, as a consequence, many fish from inland lakes and streams, as well as the oceans, are now unsafe to eat, especially by children and women of reproductive age. Methylmercury, like lead, is a neurotoxicant. The National Academy of Sciences concluded in 2000 that methylmercury causes irreversible reduction of IQ in children exposed before birth to the methylmercury in their mother's body.

Further results indicate that between 8 and 10 percent of U.S. women of reproductive age contain levels of methylmercury in their body as a result of eating fish that poses harm to their unborn child. The majority of this mercury comes from releases from coal-fired power plants, and these releases make fish, an otherwise healthy food, unsafe to eat.

Coal-fired power plants produce more hazardous air pollution in the United States than any other industrial source. The Clean Air Act requires control of hazardous air pollutants from coal-fired power plants, but absent these new rules no national standards exist to limit these pollutants from these plants. In the U.S. there are more than 400 coal-fired power plants located in 46 States across the Country, and they release in excess of 386,000 tons of hazardous air pollutants into the atmosphere each year. Hazardous air pollutants are known to cause sudden death from cardiovascular and respiratory disease and also cause cancer.

It is the responsibility of all of us to protect the health of the public, and especially the health of the unborn and of children. Implementation of these rules, which reduce air pollutants coming from power plants will help significantly to reduce the burden of disease and the death of the public.

Thank you very much for the opportunity to testify.

[The prepared statement of Dr. Carpenter follows:]

REPORT OF DAVID O. CARPENTER, M.D.

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I am a public health physician, a graduate of Harvard Medical School and the former Dean of the School of Public Health at the University at Albany. My research interests are the study of the impact of environmental exposures on human health, with a special focus on adverse effects on children. I have over 340 publications in peer-reviewed scientific literature, including a number of studies of the effects of air pollution and mercury on human health. I serve as an advisor to the World Health Organization and the National Institute of Environmental Health Sciences, and am a member of the Science Advisory Board of the International Joint Commission, the body that advises the governments of the US and Canada on issues around the boundary waters such as the Great Lakes. In this capacity I chair a workgroup dealing with issues related to concerns over consumption of fish, where mercury is one subject of study. I am the former President and current Treasurer of the Pacific Basin Consortium for Health and Environment, an international organization that coordinates activities of all of the countries in the Pacific Basin around issues related to air pollution, hazardous wastes and human health consequences of exposure to contaminants.

Power plants provide electricity to satisfy a variety of societal needs. Some power plants, such as hydroelectric, nuclear, wind, and solar, provide energy without air pollution, but fossil fuel-fired power plants are the major source of electrical power in most countries. Unfortunately, fossil fuel-fired power plants emit millions of tons of air pollutants each year (Environmental Integrity Project, 2007; Krewitt et al., 1998). In addition to formation and release of CO_2, which is a major concern with regard to climate change, fuel-fired power plants release sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM), polycyclic aromatic hydrocarbons (PAHs), acid gases and volatile organic compounds. Coal-fired power plants are the largest single source of release of mercury. While these air pollutants are also released by other sources of fossil fuel combustion, such as traffic, fossil fuel power plants are localized sources of elevated air pollution.

Hazardous air pollutants pose significant danger to human health of persons of all ages, but especially for the very young (Hertz-Picciotto et al., 2007) and older individuals with ill health (Zanobetti and Schwartz, 2005). The major components of hazardous air pollution include particulates (which often contain PAHs and metals), SO_x, NO_x and ozone, which is formed by the interactions between NO_x, sunlight and oxygen. Acid gases are also released, which include HCl, H_2S and HF. Sulfur dioxide comes primarily from fossil fuel burning, electrical power plants and industrial facilities, and combines with water to make sulfuric acid. As such, it is a major contributor to acid rain. When SO_2 is inhaled sulfuric acid forms in the lung. This is a very damaging substance, and it degrades lung tissue, causing serious lung damage, which can be irreversible with chronic inhalation. Nitrogen oxides are also released from industries and power plants, and when inhaled form nitric acid, which also directly damages the lung. While each of these pollutants alone have adverse health effects, in the real world people are exposed to all of them simultaneously. A major problem arises when individuals are exposed to chemical mixtures. While standards are usually set based on single chemicals or gases, exposure is actually to multiple chemicals or gases. The adverse health effects of the individual components may be additive, or, even more dangerously, may be more than additive; meaning that the sum can be greater than the parts (Carpenter et al., 1998; 2002). Air pollution is never of a single pollutant, and usually particulates, NO_x, SO_x, ozone, CO and CO_2 are all components, as well as volatile organic compounds (VOCs) such as benzene and 1,3-butadiene and acid gases. Thus, the net hazard is much greater than just that from a single component (Lippmann and Schlesinger, 2000). Of particular concern is risk of cancer, respiratory diseases including both infectious disease and asthma, cardiovascular disease and death from any cause.

Coal-fired power plants produce more hazardous air pollution in the United States than any other industrial pollution sources. The Clean Air Act requires the control of hazardous air pollutants from coal-fired power plants, but absent these new rules, no national standards exist to limit these pollutants from these plants. In the US, there are more than 400 coal-fired power plants located in 46 states across the country release in excess of 386,000 tons of hazardous air pollutants into the atmosphere each year.

Hazardous air pollutants are toxic emissions that are known or suspected to cause cancer or other serious health effects, such as reproductive problems or birth defects. People most at risk include: infants, children and teenagers; older adults; pregnant women; people with asthma and other lung diseases; people with cardiovascular disease; diabetics; people with low incomes; and healthy adults who work or exercise outdoors. Based on data from the American Cancer Society, the Clean Air Task Force has estimated that over 13,000 lives would be saved if the Transport Rule were implemented, and that the adverse health impacts attributable to coal-fired power plants alone is in excess of $100 billion dollars.

The diseases of concern from air pollutants are as follows:

Lung Cancer: Particulates contain several kinds of cancer-causing substances, primarily PAHs, metals such as arsenic and chromium and volatile organic compounds. These substances accumulate over time and increase risk of development of lung cancer (Sax et al., 2006). Pope et al., (2002) reported that each 10 $\mu g/m^3$ elevation in fine particulate levels resulted in an 8% increased risk of development of lung cancer mortality. Reynolds et al. (2003) reported on rates of childhood cancer in relation to concentrations of 25 hazardous air pollutants, including benzene, 1,3-butadiene, chloroform, ethylene dibromide and dichloride, vinyl chloride and trichloroethylene, and found that a significant association between concentrations of these substances and rates of leukemia in children [risk ratio (RR) = 1.21, 95% CI = 1.03-1.42].

Sudden death from cardiovascular and respiratory disease: Individuals who already suffer from ill cardiac or respiratory health have a significantly increased risk of dying on days of high air pollution. Samet et al. (2000) investigated fine particulate air pollution and mortality in 20 US cities and found an increased risk of death from all causes of 0.51% for each increase in PM_{10} of 10 μg/m^3, and an increase of 0.68% for cardiovascular and respiratory mortality. Pope et al. (2002) found that a 10 μg/m^3 elevation in fine particulate air pollution was associated with a 4% and 6% increase of all causes and cardiopulmonary mortality, respectively. Zanobetti and Schwartz (2005) reported that for every increase of 10 μg/m^3 in PM_{10} there was a 0.64% increase in risk of hospitalization for myocardial infarction. Ito et al. (2011) found that hospitalization for cardiovascular disease exhibited strong seasonal trends and day of the week patterns that correlated with levels of fine particulates in air. Wang et al. (2009) reported that an increase of 4.7% in cardio-respiratory mortality with every 1 ppb increase in annual average concentration of SO_2. Hermann et al. (2004) predicted that if 29 proposed fossil-fuel power plants in Virginia were operated for 6 years, $PM_{2.5}$ in 272 counties would increase and 104 additional premature deaths would occur.

Chronic obstructive pulmonary disease (COPD): Air pollutants lead to an increased frequency of hospitalization for COPD, and may contribute as a cause of this disease (Moolgavkar, 2000; Chen et al., 2004). Studies indicate that SO_2 and NO_2 are particularly important is causing this effect.

Respiratory infections: Research studies show an increased risk of hospitalization of children for pneumonia, bronchitis and respiratory distress during periods of elevated air pollution (Romieu et al., 2002; Hertz-Picciotto et al., 2007; Ostro et al., 2009; Sheffield et al., 2011). The latter study calculated that if the United States were to reduce levels of fine particulate matter to 7% below the current annual standard, the nation would save $15 million dollars annually in reduced health care costs. Chauhan and Johnston (2003) have presented evidence that air pollution in general, but NO_2 in particular, increases the risk of infectious respiratory illnesses. Dales et al. (2006) found a 1.66% increase in neonatal hospitalization for respiratory diseases of Canadian neonates in relation to inter-quartile concentrations of NO_2.

Respiratory allergies: Parker et al. (2009) report an increase in frequency of respiratory allergies and hay fever, especially in children, in relation to levels of ozone and particulate matter (Parker et al., 2009).

Asthma: Air pollutants cause an increased frequency of asthma attacks in both children (Schildcrout et al., 2006; Smargiassi et al., 2009) and adults (Delfino, 2002), particularly in relation to elevated levels of SO_x and NO_x. Samoli et al. (2011) reported that a 10 μg/m^3 increase in SO_2 was associated with a 5.98% increase in the number of pediatric asthma hospitalizations. Johns et al. (2010) exposed asthmatics to SO_2 for 5-10 min periods, and observed consistent evidence of an increase in broncho-constrictive responses with increasing exposure to concentrations between 0.2 and 1.0 ppm. Andersson et al. (2006) determined the incidence of adult asthma among persons exposed to SO_2, and found a highly significant elevation in asthma in exposed, as compared to unexposed persons [hazard ratio (HR) = 4.0, 95% CI = 2.1-7.7]. Liu et al. (2009) studied pulmonary function in children in Windsor, Ontario in relation to levels of $PM_{2.5}$, SO_2, and NO_2, and found that elevated pollution with all three increased the airway oxidative stress and decreased small airway function in asthmatic children.

Reduced neurologic development of children: Recent studies have found that elevated levels of air pollutants are associated with reduced motor and language development of children (Tang et al., 2008; Perera et al., 2008).

Low birth weight infants and prematurity: Chronic elevation in levels of air pollutants increases the risk of infants being born prematurely and having low birth weights (Bobak, 2000). Sram et al. (2005) and Ritz and Wilhelm (2008) have reviewed evidence for relations between ambient air pollution and birth outcomes, and find that all criteria pollutants are linked to adverse birth outcomes. They found evidence for reduced birth weight with increased air pollution, and evidence for preterm birth and intrauterine growth retardation with increasing air pollution. They report evidence for a relationship with birth defects, but this evidence is not strong.

My colleagues and I have recently completed a study of the effects residence near to fuel-fired power plants in New York and rates of hospitalization for respiratory diseases. There is increasing evidence that environmental exposures increase the risk of human disease, and these exposures come from multiple sources including air pollutants coming from fossil fuel combustion whether in power plants or vehicles. While many of the important sources of air pollutants are mobile, power plants, because they are stationary, constitute a localized source of air toxics, and as such allow one to ask the question of whether individuals living near to these power plants experience greater exposure and more disease as a result. The goal of this study was to examine rates of hospitalization for asthma and respiratory infections among individuals who live near to fuel power plants. The manuscript was submitted to a scientific journal less than two weeks, and has not yet been accepted for publication.

We used the New York Statewide Planning and Research Cooperative System (SPARCS) to obtain data on hospital discharges for the years 1993–2008. SPARCS is an administrative database maintained by the New York State Department of Health (NYSDOH). Every state-regulated hospital (except federal hospitals) must report to NYSDOH the primary diagnosis and up to 14 other diagnoses of each inpatient upon discharge, based on the International Classification of Disease, 9th Revision (ICD-9). In this study, we selected hospital discharge data that had diagnosis of (1) asthma (ICD-9: 493), (2) acute respiratory infections (ARI) (ICD-9: 460–466) and/or (3) chronic obstructive pulmonary disease (COPD) (ICD-9: 490–492 and 494–496) and included both primary and secondary diagnoses. We used this data for the years 1993-2008.

Exposure was defined as a patient's residence in a zip code that contained at least one power plant using fuel combustion as an energy source. We obtained the list of existing power plants and electric generators in New York State for the years 1990–2008 from the website of the U.S. Energy Information Administration (EIA) (US EIA, 2010). We have information about location, energy source and operating period for each generator. Fossil fuel-fired power plants used coal, oil, natural gas, landfill gas and/or solid waste. Using this information, we have created a database that identifies the zip codes that contained fuel-fired generators in all of New York State except for NYC.

We found that after adjustment for age, gender, race, median household income (MHI) and rural/urban residence, there was a significant 11%, 15% and 17% elevation in rates of hospitalization for asthma, respiratory infections and COPD, respectively, among individuals age > 10 years living in a zip code containing a fuel-fired power plant as compared to one that had no power plant. Our results are consistent with the conclusion that exposure to air pollution from fossil fuel-fired power plants increases the risk of hospitalization for respiratory diseases

Although semi-ecologic studies such as ours must always be considered to be hypothesis generating, the congruence between these results and previous information provides additional evidence that use of the large hospitalization dataset has value in identifying patterns of disease in relation to residential exposures.

Coal-fired power plants are also the single greatest source of release of mercury. There are three major forms of mercury, metallic, inorganic and organic. Because mercury is an element, it cannot be destroyed. While there is some toxicity associated will all forms of mercury, the organic form, primarily methyl mercury, is the most dangerous. Methyl mercury is formed through the action of microorganisms in aquatic sediments. Release of mercury from power plants results in it being deposited into bodies of water, where it is then converted to methyl mercury. The major source of human exposure to methyl mercury is consumption of fish, both marine and fresh water, that accumulate and bioconcentrate methyl mercury.

Methyl mercury is an extremely dangerous substance, and of greatest concern is the fact that it is a neurotoxicant that causes significant reduction in IQ of children born to mothers with elevations concentrations (Debes et al., 2006; Bose-O'Reilly et al., 2010). The National Academy of Sciences in 2000 reviewed the evidence that mercury caused human disease, and concluded that children born to mothers who eat large amounts of fish are at greatest risk. Based on data from the National Human Monitoring project there is evidence that 8 to 10% of women of childbearing age in the US have concentrations of methyl mercury in their bodies beyond the levels that EPA considers to be "safe". Fully 87% of this mercury comes from combustion point sources, and 33% of that comes from coal-fired utilities. A recent analysis has reported that mercury released from US power plants results in $1.3 billion in lost economic productivity as a consequence of the reduction in IQ that results (Trasande et al., 2005).

While the effects of children's neurologic development is the greatest concern, mercury exposure also causes severe neurological disease in adults (Hightower and Moore, 2006) and increases the risk of cardiovascular disease (Guallar et al., 2002). My colleagues and I have recently published information to assist physicians in identifying the signs of mercury poisoning in adults (Silbernagel et al., 2011).

In summary, air pollutants coming from power plants result is significant human morbidity and mortality. This is also the case for mercury released from power plants, which contaminates fish and makes fish often unsafe to eat, especially for women and children. It is critical that every possible step be taken to reduce the release of these compounds so as to protect human health.

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Institute for Health and the Environment
WHO Collaborating Center in Environmental Health

5 August 2011

Katie Lee
Senate Committee on Environment and Public Works
410 Dirksen Senate Office Building
Washington, DC 20510

Dear Ms. Lee:

This letter is in response to the letter I received dated 3 August 2011 from Senators Boxer and Inhofe requesting answers to questions posed by Senator Carper as a result of my testimony at the 30 June hearing of the Environment and Public Works Committee.

The questions and answers are as follows:

1. During the hearing, you mentioned a study that focused on mercury levels in Florida. Can you please submit this study for the record and provide an overview of the results from this study?

Answer:
The study I referenced was a report from the Florida Department of Environmental Protection dated October, 2002 and revised November, 2003. The title of this report is "Integrating Atmospheric Mercury Deposition with Aquatic Cycling in South Florida: An approach for conducting a Total Maximum Daily Load analysis for an atmospherically derived pollutant", and it is enclosed.

The section containing the information relevant to my comment is in Chapter 7. The authors show that there were large changes in mercury emissions between 1980 and 2000. Emissions were low in the period 1980-1982, but rose 3.5 time above the 1982 level in 1983 as municipal waste combustors and medical waste incinerators came on line, and continued to increase until 1991 when the peak emission was nearly 3,100 kg/yr total mercury. In 1992 more stringent requirements took effect, and many of the municipal waste combustors ceased operation and medical waste incinerators closed. This resulted in a sharp reduction in mercury emissions beginning in 1993 which continued through 2000. The total estimated decline between 1991 and 2000 was 93%. The report documents changes in mercury levels in both fish (largemouth bass) and feathers from great egret chicks. Mercury levels in largemouth bass from the Florida Everglades declined from about 2.5 mg/kg wet weight in 1988 to 0.4 mg/kg in 2000. Mercury levels in feathers from great egret chicks declined by 80% during the period 1994 to 2003.

These results are particularly important because they show that after reducing mercury emissions there is a relatively rapid consequent reduction in the mercury concentration in fish and birds. There are

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two implications from these observations. The first is that local mercury emissions are the primarily determinants of levels of mercury in local fish and wildlife. The second is that the levels in fish and wildlife respond quickly to changes in rates of local emissions.

This study provides clear evidence that reduction of mercury emissions from coal-fired power plants will have an almost immediate positive effect of reducing levels of mercury in fish, making fish a safer food source.

2. Please provide any other comments you have in response to points raised by other witnesses on your panel.

Answer:

Several other witnesses implied that implementation of these restrictions on emissions from coal-fired power plants would have negative effects of job creation and economic development. None, however, provided any basis for support of this view, whereas all of the evidence points to the contrary. Not only will imposition of the new standards for emission significantly improve human health, but it will also stimulate job creation and economic development in those industries that manufacture pollution-reduction equipment, research and development activities related to efficient pollution control and even the construction of new power plants that do not emit high levels of air pollutants. Reducing emissions from coal-fired power plants will both protect the health of the public and create jobs.

Thank you for the opportunity to testify at this hearing and to respond to the questions from Senator Carper.

Yours sincerely,

David O. Carpenter, M.D.
Director, Institute for Health and the Environment
University at Albany

EXECUTIVE SUMMARY

Integrating Atmospheric Mercury Deposition with Aquatic Cycling in South Florida:

An approach for conducting a Total Maximum Daily Load analysis for an atmospherically derived pollutant

Florida Department of Environmental Protection
October, 2002
Revised November, 2003

Purpose:

The purpose of this project was to demonstrate the technical feasibility of conducting a Total Maximum Daily Load (TMDL) analysis for a system where the contaminant of interest is derived principally from atmospheric sources. Depending on the type of aquatic system, a number of contaminants may be categorized as significantly atmospheric in origin, including mercury, fixed nitrogen, PCB's, and others. This study focuses on mercury, and incorporates extensive field data into a framework combining atmospheric mercury deposition and aquatic mercury cycling models to demonstrate the feasibility of the approach. The goal was to understand and simulate how changes in local atmospheric mercury emissions in south Florida would influence mercury concentrations in top predator fish, thus demonstrating the potential of combining air and water modeling approaches in TMDLs involving air deposition of mercury.

About 2 million acres of the south Florida Everglades ecosystem are currently under fish consumption advisories because of mercury contamination. The Clean Water Act requires that states list as impaired all waterbodies that do not meet water quality standards when the designated uses are not being met or because water quality criteria are being exceeded. Mercury-contamination fish consumption advisories represent an exceedance of water quality standards because a designated use for the Florida Everglades ecosystem is not being met. Once a waterbody such as the Everglades is placed on the Clean Water Act 303(d) list, a TMDL study is conducted to determine how much the pollutant (i.e., mercury) loading must be reduced, and from what sources, to meet the water quality standards and designated use for the waterbody. A TMDL establishes the maximum amount of a given pollutant that a particular waterbody can assimilate without exceeding surface water quality standards. TMDL-type analyses for determining needed reductions in atmospherically derived pollutants have rarely been done due to the data needs and technical complexity of developing and linking atmospheric and aquatic cycling models.

Mercury is both a naturally occurring element and a pollutant that cycles, in a variety of chemical forms, through air, water and soil. Some forms of mercury are transported around the world through the air, others tend to deposit from the atmosphere at local or regional scales. Extensive monitoring of the Florida Everglades ecosystem has shown that the primary source of mercury loading is atmospheric deposition – over 95% of the mercury load to the Everglades each year comes from atmospheric deposition. Because some atmospheric mercury is transported into Florida from both local and distant sources, a difficulty in producing a TMDL is determining the relative contribution of these sources. To conduct a TMDL analysis for mercury, atmospheric models are needed to simulate the transport of local mercury emissions and deposition onto the Everglades water surface. In addition, once the mercury deposition is estimated using atmospheric models, this deposition must be used as input to an aquatic ecosystem model that will simulate mercury cycling in the Everglades and uptake through the food chain to top predator fish, such as largemouth bass.

To that end, this modeling project was sponsored by the Florida Department of Environmental Protection and US Environmental Protection Agency to combine atmospheric mercury deposition models with an aquatic mercury cycling model. The mercury deposition output from the atmospheric models was used as input to an aquatic mercury cycling model. The aquatic mercury cycling model was used to predict the change in largemouth bass mercury concentrations that might occur if mercury emissions were reduced. The goal is to provide data and models that can be used to conduct a Total Maximum Daily Load study for mercury in the Everglades. [1]

Results and Conclusions

The following results were obtained from using output of the atmospheric model as input to the aquatic ecosystem model:

1. The E-MCM model predicts a linear relationship between atmospheric mercury deposition and mercury concentrations in largemouth bass, with a small residual mercury concentration in fish at zero atmospheric mercury deposition (Figure 9). In other words, for any reduction in mercury inputs to the Everglades a slightly lesser

[1] For additional information about the Florida DEP Mercury Program, access the web address given below: http://www.floridadep.org/labs/mercury/index.htm

reduction in fish mercury concentrations may be anticipated. Furthermore, error analysis shows that the E-MCM predicts near equivalence between the percent decrease in atmospheric mercury deposition rate and the percent decrease in largemouth bass mercury concentration over the likely range for current estimates of atmospheric deposition of mercury. The slight offset from a 1:1 relationship results from slow mobilization of historically deposited mercury from deeper sediment layers to the water column. Until buried below the active zone, this mercury can continue to cycle through the system. In addition, because mercury is a naturally occurring element, fish tissue mercury concentrations can never be reduced to zero.

2. In the absence of changes to the system other than mercury loading (e.g. changes in sulfur cycling, nutrient cycling, or hydrology), a reduction of about 80% of current total annual mercury atmospheric deposition rates would be needed for the mercury concentrations in a 3-year old largemouth bass at WCA 3A-15 to be reduced to less than Florida's present fish consumption advisory action level of 0.5 mg/kg (parts per million).

3. Mercury concentrations in three-year-old largemouth bass are predicted to achieve 50% of their long-term, steady state response following sustained mercury load reductions within approximately 10 years and 90% within 30 years (Figure 10).

4. Despite the uncertainties identified, the progress represented in these demonstrations of a unique combination of atmospheric and aquatic cycling models is remarkable. There is every reason to believe that, with modest additional effort, the remaining uncertainties can be reduced to levels that will allow reliable, confident allocation of mercury emissions to protect the designated uses of the Everglades.

5. It is also evident that there is further potential for combining such air and water modeling approaches for TMDLs involving air deposition of mercury for other aquatic ecosystems. We believe the approaches presented here can be applied to other geographic areas and in other studies of air – water chemical interactions.

Combining Atmospheric and Aquatic Models

The atmospheric modeling approach used in this study was developed by the University of Michigan Air Quality Laboratory to simulate the atmospheric transport of mercury from local emission point sources in southern Florida to its deposition onto the Everglades. The aquatic model, the Everglades Mercury Cycling Model (E-MCM), was used to simulate how mercury was cycled in the Everglades and accumulated through the Everglades food chain to top-level predator fish (e.g., largemouth bass, a popular sport fish).

The Florida Everglades ecosystem extends over 3,000 square miles, thus it was not realistic to simulate the entire ecosystem. However, extensive monitoring studies in the Everglades by USEPA (1998) revealed a mercury "hot spot" in central Water Conservation Area 3. The US Geological Survey subsequently conducted several years of intensive field study at this 'hot spot' (WCA 3A-15). Data from this site were used to calibrate the E-MCM model. Deposition and aquatic cycling data were available for 1995-1996; as a result, this period (22

June 1995 to 21 June 1996) was selected as the period of study. Atmospheric deposition rate for 1995-1996 is referred to as "current" deposition rate in this report.

Because of limited information and tools available to support modeling of a global transport domain, source-receptor modeling relied primarily on local sources to estimate deposition to the Everglades. As discussed in detail in Section 5.4.5 of the report, several lines of evidence suggest that local sources were the predominant contributor to mercury deposition on south Florida.

We acknowledge the global-scale cycling of some forms of mercury, but paucity of data or models to quantify or simulate this potential source to Florida puts this phenomenon beyond the reach of this analysis. An analysis by the principals of the FAMS project, independent of this work, examined rainfall mercury deposition in relation to trace element signatures of common sources of air pollution. They concluded that most mercury deposited at long-term south Florida deposition collection sites did not originate from local sources. Further field measurements and modeling analyses are underway to resolve this seeming paradox.

To estimate the deposition load to WCA 3A-15 measured wet deposition at multiple FAMS sites was combined with modeled dry deposition in this analysis. Estimating total deposition to the TMDL study site required analysis of historical weather patterns in south Florida and selecting representative wind direction and rainfall patterns to use in estimating both wet and dry mercury deposition over the area based on local point source mercury emissions. The atmospheric model was calibrated to 1995-96 mercury deposition rates (both dry and wet deposition). Different mercury deposition reduction scenarios were simulated (75, 50, 30, and 15% of current levels) and provided as input to the aquatic mercury cycling model.

The aquatic mercury cycling model was run using the projected estimates of mercury deposition onto the marsh water surface at WCA 3A-15. The E-MCM model was run for 200 years so that steady-state conditions would be reached between atmospheric mercury deposition and largemouth bass mercury concentrations at current deposition rates. A relationship between atmospheric mercury deposition and largemouth bass mercury concentration was developed using the results from each of the different mercury emission/deposition scenarios. In addition, the time required for largemouth bass mercury concentrations to decrease to 50% and 90% of their long term, steady state mercury concentrations based on the reduced mercury deposition scenarios was estimated to be 10 and 30 years, respectively.

Assumptions and Cautions

This analysis demonstrates that atmospheric and aquatic mercury cycling models can be combined and used to estimate the reduction in fish mercury concentration associated with reduced mercury deposition. However, several assumptions and cautions must be considered when interpreting these results:

1. This report is <u>not</u> a fully formed mercury TMDL intended for implementation; that was <u>not</u> the goal of the present analysis. However, this report does demonstrate the technical feasibility of a combined modeling analysis to encompass the multi-media aspects of an air-water-biota pollutant problem. It establishes a method that furthers the goal of conducting a mercury TMDL study for the Florida Everglades.
2. The contribution of global mercury emissions to current atmospheric mercury deposition in southern Florida is poorly understood. After model testing and evaluation to assess the strengths of the assumption, the final model analysis of the relationship between mercury emissions and atmospheric deposition assumed that most of the mercury in deposition was from local sources. Although the comparison between observed and predicted wet deposition rates based on this assumption was good, this remains an area of scientific debate.
3. The processes affecting the transformation of mercury in the atmosphere were poorly understood or quantified at the time of this report. Therefore, the atmospheric modeling may not accurately reflect the properties of the actual mercury species that are being deposited onto the Everglades.
4. Not all the aquatic cycling processes affecting the transformation of inorganic mercury to methylmercury (which is the toxic mercury species that accumulates in fish) are represented in detail in the Everglades Mercury Cycling Model. For example, sulfate reduction is an important to the process of transforming inorganic to methylmercury. Some of the byproducts of sulfate reduction bind inorganic and methylmercury, making them less available for biological uptake. The details of these processes are not yet understood, thus cannot be modeled. Until the model is progressively refined and parameterized these limitations might affect the results reported here.
5. Although the measurement set is drawn from extensive, quantitative research, uncertainties remain in all field measurements, but this uncertainty is not included in the modeled output. The magnitude of the uncertainty is unknown, but it can affect the interpretation and conclusions drawn from the results.
6. Natural year-to-year variation in mercury deposition can be relatively large. This natural variability has not been included in the minimum loading calculations (although the effects of this variability were examined over long time-frames through Monte Carlo analysis). The 1995-1996 period was used as the basis for this analysis because it is the 12 month period for which extensive field monitoring and modeling data were available. It was not, however, a typical year as 1995 and 1996 were relatively wet years in southern Florida.
7. Only one area of the Everglades was considered in the simulation - WCA 3A-15. Other areas in the Everglades might not respond similarly because of different habitat, food web dynamics and water quality.

Recommendations

The following actions are recommended in order to allow a formal TMDL to be conducted for the Florida Everglades:

1. Obtain better estimates of local vs. regional and global mercury contributions to south Florida. This is critical because estimates of regional plus global sources by various workers range from ca. 25 to >60% of the mercury deposition over southern Florida.
2. Incorporate the aquatic chemistry and cycling of sulfur into the Everglades Mercury Cycling Model. Sulfate is an important influence on the production of methylmercury, affecting not only mercury transformations, but also the biological availability of mercury for uptake. There is a strong sulfate gradient decreasing from north to south in the Everglades Protection Area that is an important cofactor controlling the severity of the mercury problem at any given site.
3. Apply the atmospheric and aquatic models to other areas of the Florida Everglades to see if similar changes occur in largemouth bass mercury concentrations following reduced atmospheric deposition of mercury.
4. Improve mercury emissions inventories and better describe mercury species' transformations in the atmosphere. These are critical information needs to improve mercury transport and fate modeling.
5. Obtain better estimates of the uncertainty in the study. Uncertainty can affect the interpretation and conclusions drawn. Uncertainties that potentially affect decisions regarding controlling local mercury emission sources should receive highest priority.

Cover, counterclockwise from top left:

Figure 1. Florida Fish and Wildlife Conservation Commission biologists collecting early fish samples for heavy metals analysis from the Chipola River. Courtesy Andrew Reich, Fla. Dept. Health. 1984.

Figure 2. Florida Atmospheric Mercury Study sampling tower at the Everglades Nutrient Removal Project. Courtesy SFWMD.

Figure 3. Thunderstorm over the central Florida Everglades. Courtesy Dan Scheidt, USEPA Region 4.

Figure 4. Experimental mesocosms for elucidating mercury biogeochemistry in the Florida Everglades. Courtesy C. Gilmour, Academy of Natural Sciences and D. Krabbenhoft, USGS. ACME Project.

Figure 5. USEPA Region 4 REMAP graphic showing spatial distribution of mercury in mosquitofish across the Everglades Protection Area, with overlay of mercury in great egret chicks from active colonies. Spatial information on fish mercury courtesy EPA Region 4, SESD; wading bird data courtesy P. Frederick, University of Florida.

Figure 6. Wood storks feeding in the Florida Everglades. Courtesy SFWMD.

This project and the preparation of this report was funded in part by a Section 103 Air Pollution Control Grant from the U.S. Environmental Protection Agency (US EPA) through a contract with the Mercury and Environmental Science Program of the Florida Department of Environmental Protection. The total cost of the project was $ 543,351 of which $161,880 or 28 percent was provided by USEPA.

South Florida Mercury
Science Program

FOREWORD

This document presents the results of a pilot project designed to evaluate the technical feasibility, given the present state of knowledge of mercury cycling in the environment, of calculating an atmospherically driven total maximum daily load (TMDL) for mercury for the Florida Everglades. This is among the first efforts to integrate atmospheric and aquatic cycling of a pollutant in a combined modeling analysis, as would be required for use in pollutant TMDLs where an atmospheric sources may be important contributors to pollutant loads. This project is not being conducted by Florida DEP with the expectation that it will be used as the basis for implementing changes to source permits or other action. Its purpose is to provide a technical analysis to provide the basis for a more comprehensive approach to a full TMDL process to be conducted subsequently.

This analysis is built upon extensive results from research on the sources, transport and fate of mercury in south Florida, and focuses on modeling approaches that might be used in the context of a TMDL for mercury deposited from the atmosphere. Florida law specifies the process the state will use for developing TMDLs for implementation. This law directs development of rules for the method of designating impaired waters and for the TMDL analysis itself. Any future TMDL analysis intended to be used to support policy will have to conform to these legal strictures. The Rule has been adopted but is subject to further review by the USEPA. As agreed between Florida DEP and USEPA Region 4, the schedule for TMDL implementation does not require completion of atmospheric TMDLs for mercury until 2010. The purpose of this project is to establish the technical basis for more definitive efforts in the future. This project is a collaborative, voluntary effort between DEP and USEPA.

This analysis was conducted for a portion of the Everglades known as Water Conservation Area 3A. This area was chosen because it offered a wealth of information gained from the extensive monitoring, modeling and research conducted by the cooperating agencies of the South Florida Mercury Science Program. This fruitful collaboration among state, federal and private groups has greatly illuminated the causes of the mercury problem in the Everglades, and by extension, the causes of the problem that exists across much of our country.

This and a similar effort being conducted by the Wisconsin Department of Natural Resources, represent an early effort to examine the issues that arise when a TMDL addresses atmospheric sources. As originally set forth in the Clean Water Act 30 years ago, TMDL analyses were conceived for direct discharge of wastes to a waterbody to address simple water quality problems such as low dissolved oxygen caused by excessive biological oxygen demand. However, it has since become apparent that pollutants from the atmosphere can represent significant loads to water bodies. Pioneering studies in Chesapeake Bay and the Great Lakes have demonstrated that the atmosphere can be a large source of nutrients or toxic substances to water bodies. Similarly, for the Florida Everglades, average annual atmospheric deposition rates for mercury outweigh surface water input by more than 20:1 (USEPA, 1998).

While the concept of an atmospheric TMDL may seem straightforward, the technical challenges in coupling air source pollutant emissions, chemistry and transport with the complex aquatic cycling and fate of mercury are daunting. At this time, significant uncertainties remain in our basic understanding of the atmospheric mercury cycle and modeling of mercury transport and fate, and likewise in our understanding of the aquatic cycling transformation processes and mercury bioaccumulation in aquatic food webs.

We wish to thank our many collaborators of the South Florida Mercury Science Program for their data, analyses, guidance, advice and efforts in the preparation of this document. We especially wish to thank William J. Bigler (DOH, retired), Forrest Ware (FWC, retired) and Thomas Savage (DEP, retired) who began the monitoring that led to the discovery of the mercury problem in Florida and which ultimately provided impetus for this work.

This document was developed by the Florida Department of Environmental Protection and its contractor, Tetra Tech, Inc. It was funded by appropriations from the Florida Legislature and in part by USEPA Region 4 by Cooperative Agreement No. X984123-97-0. The findings herein do not represent the policies or views of the USEPA. This project supported the efforts of the University of Michigan Air Quality Laboratory and Tetra Tech under DEP Contracts AQ-136 and SP-508, respectively.

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LIST OF ABBREVIATIONS USED IN TEXT

ACME	Aquatic Cycling of Mercury in the Everglades study, USGS
AT	Andytown monitoring site of the Florida Atmospheric Mercury Study (FAMS)
CMAQ	Community Multiscale Air Quality Model, an USEPA/NOAA atmospheric chemistry, transport and deposition model
CWA	Clean Water Act
DEP	Florida Department of Environmental Protection
DOH	Florida Department of Health
EAA	Everglades Agricultural Area
ENP	Everglades National Park
EPA	Everglades Protection Area (i.e. Water Conservation Areas and the Everglades National Park)
E-MCM	Everglades Mercury Cycling Model
FAMS	Florida Atmospheric Mercury Study
FEDDS	Florida Everglades Dry Deposition Study
FS	Fakahatchee Strand State Park monitoring site of the Florida Atmospheric Mercury Study (FAMS)
FWC	Florida Fish and Wildlife Conservation Commission
GIS	Geographic Information System, computer mapping system
GMT	Greenwich Mean Time (5 hours earlier than USA east coast time)
Hg	The chemical notation for the element mercury, derived from the Greek Hydrargyrum
Hg(0)	Elemental mercury, the silvery metal liquid at room temperature
Hg(II)	divalent mercury, a form of inorganic mercury; mercuric ion, RGM
Hg(p)	Atmospheric particulate-associated mercury
Hg_t, Hg_{tot}	Total mercury, i.e. lab analysis of all forms of mercury
HYSPLIT_4	Hybrid Single Particle Lagrangian Integrated Trajectories Model, a NOAA atmospheric transport & deposition model
LMB	Largemouth bass
mb	millibars of pressure in the atmosphere
MCM	Mercury Cycling Model
MDN	Mercury Deposition Network, a sub-network of the National Atmospheric Deposition Program
mg/kg	milligrams per kilogram, a unit of measure of concentration, ppm
MeHg	Methylmercury
METAALICUS	Mercury Experiment To Assess Atmospheric Loading in Canada and the United States
MSRTC	Mercury Study Report to Congress (USEPA 1997)

MWC	Municipal Waste Combustors, (aka., Municipal Solid Waste Incinerator)
MWI	Medical Waste Incineration
NADP	National Atmospheric Deposition Program
ng/L	nanograms per liter, unit of measure of concentration, ppt
NCEP	NOAA National Center for Environmental Prediction
NGM	Nested Grid Model
NOAA – ARL	National Oceanic and Atmospheric Administration – Air Resources Lab
NPDES	National Pollutant Discharge Elimination System
ppb	parts per billion, a unit of measure of concentration,
ppm	parts per million, a unit of measure of concentration
ppt	parts per trillion, a unit of measure of concentration
RAMS	Regional Atmospheric Modeling System
RELMAP	Regional Lagrangian Model of Air Pollution
REMAP	Regional – Environmental Monitoring Assessment Program
RGM	Reactive Gaseous Mercury
SFMSP	South Florida Mercury Science Program
SFWMD	South Florida Water Management District
SoFAMMS	South Florida Atmospheric Mercury Monitoring Pilot Study
TGM	Total Gaseous Mercury
TMDL	Total Maximum Daily Load
TT	Tamiami Trail monitoring site of the Florida Atmospheric Mercury Study (FAMS)
UMAQL	University of Michigan Air Quality Laboratory
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
µg/L	micrograms per liter, a unit of measure of concentration, ppb
µeq/L	microequivalents per liter, a unit of measure of concentration
WCA	Water Conservation Area, a subdivision of the Everglades

1 BACKGROUND

Our understanding of the biogeochemical cycle of mercury has improved dramatically within the past decade. Prior to the development of 'clean' sampling and 'ultra-trace' analytical procedures, concentrations or pools of mercury in air, rain and surface waters, and the fluxes between these compartments, were commonly overestimated, in some cases by two to three orders of magnitude (Fitzgerald, 1986, 1989). Against this inflated backdrop, anthropogenic sources of mercury to the atmosphere of all types appeared small, with estimates of natural emissions accounting for 90 to 95 percent of total cycle. By the early 1990's, application of more accurate measurements of the global pools and fluxes of mercury overturned this view, leading to the conclusion that natural emissions were "*between 20 and 50 percent of the direct and indirect anthropogenic sources*" (Expert Panel, 1994). Present estimates tend toward the lower end of this range. This new insight into the 'natural vs. anthropogenic' question, plus the finding that the accumulation of mercury in seepage lakes in remote areas is largely attributable to atmospheric inputs (Watras, *et al.*, 1994), has changed the way the mercury problem is viewed. Attention now focuses beyond the problem of elevated mercury in fishes in these lakes to the importance of deposition processes, atmospheric transport and chemistry, and ultimately to sources of mercury to the atmosphere.

The view that anthropogenic sources of mercury to the atmosphere predominate is buttressed by studies of long-term trends of mercury in the environment by examination of cores of sediments and similar media. "*Considered individually, these methods are subject to much uncertainty. However, when considered as a whole they indicate that the total atmospheric mercury burden has increased since the beginning of the industrialized period by between a factor of two and five.*" (Expert Panel, 1994). The significance of this increase is confounded by lack of uniformity, both temporally and geographically. For example, in some areas it has been shown that mercury deposition peaked between 1950 and 1970, at a level about three times present deposition rates. (Engstrom and Swain, 1997; Zillioux, *et al.*, 1993). Similar analyses of sediment records in the Florida Everglades indicate an increasing trend up through the decade of the 1980's (Rood, *et al.*, 1995, Delfino, *et al.*, 1993, 1994).

The most recent data on mercury trends at a site broadly representative of the continental U.S. was recently published by a team of USGS scientists (Schuster, et al., 2002). As shown in **Figure 1**, mercury has accumulated in core records since the Industrial Revolution, peaking in the 1960's through the 1980's and declining in the past decade or so.

A remaining area of great scientific uncertainty is how to incorporate the varying spatial scales of the atmospheric mercury cycle into an understanding of mercury bioaccumulation in aquatic systems. The differing chemical and physical forms of mercury found in the atmosphere vary greatly in their transport and deposition properties. Elemental mercury vapor {Hg(0)} is relatively inert and has an atmospheric half-life measured in months to years, exerting its effect world wide. Particulate-associated mercury {Hg(p)} has a half-life of days to weeks, exhibiting a regional effect (several hundred kilometers). Reactive gaseous mercury {RGM or Hg(II)} has a half-life measured in hours and, if emitted in this form, is deposited on a local scale, i.e. largely within a few score kilometers.

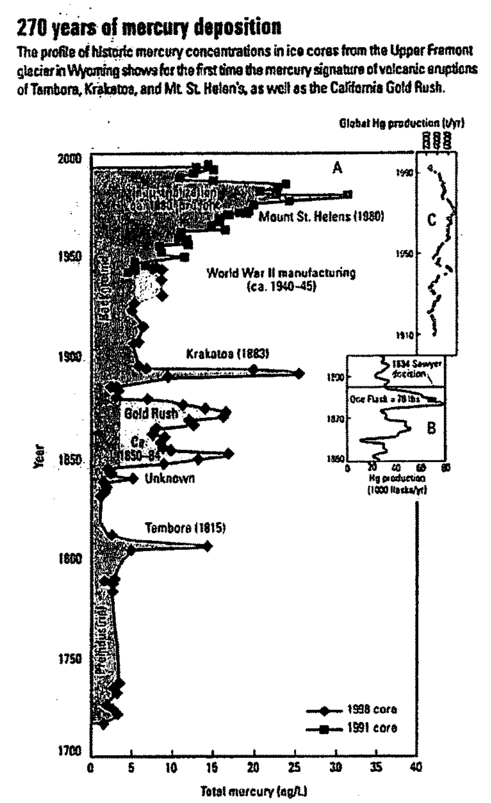

Figure 1. Long-term trends in mercury accumulation in ice cores from the Wind River Range, Wyoming, USA. Courtesy of USGS.

When looking at atmospheric loading from the frame of reference of a particular waterbody, the ability to distinguish global *vs.* regional *vs.* local scales of air transport and deposition is crucial to formulation of control strategy. Because of the geographic distribution of regional sources, and the fact that south Florida is meteorologically disjunct from the continental US, the scales important to the Everglades are local and global. This leads to the question: Is the source of mercury contributing to deposition into the Everglades predominantly coming from emissions sources within south Florida, or is it coming from long distance transport from sources around the globe? This pilot study asks: To what extent could abatement of south Florida mercury emissions reduce deposition on the Everglades and subsequent bioaccumulation in Everglades biota? This effort uses available data and mesoscale air and water models to address this question about local sources. It gives no direct information about the significance of global sources, which could limit the efficacy of local controls in reducing mercury concentrations in Everglades biota.

Although not directly relevant to the present analysis, which does not directly consider how global sources of mercury may affect Florida, it should be noted that complementary studies of mercury deposition in south Florida have yielded conflicting conclusions regarding the magnitude of global mercury sources. The present inability to directly gauge the relative importance of local vs. global sources, tells us that the scope of previous studies and some of the methods of sampling and analysis were limited in their ability to provide conclusive information. New, more specific and powerful methods have been developed, and are being applied in a series of studies over the next two years to ultimately enable us to answer this question with confidence.

2 PROBLEM STATEMENT

In 1989, monitoring by the Florida Fish and Wildlife Conservation Commission (FWC), the Florida Department of Environmental Protection (DEP), and the Florida Department of Health (DOH) revealed high levels of mercury in fish from the Everglades. Long known to be neurotoxic to humans, consumption of mercury-contaminated food had caused tragic illness and mortality in several episodes around the world. These findings led the Florida State Health Officer to issue Health Advisories urging fishermen not to eat some species of fish caught from the Everglades, and to limit consumption of largemouth bass and several other predatory fish species taken from many other fresh and coastal waters of Florida.

When extensive sampling was completed in the early 1990s, it was evident that approximately 1 million acres of the remnant Everglades system contained fish with high mercury burdens - largemouth bass averaged nearly 2.5 mg/kg mercury, which exceeded all health-based standards. More than another million acres of fresh waters in Florida contain largemouth bass with elevated but lesser levels of mercury. Were sampling to be comprehensive, we would expect mercury problems in bass to be found in one-half to two-thirds of Florida's waters. Florida DEP and USEPA have determined that inability to consume ones catch of sport fish at-will impairs recreation, a designated beneficial use of the affected waters.

This finding of excessive levels of mercury in fish is not limited to Florida. To date, over 40 states have issued health advisories restricting consumption of fish based on their mercury content, and similar problems are found broadly in North America, Europe and Asia.

2.1.1 Nature of the Everglades mercury problem

Mercury issues within the Everglades are extremely difficult to assess due to the size and heterogeneity of the Everglades, compounded by the complexity of mercury biogeochemistry. The gaps in scientific knowledge needed to control this problem are being addressed by a consortium of government and private agencies[2] collaborating as the South

[2] Florida Department of Environmental Protection, South Florida Water Management District, U.S. Environmental Protection Agency, Florida Electric Power Coordinating Group, Florida Fish and Wildlife Conservation Commission, and U.S. Geological Survey. Other SFMSP collaborators include the Academy of

Florida Mercury Science Program (SFMSP). The SFMSP goal is to elucidate the processes governing the environmental cycle of mercury through monitoring, modeling and research and to recommend sound management strategies for the mercury problem.

It is now generally accepted that this widespread mercury problem is caused by human activities that result in air emissions of mercury. Major sources to the atmosphere are municipal waste combustors (MWC), medical waste incinerators (MWI), metals mining and smelting; coal-fired utilities and industry; and the mining, smelting, use and disposal of mercury itself. The unusually severe problem in the Everglades has many unique features, and may be the result of a combination of factors (SFWMD, 1999, 2000, 2001, 2002). Both long distance transport and localized deposition around certain types of sources are important. The principal concerns there focus on local effects of waste incinerators and other emissions sources in southeast Florida, increased release of mercury or other substances from the Everglades Agricultural Area promoted by drainage and soil disturbance, or hydrologic changes.

The SFMSP has sponsored a series of projects related to this issue such as the Florida Atmospheric Mercury Study (FAMS), South Florida Atmospheric Mercury Monitoring Pilot Study (SoFAMMS), Florida Everglades Dry Deposition Study (FEDDS), Speciated Atmospheric Mercury Study (SAMS), USEPA Regional Environmental Monitoring and Assessment Program (REMAP), Speciated Atmospheric Mercury Profiling Experiment (SAMPEX) and the USGS Aquatic Cycling of Mercury in the Everglades (ACME) program. Numerous publications have resulted[3]. The South Florida Water Management District and the Florida Fish and Wildlife Conservation Commission (FWC) also have ongoing monitoring programs. Data from these programs were used extensively to develop and calibrate the models applied in this assessment.

2.1.2 Rationale for a TMDL approach

From its inception, the SFMSP approached the Everglades mercury problem as a multimedia one. The conceptual model encompassed three major processes – atmospheric sources and cycling, aquatic cycling, and bioaccumulation – and the linkages between them. Components addressed in this analysis include sources of mercury, and environmental media including air, water, sediments, and biota.

When renewed emphasis on the TMDL process emerged in the late 1990's, the approach being taken by the SFMSP was compatible; thus further monitoring, modeling and research have been coordinated with the long-term goals of the TMDL approach. Because of the extensive data collected and models developed by the SFMSP through the 1990's, USEPA in 1999 solicited Florida's participation as one of two states for pilot studies of how to

Natural Sciences of Philadelphia, Electric Power Research Institute, Florida International U., Florida Power and Light Co., Florida State U., National Oceanic and Atmospheric Administration, Oak Ridge National Laboratory, Texas A & M U. at Galveston, U. of Florida, U. of Miami, U. of Michigan, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and U.S. National Park Service.

[3] For a partial bibliography see: http://www.floridadep.org/labs/mercury/index.htm

rationally incorporate deposition of air pollutants in the TMDL process. Thus began what is termed the Florida Mercury TMDL Pilot Study.

For this project, we chose a site within Everglades Water Conservation Area 3A, Site 3A-15, because of the richness of data from that region (3A-15 was one of the USGS ACME intensive study sites, and there existed an extensive water quality database for the region from the USEPA REMAP project). This site was also known to have high concentrations of mercury in fish. It is important to recognize that, although the Everglades is widely recognized as a large freshwater wetland, it is by no means homogeneous; rather, it comprises a host of diverse environments of different types of vegetative assemblages and environmental gradients. Likewise, mercury concentrations in water, sediments, and biota also are spatially heterogeneous. Thus, the results from this pilot analysis cannot and should not be extrapolated to any other portion of the Everglades.

This pilot TMDL evaluates various scenarios of atmospheric emissions from point sources in south Florida and simulates the effects of these atmospheric loadings on bioaccumulation in top predators in the Everglades aquatic system. Key to the approach is the linkage of atmospheric deposition models (Hybrid Single Particle Lagrangian Integrated Trajectories Model, version 4 [HYSPLIT_4] and Regional Atmospheric Modeling System [RAMS]) with the Everglades Mercury Cycling Model (E-MCM) to estimate mercury concentrations in predatory fish (i.e., largemouth bass). Detailed reports containing the results of these models are provided as Appendices I and II to this document. A summary of the relevant results from the modeling efforts is provided in this report.

2.2 Description of TMDL Process

Water quality standards are established to protect the designated uses of Florida's waters. When States, Tribes or local communities identify problems in meeting water quality standards, a TMDL can be a framework for addressing those problems. The purpose of this demonstration project is to explore the utility of using atmospheric and mercury-cycling models within the TMDL framework and to provide the stakeholders with technical information that may be used to develop a water quality plan to address mercury issues in the Everglades.

Section 303(d) of the Clean Water Act (CWA) requires states to identify the waters for which the effluent limitations required under the National Pollutant Discharge Elimination System (NPDES) or any other enforceable limits are not stringent enough to meet any water quality standard adopted for such waters. The states must also prioritize these impaired water bodies for TMDL development, taking into account the severity of the pollution and the beneficial uses of the waters.

A TMDL represents the maximum amount of a given pollutant that a particular waterbody can assimilate without exceeding surface water standards. The TMDL can be expressed as the total mass of pollutant that can enter the water body within a unit of time. For this pilot TMDL, it is the total mass of atmospherically and water-borne mercury that enters the Everglades. In most cases, the TMDL determines the allowable mass per day of a pollutant and divides it among the various pollution sources in the watershed as waste load (i.e., point source discharge) and load (i.e., non-point source) allocations. The TMDL also accounts for natural background sources (e.g., atmospheric deposition derived from global sources) and provides a margin of safety.

Although this document is not a TMDL determination *per se*, we list the elements of TMDLs as described in USEPA guidance to put this pilot effort in context. Specifically, we discuss how this document compares with those elements, and in what additional elements work would be needed to fully develop a TMDL. Some of these elements are required under the Clean Water Act, while others are elements recommended in USEPA guidance. The following eight elements represent USEPA Region 4 TMDL guidance:

1. **Plan to meet State Water Quality Standards:** Although not explicitly required by the USEPA guidance for TMDL analyses, it is desirable to include a study and plan for the specific water and pollutants that must be addressed to ensure that applicable water quality standards are attained.

2. **Describe quantified water quality goals, targets, or endpoints:** The TMDL must establish numeric endpoints for the water quality standards, including beneficial uses to be protected, as a result of implementing the TMDL. This often requires an interpretation that clearly describes the linkage(s) between factors impacting water quality standards.

3. **Analyze/account for all sources of pollutants.** All significant pollutant sources are described, including the magnitude and location of sources.

4. **Identify pollution reduction goals.** The TMDL plan includes pollutant reduction targets for all point and non-point sources of pollution.

5. **Describe the linkage between water quality endpoints and pollutants of concern.** The TMDL must explain the relationship between the numeric targets and the pollutants of concern. That is, do the recommended pollutant load allocations exceed the loading capacity of the receiving water?

6. **Develop margin of safety that considers uncertainties, seasonal variations, and critical conditions.** The TMDL must describe how any uncertainties regarding the ability of the plan to meet water quality standards will be addressed. The plan must consider these issues in its recommended pollution reduction targets and must provide reasonable assurances that the appropriate load reductions will be implemented.

7. **Provide implementation recommendations for pollutant reduction actions and a monitoring plan.** The TMDL should provide a specific process and schedule for achieving pollutant reduction targets. A monitoring plan should also be included. especially where management actions will be phased in over time and to assess the achievement and validity of the pollutant reduction goals.

8. **Include an appropriate level of public involvement in the TMDL process.** This is usually met by publishing public notice of the TMDL, circulating the TMDL for public comment, and holding public meetings in local communities. Public involvement must be documented in the state's TMDL submittal to USEPA Region 4.

The elements of a TMDL required by statute are loading capacity, wasteload allocation, load allocation, margin of safety, and seasonal variation.

2.2.1 Current Status of addressing TMDL Elements

This analysis addresses of 5 of the 8 elements of the TMDL process, described below:

1. **Describe quantified water quality goals, targets, or endpoints.** The present quantitative endpoints for mercury in Florida waters derive from its propensity for bioaccumulation in aquatic food webs, presenting chronic health risks to humans and wildlife that eat large amounts of fish. The quantitative endpoints for human health are the DOH guidelines for mercury health advisories to fishermen, detailed in section 3.3 of this report, specifically in Table 4. Florida Department of Health guidelines for mercury in fish consumption advisories.
2. **Analyze and account for all sources of pollutants.** The primary sources of mercury to the Everglades are storm water runoff via canal structures draining into the Everglades, and atmospheric deposition. The data given in **Table 1** (USEPA, 2001) define the proximate sources of the mercury load to the Everglades Protection Area (i.e. the water conservation areas and ENP). However, until apportionment of the mercury deposition between local emissions and global background sources has been resolved, this element cannot be completed to the extent of formulation of source-specific controls.

Table 1. EPA Mercury Loading. Comparison of Atmospheric vs. Surface Water Loading to the Everglades Protection Area

Year	Atmospheric Deposition Hg kg/yr.[4]	EAA Water Discharge Hg kg/yr.[5]
1994	238	2
1995	206	3-4

3. **Identify pollution reduction goals.** The pollutant reduction goal here is the reduction of atmospheric mercury deposition necessary to achieve mercury deposition needed to achieve a concentration in Everglades fish of less than 0.5 mg/kg. Within the limitations of the assumptions of the air and water models, the pollutant reduction goal for atmospheric deposition from locally derived sources has been estimated.

[4] Annual deposition derived from Florida Atmospheric Mercury Study (FAMS), 1993 – 1996.
[5] Derived from biweekly monitoring of 'into' structures discharging from the EAA into the Everglades Protection Area, USEPA, 1994 - 1996.

4. **Describe the linkage between water quality endpoints and pollutants of concern.** This is described by the modeling presented in Chapter 4 of this analysis, which suggests a strong direct relationship between inorganic mercury loads to the Everglades Protection Area from atmospheric deposition (**Figure 9**) and mercury concentrations in largemouth bass. In addition, modeling suggests a relatively rapid response of mercury in fish to changes in load (**Figure 10**).
5. **Develop margin of safety that considers uncertainties, seasonal variations, and critical conditions.** A margin of safety could be incorporated into the analysis as regards a human health reference dose for mercury, and in the atmospheric and aquatic modeling. This issue is discussed more fully in Section 5.3.

Because this is a pilot TMDL, none of the elements of the TMDL methodology has been completely resolved in this report. Key portions of Elements 2 - 6 are addressed, but these must be treated more exhaustively in later analyses. Addressing Element 7 awaits narrowing the uncertainties highlighted here. Both external[6] and internal peer review of this pilot study have been completed; comments from various stakeholders – public, private and interested parties – have been incorporated herein. As this document is not a complete TMDL analysis, the stakeholder review for the pilot – Element 8 – was not intended to fulfill the public review requirements for a TMDL. Review comments and responses are summarized in Appendix III.

2.3 Florida's 303(d) Process

Florida's rivers, streams, and lakes are spectacularly beautiful and are essential natural resources, supplying water necessary for public consumption, recreation, industry, agriculture, and aquatic life (DEP, 2000). DEP is responsible for preserving and maintaining the quality of Florida's waters. The TMDL program is a key component of a comprehensive approach to protecting water quality in Florida. As directed by Florida Statues, rules have been developed to give specific guidance for implementing the TMDL process. Rule 62-303. F.A.C (Impaired Waters Rule) defines the data and methodologies required for placing waterbodies on the impaired list.

DEP has developed a five-phase approach to eliminating water quality impairment through its 303(d) Process (Table 2). This integrates monitoring and evaluation on a five-year cycle to assess quality of all waters. Waterbodies listed in earlier assessment cycles have been placed on a 'planning list,' whereby further monitoring is initiated to validate the original listing and determine probable sources of the stressors causing the listing. This monitoring step was added because waters often were originally listed based on nominal data and information. The data analysis step provides detailed documentation of the water quality and serves as the basis for the development of the TMDL for waterbodies on the validated list.

[6] The first draft of this report was submitted to an independent panel for review. Those reviewers were:
Dr. Mark Cohen, NOAA Air Resources Laboratory
Dr. Kent Thornton, Principal Ecologist, FTN Associates, Ltd.
Dr. Joseph V. DePinto, LimnoTech, Inc.
Dr. Donald B. Porcella, Environmental Science and Management, Electric Power Research Institute
Dr. Robert P. Mason, Associate Professor, Chesapeake Biological Laboratory, University of Maryland

The TMDLs and other basin related issues are incorporated into a Basin Management Plan in consultation with local stakeholders. When water quality impairment is found, TMDL assessments are initiated.

Table 2. Steps in Florida's 303(d) Process
1. Initial Basin Assessment. Identification of waterbodies requiring restoration, protection, or TMDL development.
2. Coordinated Monitoring. Supplement existing data for TMDL development
3. Data Analysis and TMDL Development. Document water quality and conduct TMDLs
4. Basin Management Plan Development. Work with local stakeholders Incorporate implementation of TMDLs Address watershed goals
5. Begin Implementation of Basin Management Plan.

If additional data or closer examinations of existing data show that the water quality is impaired, then the most appropriate action to bring this water body back into compliance with its standard is pursued. Typically, this action would include completing a TMDL analysis for the drainage basin.

Changes in standards or the establishment of site-specific standards are the result of ongoing science-based investigations or changes in toxicity criteria from USEPA. Changes in designated uses and standards are part of the USEPA's surface water standards triennial review process and are subject to public review. Standards are not changed simply to bring the water body into compliance, but are based on existing uses and natural conditions.

Seventeen areas of the Everglades are included on Florida's 1998 Water Quality Limited Waters List (303(d) List) for violations due to fish consumption advisories for mercury, including WCAs 1, 2, 3, and Everglades National Park (ENP). The project study area, WCA 3A-15, is listed for fish consumption advisories for mercury (**Figure 2**).

2.4 Watershed

2.4.1 Overview

The Everglades are a naturally occurring wetland system that historically (i.e., prior to 1855) occupied the lower third of the Florida peninsula south of Lake Okeechobee (**Figure 2**). Hydrologically, the Everglades are part of the greater Kissimmee River-Lake Okeechobee-Everglades system that conveyed water from central Florida southward towards Florida Bay.

Water flowed southward through a "ridge and slough" landscape that consisted of sloughs, channels, sawgrass ridges, and tree islands (SFWMD, 1992a, 1992b, 1999, 2000, 2001).

During the 20th Century, the extent of the Everglades was significantly reduced and the spatial and temporal patterns in hydrology, fire, and nutrient supply altered (Davis and Ogden, 1994). Approximately half of the Everglades were drained for agriculture and urban development during the early to mid 20th Century. Presently, the north to south movement of water through the remnant Everglades is regulated by control structures at Lake Okeechobee and in the Water Conservation Areas (**Figure 2**).

GIS coverages for land use, land ownership, and vegetation types were obtained from BASINS2 (USEPA, 1998). Land usage is based on the Anderson Level 2 land classification system. Topographic information was obtained from BASINS2 (1:250,000 scale DEM).

2.4.2 Hydrology

The present Everglades system extends from the southern edge of Lake Okeechobee through the Everglades Agricultural Area (EAA), Water Conservation Areas and Everglades National Park to Florida Bay. The EAA has been diked and drained to supply land for agriculture. Water flows slowly in a southerly direction from Lake Okeechobee. The overall topographic gradient between Lake Okeechobee and Florida Bay is approximately 1 foot per 10 miles (0.3 m/16.1 km) (Davis and Ogden, 1994).

WCA-3A is contained by levees on three sides. On the western side it is only partially leveed to allow overland water flow from the Big Cypress swamp (Davis and Ogden, 1994). Major water inputs are from the S-11 structures (A, B, & C) and the S-8 and S-9 pump stations on the Miami Canal and the S-140 pump station that drains from Hendry County. Gravity drainage from the S-150 spillway also occurs at times. Within WCA-3A, ground elevation ranges from 7 to 10 feet above Mean Sea Level (Davis and Ogden, 1994).

Rainfall supplies approximately 70 percent of the annual water budget of the Water Conservation Areas (Davis and Ogden, 1994). The remainder comes from runoff from the EAA. Long-term average annual precipitation near WCA 3A ranges between 51.6 inches at a station near Lake Okeechobee, to 50.4 inches in the ENP (SERCC, 2000). During the period between 1970 and 1998, the station located at WCA 3A-S_R averaged 50.3 inches per year (SFWMD, 1999). The highest precipitation occurs from June through September with between 6 and 9 inches of rainfall per month. The winter months are considerably drier, with rainfall approximately 1 inch/mo.

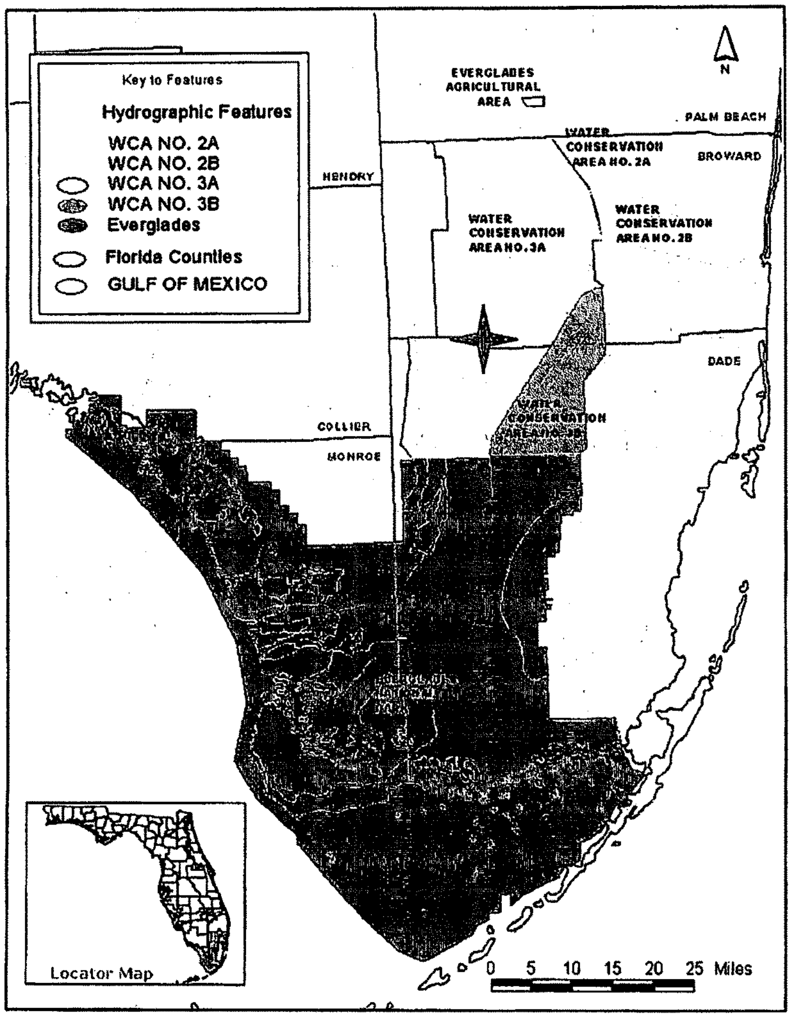

Figure 2. Location of Everglades watershed, Water Conservation Area 3A, and study site 3A-15.

The annual ambient air temperature is between 72 and 75 °F (22 – 24 °C), varying from an average monthly temperature of 62 to 66 °F (16.7 - 19 °C) in January to an average of 80 to 83 °F (26.7 - 28 °C) in August (SERCC, 2000). Minimum temperatures for January averaged 52°F (11 °C), and maximum temperatures for August averaged 91°F (32.8°C) between 1961 and 1990 (SERCC, 2000).

2.4.3 Physiographic Characteristics

Land elevations change only subtly throughout the Everglades. The average slope between Lake Okeechobee in the north and Florida Bay in the south is approximately 1:53,700 (Davis and Ogden, 1994).

Everglades soils consist predominantly of peat soils underlain by limestone deposits.

2.4.4 Vegetation and Land Use

WCA-3A is predominantly composed of wetlands dominated by herbaceous plants (95%), of which approximately 50% is comprised of sawgrass and cattails, approximately 45% is wet prairies, and some forested wetland areas (3.5%) do occur. Evergreen forests, mixed rangeland, and localized built-up areas make up the remaining 1.5 percent of the area (BASINS2, USEPA, 1998).

WCA 3A provides flood protection and water supply to residents in southeast Florida. In addition, this area provides fish and wildlife habitat as well as recreational opportunities (e.g., fishing).

2.5 Existing Conditions and Summary of Monitoring Data

Several water quality parameters have been identified as having an impact on concentrations of total and methylmercury in freshwater systems. In particular, dissolved organic carbon, pH, sulfate (and sulfide), and chloride have received much attention. Table 3 shows the average values for water quality parameters at WCA 3A-15.

Mercury concentrations were measured in surface waters at WCA-3A-15 on 8 occasions between 1995 and 1998. Total mercury ranged from 1.05 ng/L to 2.70 ng/L and averaged 1.94 ng/L (Krabbenhoft, *et al.*, 1998). Largemouth bass (*Micropterus salmoides*) were collected at WCA 3A-15 on 5 occasions between December 1996 and November 1998 by the FWC (Lange, *et al.*, unpublished data). Fish ranged in length from 12 cm to 51 cm. Mercury concentrations in the tissue ranged from 0.45 mg/kg to 4.3 mg/kg (**Figure 3**).

Table 3. General Water Quality Characteristics of WCA 3A-15.	
Parameter	Value
Dissolved organic carbon	~ 16 mg/L
Surface water pH	~ 7.2
Surface water chloride	~ 5 mg/L
Surface water sulfate	100 μeq/L
Sedimentation rate	< 1 cm/yr.
Total suspended solids	~ 2 mg/L
Fraction of marsh with open water	<50%
Periphyton density	High
Macrophytes	Includes sawgrass, cattails, water lilies

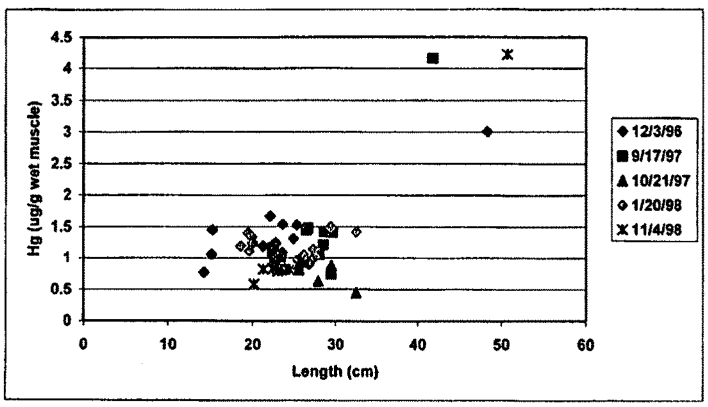

Figure 3. Methylmercury concentrations in largemouth bass in WCA 3A-15. (Lange, *et al.* unpublished data).

2.6 Identification of Violated Water Quality Standards and Impaired Designated Uses

Under the federal Clean Water Act, states are responsible for establishing, reviewing, , and revising water quality standards. The components of the surface water quality standards system include: classifications, water quality criteria, an antidegradation policy, and special protection of certain waters. Florida has five classes of waters with associated designated uses, which are arranged in order of degree of protection required:

Class I - Potable Water Supply
Fourteen general areas throughout the state including: impoundments and associated tributaries, certain lakes, rivers, or portions of rivers that are used as a drinking water supply.

Class II - Shellfish Propagation or Harvesting
Generally coastal waters where microbial water quality allows for commercial shellfish harvesting.

Class III- Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife
The surface waters of the state are Class III unless otherwise described in rule 62-302.400 of the Florida Administrative Code. These uses are also protected for all Class I and Class II waters.

Class IV- Agricultural Water Supplies
Generally located in agriculture areas around Lake Okeechobee.

Class V - Navigation, Utility and Industrial Use
Currently, there are no Class V water bodies.

To protect the present and future most beneficial uses of these waters, water quality criteria have been established for each classification. While some of these criteria are intended to protect aquatic life, others are designed to protect human health. Water quality standards, described in Rules 62-302.500 and 62.302.530, F.A.C, are expressed as either numeric (a specific concentration which cannot be exceeded) or narrative (used to describe a condition that is not desired). All of the Everglades, including Water Conservation Area 3A, is classified as a Class III water body. This designation means its waters are to be suitable for recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife.

Florida's Class III water quality criterion of 12 ng/L for total, unfiltered mercury has not been exceeded in either the Everglades marsh, or in tributary waters. However, the Department of Health (DOH) fish tissue guidance concentration of 0.5 mg/kg is currently exceeded throughout areas of the marsh, prompting the issuance of fish consumption advisories by the Florida State Health Officer. DEP recognizes that health advisories impair recreation and that this means that the current water quality criterion, which is met, is of limited utility.

Furthermore, as regards protection of Everglades wildlife, risk assessments conducted by the SFWMD (Fink *et al.*, 1999) as part of the South Florida Mercury Science Program have identified the potential for adverse effects from mercury for wading birds. A preliminary risk assessment for the Florida panther (*Felis concolor coryi*, a Federally-listed endangered species), indicates that this species may be at risk from methylmercury, particularly in areas where panthers consume prey that feed on fish-eating wildlife.

Detailed discussions of the atmospheric and aquatic fate and transport processes are provided in the modeling technical support documents (Keeler, *et al.*, 2001; Tetra Tech, 2001) prepared to support this analysis. These documents are provided as Appendices I and II.

2.7 Identification of Pollutants Being Addressed and Why

This TMDL addresses the trace element mercury in its various environmental forms. The behavior of mercury in the environment is highly complex with each of the several chemical forms behaving differently. Methylmercury, formed from inorganic mercury by sulfate-reducing bacteria in the sediments is the most biologically active form. Once formed, methylmercury is readily taken up and retained by organisms and tends to increase in concentration in higher trophic levels (i.e., biomagnifies). Although at ambient levels methylmercury does not appear to significantly affect plants, invertebrates, or fishes, when biomagnified, as in the Everglades 1 to 10-million fold, it poses the risk of chronic neurotoxicity to birds and mammals, including humans.

Previous work in the Everglades has shown that the dominant input of mercury (95%) to the WCA 3A is from atmospheric sources (USEPA, 1998; SFWMD, 1999). The remainder of the mercury enters the system via overland flow from tributary watersheds.

3 NUMERIC TARGETS AND WATERSHED INDICATORS

This section identifies the selection of water quality targets for the TMDL. An objective of a TMDL is to define a safe concentration, in this case, of mercury. Additionally, this section develops a source allocation (air and water) that will allow the water quality goal to be met.

3.1 Numeric Targets

Because of the biogeochemical cycling of mercury between the earth and the atmosphere, and because many factors affect its availability and propensity for bioaccumulation, mercury poses unique problems in setting numeric targets. No simple relationship links mercury concentrations in water and mercury concentrations in fish; the relationship is site specific.

Using previous (1984) USEPA guidance, Florida in 1992 adopted a Class III water quality criterion for total (unfiltered) mercury of 12 ng/L, which was believed adequate at the time to prevent excessive mercury accumulation in fish such that these fish could be consumed without concern as regards human health effects. Subsequent studies have shown that mercury levels in fish exceed the DOH consumption advisory level of 0.5 mg/kg in many waters that met the Class III water quality criterion, including most of the Everglades. The Florida Department of Environmental Protection has determined that the inability of anglers to eat their catch at-will impairs recreation, a designated use of Class III waters. Through its participation in the SFMSP and this TMDL study, DEP is working to develop sufficient information to establish a mercury criterion that will protect all of the beneficial uses.

Since it is fish mercury levels rather than mercury concentrations in water that have the potential to impair both the recreational use and protection of fish and wildlife designated uses of Class III Florida waters, a fish mercury level is a more appropriate criterion for this pilot project. A fish mercury criterion integrates those site-specific biogeochemical and food web effects that result in bioaccumulation. While prediction of fish mercury levels from atmospheric loading is a complex endeavor, it is not significantly more complex that predicting mercury concentrations in water, and it is a far better indicator of effects on beneficial uses. In recognition of this, in 2000 the USEPA issued a new human health methylmercury criterion as a fish tissue criterion.

For this TMDL pilot project, a numeric target of 0.5 mg/kg total mercury in age 3 largemouth bass has been selected, as this is currently the level which Florida uses as the basis for fish consumption advisories. Whether this numeric target is protective of human health or wildlife populations awaits further review (see below).

3.2 Identification of Watershed Indicators

Mercury concentration in the edible flesh of fish determines whether the recreational use of a waterbody is impaired. Mercury concentration in prey fish determines whether the fish and wildlife use is impaired. The indication of impairment in wildlife is wildlife daily dietary mercury consumption in comparison to the maximum, safe daily dose. The maximum, safe daily dose is not known for any Everglades species, but is inferred with unknown uncertainty for wading birds from mallard duck feeding studies. Safe daily dose must be determined for the species of interest and compared with actual exposure. Without this information, there is no basis for establishing a margin of safety.

3.3 Identification of Target Levels to be Protective of Beneficial Uses

The Everglades Protection Area (i.e. the water conservation areas and ENP) are designated as Class III waters of the State, which are to be protected for recreation and for the propagation and maintenance of a 'healthy, well-balanced population of fish and wildlife.'

Following the finding in 1989 of elevated levels of mercury, the Florida Department of Health, Toxicology and Hazard Assessment Section, surveyed the literature and consulted toxicologists in other states as to risks posed to fishermen and their families. DOH developed advisories to the public in general accord with exposure limits then recommended by the World Health Organization and other states. Since the late 1980's, several studies, re-analyses and meta-analyses have been conducted to further refine estimates of acceptable human exposure to mercury.

In its Mercury Study Report to Congress (USEPA, 1997), USEPA proposed lowering its 'reference dose' for methylmercury from 0.3 µg/kg body weight/day to 0.1 µg/kg body weight/day. Congress referred this risk assessment to the National Research Council for independent review, and in 2000 the National Research Council gave substantial support to the new USEPA reference dose. Subsequently, in late 2000, USEPA published a new recommended water quality criterion for mercury of 0.3 mg/kg, expressed as methylmercury in fish flesh. This recommended criterion will be considered in due course by DEP through the Clean Water Act mandated Triennial Review process.

Pending reevaluation of standards, Florida DOH guidelines (Clewell, et al., 1998) for acceptable concentrations of total mercury in the edible portions of wild-caught fish are those given in Table 4.

Table 4. Florida Department of Health guidelines for mercury in fish consumption advisories.

Advisory	Mercury Concentration
See information provided by USEPA below [7]	Less than 0.5 mg/kg
Limited Consumption – fish should not be eaten more than once per month by women of childbearing age or children, nor more than once per week by other adults.	0.5 to 1.5 mg/kg
No Consumption – fish should not be eaten	Greater than 1.5 mg/kg

Note from **Table 4** that fish tissue total mercury concentrations greater than 0.5 mg/kg result in the establishment of fish consumption advisories. (For high trophic level fish, such as largemouth bass, total mercury and methylmercury concentrations are essentially equivalent.) DEP has made the determination that recreational use necessitates that fish not only be present and available to anglers, but also that these fish must be safe to eat.

Mercury concentrations in fish tissue currently exceed the 0.5 mg/kg fish consumption advisory level throughout the Everglades/Big Cypress system, and exceed the 1.5 mg/kg level in parts of Water Conservation Areas 2, and 3, and in the freshwater portions of Everglades National Park.

Mercury bioaccumulates in the aquatic food chain. Therefore, top predators such as the largemouth bass can be expected to accumulate the greatest concentrations of mercury. This pilot TMDL uses the Florida DOH guideline for acceptable mercury concentration in fish of 0.5 mg/kg in 3-year-old largemouth bass as the numeric target, because this is currently the level that Florida uses as the basis for fish consumption advisories. Three-year-old (*ca.* 1000 g) bass were selected as the appropriate index of ingestion exposure because this size class is legally harvestable, abundant, and is the most prevalent cohort in the angler's catch (F. Ware, personal communication).

The pilot TMDL study indicates that mercury from atmospheric deposition needs to be reduced to achieve the desired fish tissue concentration. The target range for mercury and possible strategies for attaining the desired levels of mercury are provided in Chapter 4 *Air and Watershed Modeling* and Chapter 6 *Conclusions, Research Needs and Plans,* of this report.

[7] The USEPA recommends women of childbearing age eat no more than 8 ounces of freshwater fish caught by family and friends in a week's time period; children under 10 should eat no more than 4 ounces. For further details on the EPA advisory see world wide web: http://www.epa.gov/ost/fishadvice

3.4 Comparison of Numeric Targets and Existing Conditions

This section assesses how far the water quality parameters of concern for WCA 3A must change in order to comply with the stated water quality standards for the water body. **Table 5** gives the existing water quality conditions, the desired water quality endpoints, and comments.

Table 5.
Comparison of Existing Conditions to Water Quality Endpoints

Parameter	Existing Value (Mean and range)	Water Quality Endpoint	Comments
Mercury in ambient water (ng/L)	1.94 (1.05 – 2.70)	Florida Class III Water Quality Standard: < 12ng/L	This value is designed to ensure that water standards are met.
Mercury in edible sport fish tissue (mg/kg)	1.28 (0.45 – 4.3)	Florida DOH fish consumption advisory: < 0.5 mg/kg	Concentrations greater than this value trigger the issuance of fish consumption advisories by DOH.
Mercury in whole prey fish (mg/kg)	0.1 mg/kg provisional USFWS standard	Safe tissue concentration for propagation and maintenance of a healthy, well-balanced population of fish and wildlife	This value is estimated to be protective of fish-eating wildlife and animals that feed on them.

4 AIR AND WATERSHED MODELING: SOURCE ANALYSIS FOR LOADINGS, MERCURY MASS BALANCE, LINKAGE OF STRESSORS TO WATER QUALITY ENDPOINTS

This section summarizes the methods and results of the atmospheric modeling (Keeler *et al.*, 2001) and aquatic mercury cycling (Tetra Tech, 2001) modeling efforts used in this project. Full details of the modeling efforts can be found in the Technical Reports provided as Appendix I (Atmospheric Model) and Appendix II (E-MCM) of this report.

There are four primary forms of mercury considered in the models: three of these are methylmercury {MeHg}, divalent mercury salts and compounds {Hg(II)} and elemental mercury {Hg(0)}. Hg(II) is explicitly defined here as all divalent inorganic mercury (other than particulate associated divalent inorganic mercury). The fourth form is Hg(p) representing divalent inorganic mercury {Hg(II)} that is associated with suspended particulate matter in water or air. Provisions have also been made in the E-MCM for some of the particulate Hg(II) on non-living solids in water to exchange slowly, while the remainder is assumed to exchange rapidly enough to assume instantaneous partitioning.

4.1 Technical Approach

Two modeling components were employed for this project. The first modeling approach, developed by the University of Michigan Air Quality Laboratory (UMAQL), was used to simulate the atmospheric transport of mercury from point sources in southern Florida to its deposition onto the Everglades (Keeler, *et al.*, 2001; Appendix I). The second model, the Everglades Mercury Cycling Model (E-MCM), was used to simulate the fate and transport of the mercury within the aquatic environment (Tetra Tech, 1998, 2001; Appendix II). The E-MCM provides estimates of the rates of mercury methylation and bioaccumulation through the food chain to a top-level predatory fish (largemouth bass). Detailed descriptions of these models and uncertainties are provided in the referenced technical support documents for this analysis.

4.1.1 Source Analysis of Loadings

Sources evaluated in this study include both atmospheric emissions and surface water inputs of mercury. The atmospheric source characterization was based on the emissions database used for the RELMAP (Bullock, *et al.*, 1997) modeling simulations performed for the USEPA Mercury Study Report to Congress (USEPA, 1997). The USEPA mercury emissions database includes speciated data for both area- and point-source emissions, with a summary of the standard speciation profiles used for point-source emissions listed in **Table 6. Figure 4** shows the location and relative magnitude of the 38 point sources considered in this analysis. The analysis of Dvonch, *et al.*, (1999) utilizing receptor modeling and emissions inventory scaling techniques, estimated the importance of local mercury sources potentially impacting south Florida. That analysis indicated that approximately 92% of the total mercury deposition to south Florida could be accounted for by local sources alone. Thus, this analysis was limited to Florida sources and a complete listing of the point sources used in this study can be found **in Table C1** of Appendix I. The USEPA mercury emissions database considered 'area source' emissions to be only mercury in the elemental form, Hg(0), and these accounted for only 2 percent of the total emissions. As a result, area sources were not considered in this study.

Table 6.
Mercury Speciation Percentages Used In Current Study

Mercury Emission Source Type	Speciation Percentages		
	Hg(0)	Hg(II)	Hg(p)
Municipal Waste Combustion	20	60	20
Medical Waste Incinerators	2	73	25
Electric Utility Boilers (coal, oil, gas)	50	30	20
Commercial and Industrial Boilers	50	30	20
Hazardous Waste Incinerators	As specified per location in USEPA database		

Mercury inputs to WCA 3A-15 via surface water flow were based on data collected as part of the USGS ACME study (Krabbenhoft, *et al.*, 1998, *et al.*, 1998, Hurley, *et al.*, 1998, Cleckner, *et al.*, 1998). For these studies, surface water was collected at several sites, including site 3A-33, located *ca.* 50 km upstream of 3A-15, for analysis of total and methylmercury. The average concentrations of unfiltered Hg(II) and unfiltered methylmercury at 3A-33 were 2.14 and 0.27 ng/L respectively for 7 sampling dates between December 1996 and November 1999 [unfiltered Hg(II) is derived as the difference between measured Hg_{tot} and unfiltered MeHg]. These concentrations were assumed to be the surface inflow concentrations for site 3A-15.

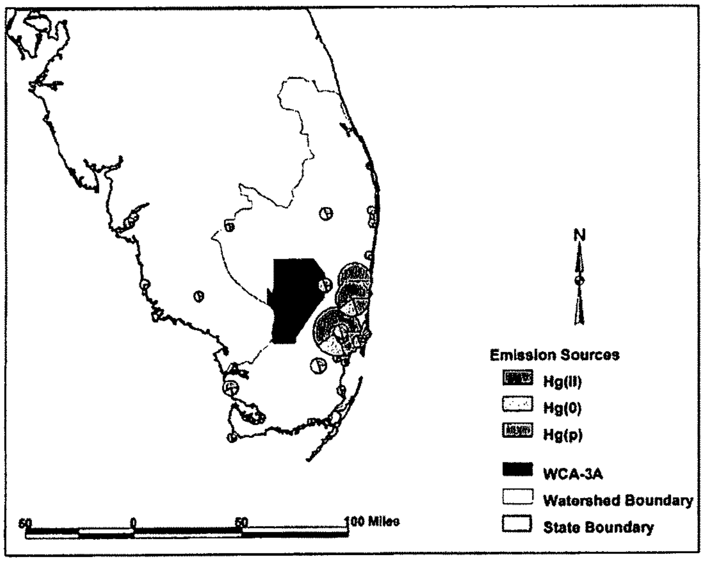

Figure 4. Locations and relative magnitudes of atmospheric point sources of mercury in south Florida.

4.2 Atmospheric Transport and Deposition Modeling

4.2.1 Approach Overview

The modeling conducted by UMAQL to link local emissions of mercury with deposition in south Florida and at site 3A-15 involved a 'hybridized' modeling approach (**Figure 5**). Two types of models were used to ultimately obtain estimates of the monthly and annual wet- and dry-deposition of speciated mercury {Hg(0), Hg(II) and Hg(p)} to the South Florida Water Management District's Water Conservation Area 3A (SFWMD WCA-3A). The first was a mesoscale meteorological model (Regional Atmospheric Modeling System {RAMS}; Pielke, *et al.*, 1983), which provided the meteorological components driving and influencing air parcel transport and mercury species deposition. The second was a Lagrangian air-pollution dispersion/deposition model to estimate average wet- and dry-deposition patterns and amounts (HYbrid Single Particle Lagrangian Integrated Trajectories Model Version 4 [HYSPLIT_4]; Draxler and Hess, 1997). Because simulating every day of the year-long study period would be prohibitively time- and resource-intensive, a clustering approach was adopted to identify distinct meteorological flow regimes which would likely lead to distinct wet- and dry-deposition patterns. Weighting each cluster by its annual frequency of occurrence in turn yielded an estimate of monthly and annual deposition.

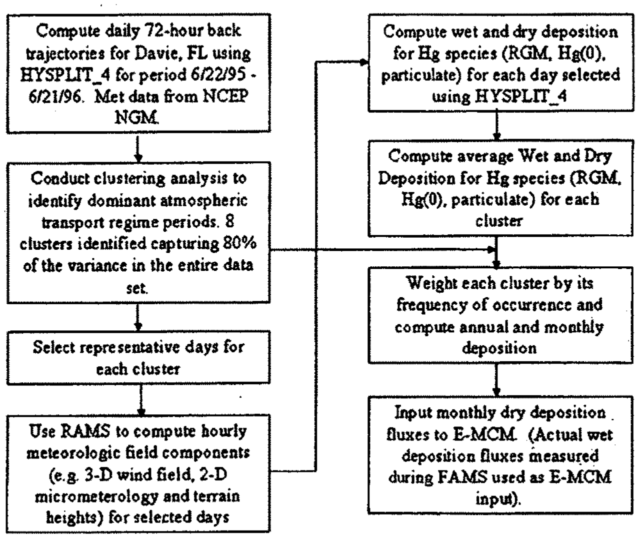

Figure 5. Schematic depiction of hybridized meteorological-atmospheric dispersion, transport and deposition modeling approach used to simulate Hg deposition in the WCA-3A by UMAQL. RGM is reactive gaseous mercury, believed to be Hg(II).

The specific steps employed in this hybrid approach are as follows:

(1) Compute daily back-trajectories (for air parcels arriving in Davie, FL) for each day of a one-year study period (22 June 1995 to 21 June 1996) during which precipitation was collected on an event (i.e., daily) basis at the University of Florida Agricultural Experiment Station in Davie, FL.

(2) Identify meteorological clusters, or groups, of back-trajectories that represent the dominant atmospheric transport regimes that impacted south Florida during the one-year study period.

(3) Select a number of representative days from each cluster and use RAMS to obtain hourly three-dimensional meteorological fields (U and V wind components, vertical velocity, temperature, specific humidity and pressure) and two-dimensional meteorological fields (terrain height, mean sea-level pressure, total precipitation, pressure, temperature, and micrometeorological parameters, which include u*, t* and q*) for the selected representative days.

(4) Using the three-dimensional and two-dimensional meteorological fields computed in part (3) as input fields; use HYSPLIT_4 to estimate average wet- and dry-deposition patterns/amounts for each of these representative days, computing a cluster average deposition for each of the clusters. HYSPLIT_4 was modified by UMAQL to

incorporate both basic mercury physical parameters and chemical processes, and include the ability to simulate the fate of the various mercury species important in the atmospheric deposition of mercury.

(5) Weight the average daily wet- and dry-deposition estimates for each cluster by the number of days assigned to each cluster, and thus obtain an estimate of the speciated monthly and annual wet- and dry-depositional loading of mercury to the SFWMD WCA-3A.

As mentioned above, climatological records for the one-year period from 22 June 1995 to 21 June 1996 were used to characterize the climatological conditions in the Everglades. This period was chosen as the 'year of record' because precipitation chemistry for mercury had been collected on an event (i.e., daily) basis at the University of Florida Agricultural Experiment Station in Davie, FL. How representative this one-year meteorological record was relative to the overall meteorologic regime of the area was investigated as part of this study (Keeler, *et al.*, 2001). The results indicated that the study year was indeed representative of meteorological conditions over the eight-year period from 1991-1999, in terms of the frequency of the 8 meteorological clusters. However, average precipitation depth for 3 south Florida FAMS sites was 156 cm, somewhat higher than the long-term average range of 125 – 140 cm.

The input data used for the calculation of the daily back-trajectories consisted of analysis of short-term forecasted meteorological fields from the National Center for Environmental Prediction's (NCEP) Nested Grid Model (NGM). The standard NGM model domain encompasses the contiguous United States and Canada with a latitudinal and longitudinal grid spacing of approximately 90 km.

Early research suggested that the atmospheric deposition of mercury to south Florida is dominated by wet deposition, with the majority of this deposition associated with summertime convective precipitation events (Guentzel *et al.*, 2001, Dvonch *et al.*, 1999). The convective events responsible for the preponderance of wet deposition typically occur during the mid- to late-afternoon hours in south Florida and thus daily back-trajectories were calculated for 2000 GMT each day. The modeled analysis of dry deposition conducted as part of this study, however, suggests that dry deposition is important as well, comprising perhaps 34 to 40% of the total mercury deposition signal.

A number of previous regional atmospheric modeling studies have employed objective analyses of meteorological flow regimes to assess annual impacts from briefer intensive studies. Cluster analysis is an objective mathematical technique whereby large data sets can be divided into similar groups or clusters that reflect some underlying structure within the data set. For this analysis, the goal was to identify meteorological flow regimes which would likely lead to distinct wet- and dry deposition patterns. Weighting each cluster by its monthly and annual frequency of occurrence results in an estimate of the monthly and annual deposition without the necessity of modeling every day of the 1-year period studied.

Following the completion of the objective clustering of the back-trajectories, Daily Weather Maps from NOAA were used to evaluate each day of the year-long period to determine if the clustering resulted in an accurate representation of meteorological flow regimes. This hand analysis of the daily maps provided independent validation of the trajectory clustering approach.

Eight different atmospheric transport clusters were obtained through this analysis procedure, and a summary of these is presented in **Table 7**. For each meteorological cluster, the measured rainfall depth, volume-weighted mean mercury concentration, and the total mercury wet deposition are given from the Davie Monitoring site. The efficacy of the clustering technique is evident, with Meteorological Clusters 3 & 6 resulting in the majority of wet deposition of mercury. This data provides impetus for continuation of the hybrid modeling using the clustering and aggregation approach described later. Plots showing the general nature of each of the clustered back-trajectory groups can be found in Appendix A of Appendix I. Maps of the surface meteorological features for days representative of each cluster can be found in Appendix B of Appendix I.

Table 7.
Summary of "clustered" atmospheric transport regimes and precipitation statistics associated with each cluster based upon data collected at Davie, Florida during the 1995-96 SoFAMMS study period.

Cluster Number	Description of flow regime represented	No. of Days within cluster	No. of Days with Rainfall (Davie, FL)	Total Rainfall for Cluster (cm) (Davie, FL)	Volume Weighted Mean Hg Concentration for Cluster (ng/L) (Davie, FL)	Total Hg Wet deposition observed (μg/m²) (Davie, FL)
1	Weak local flow, variable in direction	65	18	12.1	31.8	3.84
2	Weak synoptic flow from north	35	5	2.7	29.2	0.79
3	Moderate local/synoptic flow from east	104	30	26.2	20.9	5.47
4	Strong synoptic flow from northeast.	48	8	22.1	10.8	2.39
5	Strong synoptic flow from northwest	32	9	6.9	10.6	0.73
6	Moderate synoptic flow from south	58	29	94.0	14.5	13.64
7	Moderate synoptic flow from southwest	11	4	8.7	12.8	1.12
8	Strong synoptic flow from north	13	1	0.1	7.1	.0.01

For each cluster, two wet days and two dry days were selected for use in the modeling exercise (**Table 8**). Where possible, these days were chosen such that they represented extremes in the spatial nature of the atmospheric transport and deposition for the given cluster. It was believed that in doing so, potential biases from choosing two days with nearly identical deposition patterns would be minimized.

Table 8.
Representative Cluster Days Chosen for Hybrid Modeling Exercise

Cluster Number	Wet Days	Dry Days
1	29 MAY 1996 09 SEP 1995	22 FEB 1996 27 JUN 1995
2	13 MAY 1996 16 AUG 1995	20 SEP 1995 06 JUN 1996
3	11 SEP 1995 13 JUN 1996	17 DEC 1995 30 MAR 1996
4	11 MAR 1996 29 SEP 1995	23 OCT 1995 07 FEB 1996
5	19 MAR 1996 09 APR 1996	17 FEB 1996 21 MAR 1996
6	23 JUN 1996 27 MAY 1996	13 APR 1996 07 MAR 1996
7	02 MAR 1996 15 OCT 1995	12 JAN 1996 22 MAY 1996
8	Not Modeled*	03 MAR 1996 23 DEC 1995

* No days with rain (>1mm) occurred during the year of record

4.2.2 Airshed Pollutant Loads

Atmospheric inputs of mercury to WCA 3A-15 were estimated for both wet and dry deposition as described above. The model estimates reported here were developed using the source-specific emissions rates and mercury speciation factors used in the USEPA Mercury Study Report to Congress. Two additional emissions scenarios were evaluated but not used in this analysis, as described in Appendix 1. Results from the dry deposition simulations were used, in conjunction with measured wet deposition rates, as input into E-MCM. Detailed discussions of the atmospheric modeling can be found in Appendix I.

Wet Deposition

These model results predicted a total mercury wet deposition of 18.74 ± 1.57 $\mu g/m^2/yr$. (± 1 standard deviation) to WCA 3A-15. The temporal variation in the wet deposition of total mercury to the WCA 3A-15 is presented in **Figure 6.** As would be expected from the marked seasonality of rainfall in south Florida, the model indicates a significant seasonal trend in total mercury wet deposition to the area, predicting that over 80 percent of the wet deposition would occur from May through October.

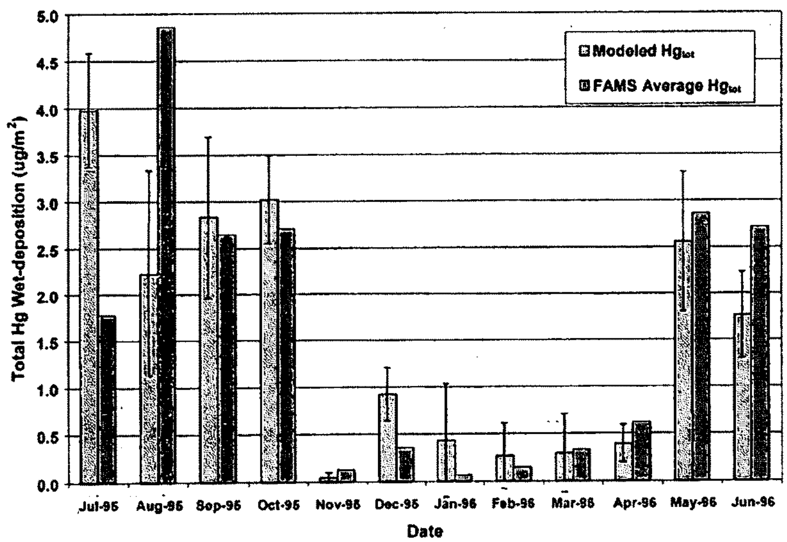

Figure 6. Comparison of the modeled monthly total mercury wet deposition to WCA 3A-15 and FAMS[8] observed total mercury wet deposition (average of Tamiami Trail Ranger Station and Andytown sites).

The speciated mercury wet deposition is presented in **Figure 7.** From this figure, it can be seen that the predicted total wet deposition of mercury is dominated by deposition of reactive gaseous mercury (RGM), believed to be in the form of Hg(II). In contrast, model results suggest that the deposition of gaseous elemental mercury, Hg(0), is negligible. Once again, the seasonal nature of the deposition is apparent.

[8] The Florida Atmospheric Mercury Study (FAMS) measured mercury deposition (both bulk and wet-only rainfall collection), particulate-associated mercury and total gas-phase mercury (TGM) at 9 sites in Florida (i.e. panhandle, north-central Florida, marine background site, 4 sites near the Everglades, and 2 sites in the southwestern peninsula). Long-term integrated samples were collected (monthly precip, weekly TGM and Hg(p). Operations began in 1993; all sites were operational by mid-1995 and operated through the end of 1996 (Pollman, *et al.*, 1995; Guentzel, 1997; Guentzel, *et al.*, 2001).

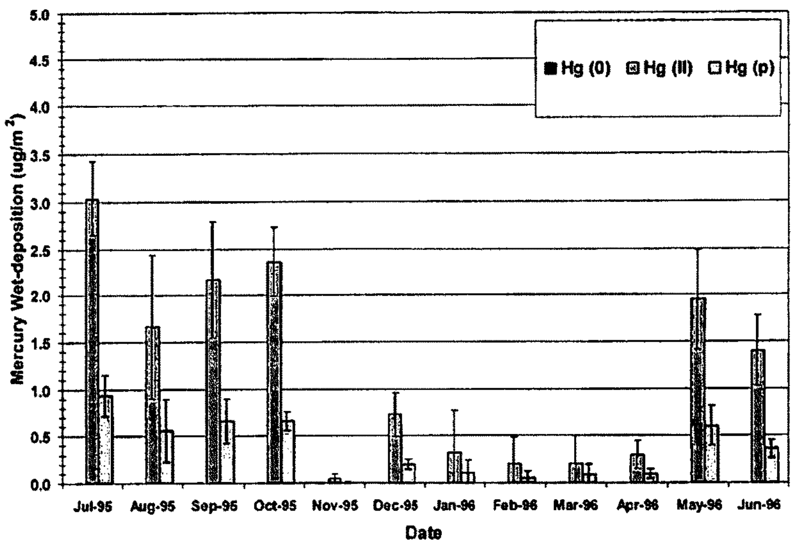

Figure 7. Modeled monthly speciated mercury wet deposition to WCA 3A-15.

Dry Deposition

The hybrid model estimates of the dry deposition of mercury to the WCA 3A-15 were performed for the same emissions inventory employed in the wet deposition modeling (Appendix I). As for the simulated wet deposition results, the results presented here use the emissions from the USEPA Mercury Report to Congress as input for the model.

The hybrid model estimate for dry deposition of mercury to WCA 3A-15 during the one-year period of record was 12.2 ± 2.0 $\mu g/m^2/yr$. (± 1 standard deviation). While considerable variability was evident in the monthly deposition estimates, on average, dry deposition to the site showed a seasonal trend, with relatively greater deposition occurring during the climatological wet season. As was the case for the wet deposition to WCA 3A-15, dry deposition to this area is dominated by the Hg(II) fraction. Note that the dry deposition estimate derives from local source emissions alone and includes no contribution from global background.

Levels of Hg(II) calculated by the model were the result of the dispersion and deposition of Hg(II) emissions from the USEPA Mercury Study Report to Congress (USEPA, 1997), not the result of Hg(II) production from atmospheric chemical reactions. Measurements of Hg(II) species in the atmosphere were not available due to the limitations of measurement techniques. In addition, based on our understanding of the rates of conversion of Hg(0) to Hg(II) at the time, the conversion of Hg(0) to RGM during passage from the coast to the Everglades was too slow to be significant, and therefore not included in these calculations.

By 1999 more robust techniques had been developed and field measurements were available for comparison with model results. Interestingly, the levels of Hg(II) predicted by the model were consistent with the values measured by the UMAQL and USEPA FEDDS and SAMPEX studies in south Florida during 1998 and 2000. Values of Hg(II) were measured and estimated by the model to range from 0 to 100 pg/m^3 and varied spatially and temporally across the eastern portion of the Everglades in Broward County.

Model-calculated total atmospheric deposition of mercury to WCA 3A, estimated as the sum of the wet and dry deposition, is approximately 30.94 ± 13.55.

One end point of the atmospheric modeling was selection of the appropriate loading term of mercury to the 3A-15 study site. While we had both measured and modeled wet deposition rate estimates, we chose a combination of measured wet deposition of 23.1 μg/m^2/yr. from the FAMS project (average of deposition rates for the Andytown, Fakahatchee Strand and Tamiami Trail sites) and the modeled estimate of dry deposition 12.2 ± 2.0 μg/m^2/yr., for a total of 35 μg/m^2/yr. For all ensuing aquatic cycling modeling efforts, this combined estimate was used.

4.3 Aquatic Mercury Cycling Modeling

A dynamic mercury cycling model has been developed to simulate the conditions found in marsh areas of the Florida Everglades. The Everglades Mercury Cycling Model (E-MCM) (Tetra Tech, 1999b) is an adaptation of the Dynamic Mercury Cycling Model for lakes (D-MCM) (Tetra Tech, 1996, 1999a). E-MCM accommodates unique features of Everglades marshes from the point of view of mercury cycling in aquatic systems. These features include shallow waters, a system of canals and managed water levels, a warm subtropical climate, high sun exposure, neutral to alkaline pH, high concentrations of dissolved organic carbon and sulfate, large biomass of aquatic vegetation including periphyton, sawgrass, cattails and water lilies, and a wide range of nutrient levels and primary productivity. Field data (USEPA, 1998) for parts of the Everglades have shown considerable spatial and temporal variability, with some locations apparently conducive to methylmercury production and bioaccumulation.

E-MCM also incorporates recent advances made by researchers investigating mercury cycling in freshwater systems and in the Everglades specifically. These advances include an improved understanding of the factors governing methylation, demethylation, Hg(II) reduction, food web mercury transfers, and the role of aquatic vegetation in the mercury cycle (e.g. Krabbenhoft, *et al.*, 1998, Gilmour, *et al.*, 1998a, Hurley, *et al.*, 1998, Cleckner, *et al.*, 1998).

4.3.1 Model Description

E-MCM is a mechanistic simulation model that runs on Windows™-based computers. The model uses a mass balance approach to predict time-dependent concentrations of the three primary forms of mercury [methylmercury, Hg(II), and elemental mercury (Hg(0)] in water and sediments (dissolved and particulate phases), vegetation, and a simplified food web (**Figure 8**).

Model compartments include the water column, three macrophyte species (cattails, sawgrass, water lilies), up to four sediment layers and a food web. The model has two types of particles in the water column: detritus and "other" suspended solids, plus solids in the sediments. For each type of particles - detrital, suspended and sediment solids - compartments have been set up for two types of Hg(II) exchange: (1) instantaneous and (2) slow exchange governed by the kinetics of adsorption and desorption.

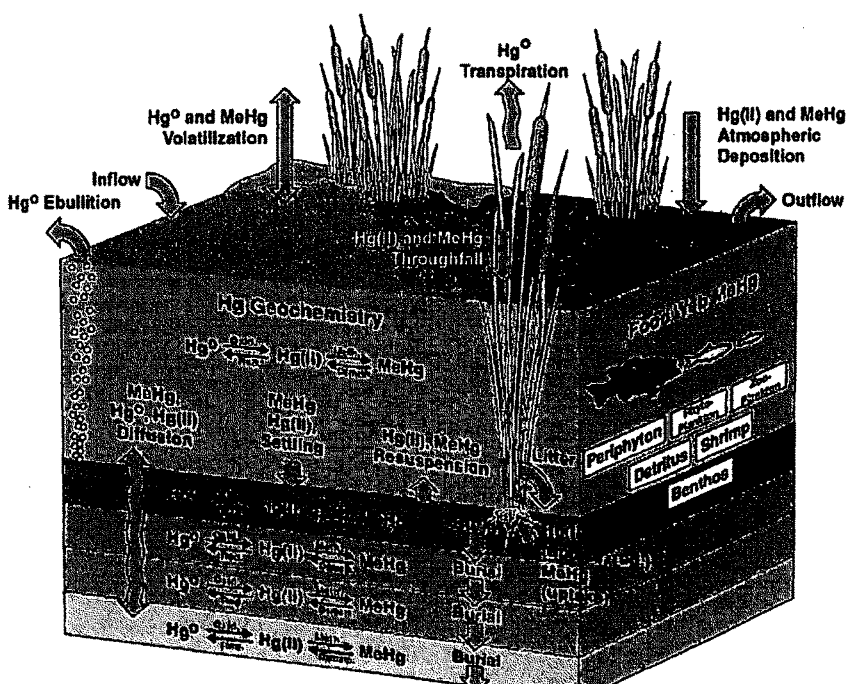

Figure 8. Conceptual model of aquatic mercury cycling processes described in the Everglades Mercury Cycling Model (E-MCM).

The simplified food web consists of detritus, periphyton, phytoplankton, zooplankton, benthos, shrimp, *Gambusia* (mosquitofish), bluegill/warmouth sunfish, and largemouth bass. Fish mercury concentrations tend to increase with fish age, and are therefore followed in each year-class (up to 20 cohorts for each species). Bioenergetics equations developed for individual fish at the University of Wisconsin (Hewett and Johnson, 1992) are modified to consider temperature dependent growth and coupled to methylmercury fluxes (Harris and Bodaly, 1998). These fluxes for individual fish are then adapted to simulate year classes and entire populations (Tetra Tech, 1999b).

Major processes involved in the mercury cycle in an Everglades marsh are shown in **Figure 8**. These processes include surface inflows and outflows, vertical groundwater flow, instantaneous mercury partitioning between some binding sites on abiotic solids and dissolved complexes, slower adsorption/desorption kinetics for Hg(II) on other sites on abiotic solids (see Appendix A, Modeled Deposition of Mercury to Everglades Water Conservation Area 3A-15), particulate settling, resuspension and burial, macrophyte related fluxes (throughfall, litter, transpiration), atmospheric deposition, air/water gaseous exchange, *in-situ* transformations (e.g. methylation, demethylation, methylmercury photodegradation, Hg(II) reduction, Hg(0) oxidation), mercury kinetics in plankton, and methylmercury fluxes in fish populations (uptake via food and water, excretion, egestion, mortality, fishing).

Although the Everglades is shallow, significant temperature vertical gradients in the water column have been observed by ACME researchers (D. Krabbenhoft, unpublished data). The model allows for surface and bottom water layer compartments if desired.

4.3.2 Modeling Approach

The aquatic mercury cycling component of this project uses the site designated as WCA 3A-15 as the basis for the model calibration and calculations. Site WCA 3A-15 is in the northern portion of WCA 3A and was selected because it has elevated mercury concentrations in largemouth bass, and has been extensively studied by the USGS ACME program. The approach to aquatic modeling for the pilot mercury TMDL included the following key components:

- Calibration of E-MCM using estimates of typical long-term conditions at site WCA 3A-15 (e.g. after 100 years. of simulation). The critical endpoint was mercury in largemouth bass, but the calibration examined total and methylmercury concentrations in each compartment for which data were available. The model calibration was performed using average wet deposition rates measured by the FAMS program between 1993 and 1996 at the FAMS sites located at Tamiami Trail, Fakahatchee Strand, and Beard Research Center in Everglades National Park (Guentzel, 1997; Guentzel, *et al.*, 2001; see Appendix II, Section 4.3). Dry deposition rates were obtained from the hybrid modeling conducted by UMAQL.

- Development of a long term steady- state dose-response curve relating predicted long-term average fish mercury concentrations to different levels of long term continuous atmospheric Hg(II) deposition. For example, if atmospheric deposition decreased to 50% of current levels and was maintained at the lower value for a long period, at what concentration would mercury in fish ultimately stabilize? Model runs were carried out for several mercury deposition scenarios to develop the curve.

- Assessment of the predicted timing of the response of fish mercury concentrations to different loadings of inorganic Hg(II).
- Sensitivity analysis of E-MCM predictions to various model input parameters, including atmospheric deposition rates of mercury.
- Assessment of the effects of year-to-year variations of atmospheric deposition under long-term constant mean annual loadings.
- Uncertainty analysis: Quantifying the effects of uncertainty regarding true current atmospheric deposition rates on model predictions and study conclusions.

General characteristics of site WCA 3A-15 are summarized in **Table 9**.

Table 9.
Characteristics of Water Conservation Area 3A-15

Parameter	Value
Area modeled	1 km x 1 km
Surface water depth	0.2 to 0.7 m
Air temperatures (monthly means)	12 to 30 C
Productivity	Low to Moderate
Flow pattern	Surface flow
Stratification	Intermittent
Anoxia	Yes
Dissolved organic carbon	~ 16 mg/L
Surface water pH	~ 7.2
Surface water chloride	~ 5 mg/L
Surface water sulfate	100 μeq/L
Sedimentation rate	< 1 cm/yr.
TSS	~ 2 mg/L
Macrophytes	Includes sawgrass, cattails, water lilies
Fraction of marsh with open water	<50%
Periphyton density	dense

Top predator fish	Largemouth bass

An important note on the model calibration is that, under ideal circumstances, E-MCM would have been calibrated to a long-term data set. Unfortunately, such long-term water chemistry and biota data sets do not exist, nor do high-quality, high-resolution mercury deposition and sediment accumulation rate data. This currently precludes a long-term, historical calibration, and was the impetus for choosing a calibration approach that assumed that current conditions reflect long-term dynamics – in essence, a quasi steady-state calibration. Further information on the approach to model calibration, sensitivity analysis, uncertainty analysis and assessment of year-to-year variations are provided below and discussed in detail in Appendix II.

Model Inputs

In response to the mercury issue in the Everglades, several agencies initiated research and monitoring programs in the 1990's as the SFMSP. These began with the FAMS and USEPA Regional Environmental Monitoring and Assessment Program (REMAP) project. In 1993-1995 REMAP collected extensive data on the canal system, and in 1995-1996 sampled water, soil, vegetation and fish at 500 sites. Subsequently, in 1999, REMAP again sampled across the entire marsh system, examining the relationships between parameters and temporal trends. A joint study by USEPA and SFWMD sampled 9 surface water control structures over two years. (1993-1995) to determine surface water loads to the Everglades Protection Area (**Table 1**). FWC collects and maintains a long-term database on mercury in largemouth bass and other fishes. As a result, there are extensive air, water, soils and biota data on mercury at WCA 3A-15. From 1995 through the present, the USGS ACME Team has conducted intensive process-oriented research at 9 sites from north to south in the Everglades. Data from all these studies have been used to guide formulation and parameterization of the Everglades-Mercury Cycling Model, and subsequently its testing under a variety of Everglades conditions.

Estimates of atmospheric loading rates of mercury via wet deposition are available from three sources:

1. Direct estimates of wet deposition for three sites in the Everglades region obtained as part of the FAMS monitoring program conducted between 1992 and 1996;
2. Direct estimates of wet deposition for three MDN sites in the Everglades region between late 1995 and the present, and
3. Modeled estimates of wet deposition derived from the source-receptor modeling conducted by UMAQL as part of this study.

Dry deposition fluxes are difficult to measure directly with reasonable precision, and are usually inferred in part from modeling. Carefully conducted direct measurements of wet deposition such as those obtained during FAMS are inarguably more reliable than estimates derived from source receptor modeling. For that reason, we elected to use the wet deposition fluxes directly measured during FAMS as input to E-MCM.[9]

Input data types and sources for WCA 3A-15 long-term simulations are summarized in **Table 10.** Mercury concentrations from the atmospheric model were input as boundary conditions to calculate fluxes across the air/water interface (gaseous, wet deposition, dry deposition, deposition of reactive gaseous mercury). Additional information describing inputs used in simulations is provided in Appendix II.

Table 10. Summary of Data Inputs by Major Data Type Category

Data Type	Parameter Estimate and Source
Hydrologic Data	
Precipitation	Monthly means from FAMS sites AT, FS, and TT, 1992-1996 (Guentzel, '97; Gill, *et al.*, '99)
Surface water elevations	Direct daily measurements (USGS, Miami Florida Sub District Office)
Surface Flow	Monthly means computed based on cell size configuration, assumed hydraulic retention time, and precipitation seasonality.
Physical Data	
Temperature and incident light	Monthly means estimated from NOAA gauge data at West Palm Beach, 10/89 to 9/94 – HydroQual (1997)
Soil moisture content	Assumed 100% saturation at all times
Mercury Loadings	
Wet Hg(II) deposition	Monthly means from FAMS sites AT, FS, and TT, 1992 –1996. Guentzel, 1997; Gill, *et al.*, 1999.
Dry Hg(II) deposition	Model mean monthly estimates from Keeler, *et al.*, (2001)
Leaf Area Index	3 (assumed)
Upstream Surface water concentrations – Hg(II)	Based on average for 3A-33 = 2.14 ng/L (n = 7) sampled by USGS
Upstream Surface water concentrations – MeHg (unfiltered)	Based on average for 3A-33 = 0.27 ng/L (n = 7) sampled by USGS

[9] This is not to say that the modeled wet deposition fluxes have little or no value. First, the robustness of the simulated dry deposition fluxes that the E-MCM model relies upon as additional atmospheric input is reflected in part by how well the source-receptor modeling captures the relationship between sources and wet deposition. The extent that the modeled wet deposition fluxes match observed values (*cf.*, Figure 6) provides some assurance that the modeled wet, and by extension, dry deposition relationships are reasonable. Second, the fact that a TMDL analysis requires quantifying the relationship between sources and the target metric also necessitates the modeling of the relationship between sources and wet deposition of mercury.

Surface Water Chemistry	
DOC	ACME data (n = 8) (G. Aiken, USGS unpublished data)
pH and dissolved oxygen	Limno-Tech (1996)
SO_4^{2-}	~100 μeq/L (Gilmour, *et al.*, 1998b)
Hg Concentrations in Marsh	
Surface water Hg_{tot} and MeHg (filtered and unfiltered)	1995-1998 data from ACME (D. Krabbenhoft, unpublished data)
Elemental Hg (DGM)	20 – 40 pg/L (Krabbenhoft, *et al.*, 1998)
Sediment Hg	Gilmour, *et al.*, 1998b
Sediment porewater chemistry	Gilmour, *et al.*, 1998b
Food Web and Vegetation	
Fish growth (largemouth bass) and Hg concentrations	T. Lange, Florida Fish and Wildlife Conservation Commission (unpublished data)
Mosquitofish Hg concentrations	D. Krabbenhoft (ACME unpublished data)
Fish diets	Cleckner and Gorski (ACME unpublished data)
Fish biomasses	Marsh-wide average = 40 kg/ha (wet) (Jordan, 1996 cited in Ambrose, *et al.*, 1997)
Macrophyte and periphyton biomasses and turnover rates	Ambrose *et al.*, 1997
Macrophyte Hg_{tot} concentrations	USGS collected samples, DEP funded analyses by Frontier Geosciences
Shrimp and zooplankton MeHg concentrations	100 - 200 ng/g (dry) (Cleckner, personal communication)
Benthos MeHg and Hg_{tot} concentrations	No data
Periphyton MeHg and Hg_{tot} concentrations	(Cleckner, *et al.*, 1998)
Particle Dynamics	
Hg(II) Sorption	Calibrated
Sediment accumulation rates	Derived from Delfino, *et al.*, (1993 and 1994)
Sediment decomposition rates	Derived from litter turnover rates and net mass sedimentation.

4.3.3 Linkage of Mercury Loads to Fish Tissue Concentrations

A fundamental question to examine in this pilot TMDL study was the relationship between atmospheric Hg(II) deposition and long term fish mercury concentrations. Once the model was calibrated to the current atmospheric Hg(II) deposition estimate of 35 $\mu g/m^2/yr.$, simulations were also carried out with loadings at 75, 50, 25 and 15% of current levels. In these simulations, Hg(II) and methylmercury concentrations in inflows were adjusted in proportion to Hg(II) deposition. Atmospheric loadings of methylmercury also were changed proportionally. Predicted fish mercury concentrations were compared after each simulation had run 200 years, producing essentially steady state conditions. Annual cycles of site conditions and mercury deposition were repeated throughout the simulation period.

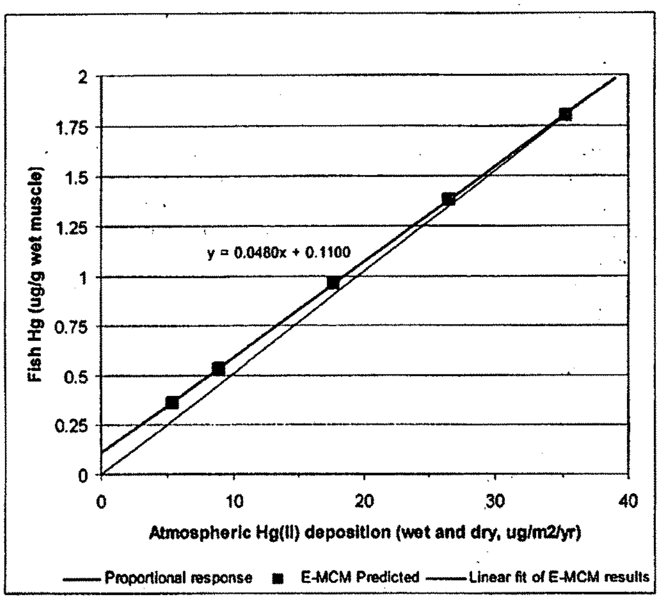

Figure 9. Predicted Hg concentrations in age 3 largemouth bass as a function of different long term constant annual rates of wet and dry Hg(II) deposition. Predictions are based on calibration to current loading of 31 $\mu g/m^2/yr$.

Figure 9 shows the predicted long term relationship between atmospheric mercury deposition and mercury concentrations in age 3 largemouth bass in WCA 3A-15. A linear relationship is predicted, but the slope is not 1.0 and the intercept is non-zero. This suggests that there is not an exact correspondence between relative reductions in Hg(II) loading and fish mercury response. Moreover, the figure suggests that, in the absence of any Hg(II) loading, there will still be some mercury accumulating in largemouth bass. The source of this mercury is, in essence, "legacy" mercury, historically deposited and now lying deep within the sediments (5 to 20 cm below the sediment-water interface) that the model predicts is mobilized and brought into the water column by macrophyte roots. As **Figure 9** illustrates, this source of mercury becomes important only if atmospheric sources are substantially reduced. Eventually this legacy mercury would become exhausted, but at current sedimentation rates, the model predicts that this would not occur for some hundreds of years.

Both the linearity and the deviation of the predicted relationship from unity are strongly influenced by model assumptions not verified by field data. These include:

1. We assumed that two limiting factors govern methylation and demethylation rates: the supply of available mercury and the rate of activity of the methylating and demethylating microbes. We also assumed that methylation occurred in sediments and that it was porewater Hg(II) or a fraction of it being methylated. We further assumed that no cinnabar (HgS) formation would occur for any of the loading scenarios tested. It is possible that cinnabar formation or other geochemical constraints could result in the current levels of porewater Hg(II) remaining unchanged over a range of Hg(II) loading conditions. In this case, methylation rates in sediments might not respond in a linear manner to a change in Hg(II) loading. Work is needed to clarify the location of methylation and demethylation in the system and whether the concentrations of mercury available for the reactions change in response in a linear way to different Hg(II) loading to the system. Stable isotope addition studies conducted by the ACME team using enclosures in the Everglades are expected to yield considerable insight towards these issues. These experiments, which are supported by USGS and DEP, are currently underway.

2. We also assumed that microbial methylation and demethylation rates were limited only by their respective mercury substrates. It is possible that at some point these reactions could be limited by other factors such as the availability of carbon or a micronutrient in short supply.

3. We assumed that Hg(II) and MeHg concentrations in inflows would respond linearly to changes in atmospheric deposition. In fact, if other factors emerge which suggest that Hg(II) or MeHg concentrations in surface waters of the cell being modeled do not respond linearly to changes in atmospheric Hg(II) deposition, then the assumed linear relationship for inflowing mercury would not be appropriate either. This would further contribute to a non-linear response in the cell being modeled.

A second fundamental question addressed by the pilot mercury TMDL was: How fast will fish mercury concentrations change following reductions in mercury loading? This question was examined by running simulations for 200 years to reach steady state conditions, then instantaneously reducing atmospheric deposition as a step function and continuing the simulation for an additional 200 years. Surface water inflowing Hg(II) and MeHg concentrations were reduced as well but, unlike the reductions in atmospheric loading rates, a time lag was imposed on the inflows to reflect the time expected for upstream areas to respond to load changes (see Appendix II, Section 6.3). The results for load reductions of 25, 50, 75 and 85% from the current deposition estimate of 35 $\mu g/m^2/yr$. are shown in **Figure 10.**

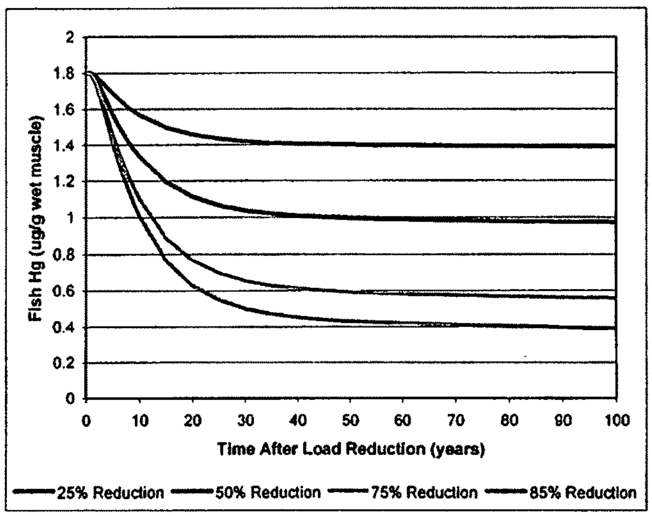

Figure 10. Predicted dynamic response of Hg concentrations in largemouth bass in WCA 3A-15 following different reductions in Hg(II) deposition. Predictions are based on calibration to current loading of 35 $\mu g/m^2/yr$.

Figure 11 shows that the number of years required for the system to approach a new steady state is effectively independent of the actual magnitude of the change. Two phases are illustrated by the curve: the first is a period of comparatively rapid response driven by the decline of Hg(II) loading and the hydraulic residence time of the system; the second phase is far slower, and is governed by the turnover rate of labile Hg(II) in the sediments supporting methylation. Because the simulated concentrations of mercury in largemouth bass ultimately reflect net methylation rates in the sediments, the response of largemouth bass is prolonged. For example, the time required to achieve 50 percent of the ultimate response in fish tissue mercury concentrations is approximately 10 years for all load reduction scenarios tested with the base calibration with atmospheric Hg(II) deposition = 35 $\mu g/m^2/yr$. Within 30 years, approximately 90 percent of the ultimate predicted response is projected to occur.

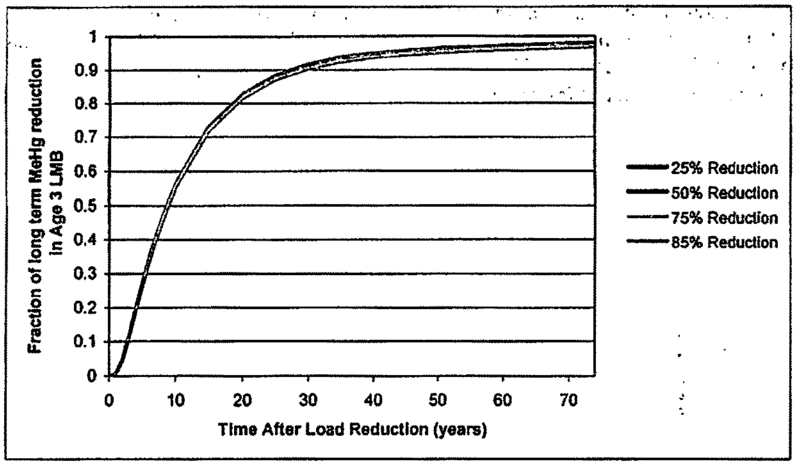

Figure 11. Comparison of the rate at which age 3 largemouth bass concentrations approach steady state following different reductions in Hg(II) deposition (simulations all based on calibration with current Hg(II) deposition = 35 μg/m^2/yr.).

5 UNCERTAINTY ANALYSIS

Assumptions – The limits of our knowledge

Our understanding of the biogeochemical cycle of mercury has advanced greatly in the past decade but a number of features of that cycle remain obscure. In any modeling analysis such as this, the degree of realism in the simulations and the ability of the models to reliably predict future reality (i.e., response to changes or management actions) is based on the degree to which the fundamental processes involved are properly represented in the models. Where these processes are not well understood or can only be represented by empirical data, the results therefrom grow in uncertainty. Several areas where this analysis outpaces the desired level of scientific understanding are discussed below.

5.1.1 The Atmospheric Cycle of Mercury:

The general features of the atmospheric portion of the mercury cycle have been understood for some decades. However, it is only more recently that the importance of speciation as it controls the transport and deposition of mercury has been appreciated. Since 1998 sampling methods have been developed and tested that can measure the relevant gaseous and particulate forms of mercury in both emissions and in the free atmosphere with greater precision and less bias than previously. The key unknowns at this time are the chemical and physical transformations that occur in the atmosphere. Several attempts have been made at construction of global mercury models but all lack key information on the atmospheric reactions of mercury and their rates.

As demonstrated in this analysis, we have achieved a measure of sophistication in measuring and modeling the local transport of emissions, but we lack the context of the overarching global cycle against which to compare local mercury emissions. For example, there is almost no information on ambient concentrations of reactive gaseous mercury in the troposphere, and likely fluxes of reactive gaseous mercury originating from local and hemispheric sources. Yet, it is this chemical species that largely governs wet and dry deposition rates.

The relationship between local emissions and deposition also is very sensitive to our assumptions regarding emission rates and the speciation of emissions. Speciated measurements from three different source types in south Florida performed during SoFAMMS (Dvonch, *et al.*, 1999) evinced large (4 to 10x) differences from the emissions inventory compiled by USEPA for south Florida as part of it's 1997 Mercury Study Report to Congress (MSRTC). Subsequent evaluation of the mercury emissions for south Florida, supported by Florida DEP, found similar emissions (within 20% for the large point sources) to those reported in the MSRTC. The speciation results from SoFAMMS clearly indicated that the fraction of reactive gaseous mercury leaving municipal and medical waste incineration facilities was higher than the USEPA inventory reported. The sensitivity of all atmospheric deposition model estimates to the speciation of mercury emitted, and in the ambient air, is currently the greatest source of error. This uncertainty ultimately speaks to our ability to mitigate the problem of high mercury concentrations in fish in the Everglades by controlling local sources. Clearly, the need remains for more substantial and fundamental research on: (1) the nature and magnitude of emissions in south Florida; (2) the magnitude of sources beyond south Florida; and (3) the atmospheric reactions of mercury and their rates.

5.1.2 The Aquatic Cycling of Mercury:

There are many assumptions and parametric uncertainties in the E-MCM. To produce accurate fish mercury concentrations, the model must be calibrated with the actual atmospheric load, including global background. Nevertheless, error analysis shows that this model predicts equivalence between the percent decrease in atmospheric deposition rate and the percent decrease in largemouth bass mercury concentration over the likely range for current estimates of atmospheric deposition of mercury.

5.1.3 Mercury Bioaccumulation and Risk:

The prey fish mercury concentrations that will protect wildlife populations are not accurately known at this time. However, the means of measuring these values are well understood and it is only a matter of finding the resources to carry out these studies.

5.2 Uncertainty

In a complex scientific endeavor, explicit, detailed treatment of the uncertainties inherent in any program of measurement, modeling or analysis is a part of the scientist's duty to be self critical of one's own analyses. Uncertainty is an attribute of all measurements – sampling, analytical, *etc.* – and, in a complex analytical and modeling paradigm, uncertainties may add or compound at each step. It is axiomatic in science that the data must support the conclusions; uncertainty analysis is a requisite for understanding how confident one may be in any particular conclusion.

One goal of this TMDL Pilot Study is to take the present state of the art of mercury research – as exemplified by the SFMSP – and attempt a comprehensive, multimedia integrated analysis. The treatment of the uncertainties herein will give us an indication of the power of our present knowledge and, more constructively, guidance for the final phase of SFMSP studies to constrain these uncertainties to acceptable levels.

5.2.1 The Aquatic Cycling of Mercury

Although considerable research on mercury cycling in aquatic systems is embodied in the E-MCM, several gaps regarding model inputs and the state of knowledge became apparent during the pilot TMDL study which impose uncertainty in the aquatic modeling results. The following recommendations would reduce uncertainty in future model applications:

1. The processes of methylation and demethylation and their rates require further research to improve our understanding and ability to more reliably characterize them. In particular, the environmental factors governing both these processes need to be better understood. For example, the link between sulfur cycling and methylation/demethylation needs to be clarified, including the roles of sulfate reduction and sulfide concentrations. Likewise, the role of periphyton in methylation and demethylation needs to be clarified, including the effects of different periphyton types. The end product of biological demethylation should be elucidated, i.e. (Hg(0) vs. Hg(II)).
2. The sorptive (both adsorption and desorption) characteristics of Hg(II) and MeHg on sediment solids need to be better understood. Sorption helps dictate the amount of Hg(II) in solution and available for methylation; it also has implications regarding response times of the system to changes in atmospheric loading rates of mercury. There are currently experiments underway using stable mercury isotopes to address this issue for a site in the Experimental Lakes Area, Ontario. Similar experimental work is in progress using substrates from the Everglades.
3. Mercury fluxes associated with macrophytes, water column solids, and sediment solids appear to play an important role in mercury cycling in the Everglades. Mercury concentrations in macrophytes (Hg_{tot} and MeHg) should be better quantified, as should the mercury fluxes associated with litter, throughfall, and transpiration. In the current model representation of mercury cycling in macrophytes, we assumed accumulation of RGM and dry particle mercury deposition onto leaves, but did not include any uptake of Hg(II), MeHg, or elemental mercury from the atmosphere directly *into* the plant material. Better information is needed on the sources of mercury accumulated by macrophytes to test this assumption. Furthermore, our approach to Hg(II) uptake by macrophytes suggests that porewater uptake of mercury is incapable of sustaining the high rates of mercury evasion over macrophytes reported by Lindberg, *et al.* (1998). Measurements should be made to confirm the reported flux rates, and research is needed to explain the source of this mercury, i.e. whether it is atmospheric in origin or from the sediments. Clarification also is needed regarding the depths from which most water is drawn into macrophytes and the potential for mercury in deeper sediments to be remobilized via root uptake.
4. We do not have species-specific bioenergetics and growth data for *Gambusia*. This information should be obtained from the literature if available. If such information is not available, experimental work is needed to obtain it.
5. As discussed in the next section, we addressed uncertainty associated with actual Hg(II) deposition rates and year-to-year variability in deposition. We did not address, however, the combined uncertainty and natural variability associated with other

model inputs. A Monte Carlo version of E-MCM has been developed and will be used in future assessments.

6. E-MCM was calibrated assuming site 3A-15 was essentially at steady state relative to current inputs of mercury. As evidenced by recent analyses of both mercury in fish fillets and in wading bird feathers collected in the Everglades – there is a strong indication that declines in the mercury burden for both types of biota have occurred since *ca.* 1990 — this steady-state assumption is in all likelihood incorrect. Ideally, the model calibration would have been time-dependent, and would be able to reproduce historical trends of mercury accumulation in the sediments. Such a calibration relies on independent estimates of the trends in emissions and deposition over approximately the past 100 years that are not available.

7. Finally, we calibrated E-MCM to a single site in this study. We were therefore unable to compare model predictions to observations in terms of the effects of different site conditions such as pH, DOC, fish growth rates, sulfate and sulfide levels, and other site conditions that vary systematically across the Everglades. As part of continuing E-MCM modeling support work funded by DEP and SFWMD, the model is currently being applied to at least five other sites located widely across the Everglades. This will allow testing of the predicted effects of changing site conditions.

5.3 Margin of Safety

A *Margin of Safety* determination is a requisite component of a TMDL analysis to account for the uncertainty in the understanding of the relationship between pollutant loadings and water quality impacts. Typically, this is incorporated explicitly by setting aside a fraction of the calculated maximum acceptable load as an unallocated source, or incorporated implicitly by utilizing a set of appropriately conservative (protective) assumptions in the analysis.

For this analysis, the Margin of Safety can be separated into three components: (1) that associated with the Florida Health Department consumption advisory level of 0.5 mg/kg mercury in fish; (2) that associated with the modeled relationship between atmospheric sources and atmospheric loadings; and (3) that associated with the modeled relationship between loadings and biotic response. To put this pilot effort in context, we describe some aspects of margin of safety that would need to be considered when developing a TMDL involving atmospheric deposition of mercury. These elements are discussed below.

5.3.1 Health risk margin of safety

In light of recent findings, a *Margin of Safety* is not incorporated in the water quality endpoint for this pilot TMDL. That endpoint is the 0.5 mg/kg mercury concentration in fish flesh, fish consumption advisory limit, as issued by the Florida DOH. Concentrations greater than this value trigger the issuance of fish consumption advisories by DOH. This number had been considered protective of human health for exposure to mercury from fish consumption. The 0.5 mg/kg advisory limit was based on the Provisional Tolerable Weekly Intake value proposed by the World Health Organization (WHO) in 1972. However, the mercury reference dose used by the WHO of 0.43 µg/kg body weight-day exceeds the recent USEPA recommended and National Research Council confirmed reference dose of 0.1 µg/kg body weight-day. As well, the Florida relative source contribution for mercury from human consumption of marine and estuarine fish is in need of recalculation based on new data which indicate that fish consumption by Floridians is higher that the national average. This, along with the recent USEPA issuance of a guidance mercury water quality criterion for protection of human health of 0.3 mg/kg mercury concentration in fish flesh, suggests that the Florida 0.5 mg/kg limit is not conservative. The Florida 0.5 mg/kg advisory limit is currently under review.

5.3.2 Atmospheric modeling margin of safety

The manner in which atmospheric sources were considered and used in the source-receptor modeling must be considered *non-conservative* at this juncture. The current state of the art in atmospheric source-receptor modeling used in the analysis does not allow for background sources beyond the immediate model domain to be considered explicitly. Since the model considers only local sources as the forcing function controlling mercury deposition in the Everglades and, since local sources are the only inputs that have a reasonable likelihood of control, this makes the allocation of an acceptable load inherently *non-conservative*. Given that we cannot control background sources, to the extent that mercury fluxes into the Everglades are derived from global or regional sources, the benefit of controls on local sources would be minimized proportionately.

5.3.3 Aquatic cycling model margin of safety

The aquatic cycling modeling does not incorporate any margin of safety explicitly. The model was calibrated to our best estimates of current conditions to try and accurately simulate both existing and likely future behavior of mercury at Site 3A-15. A margin of safety could be incorporated into the analysis that considers the inherent uncertainty in the model predictions, but is not reasonably possible until the Monte Carlo capabilities are completed in E-MCM.

In summary, a margin of safety was initially built into the analysis by virtue of using the Florida Health Department consumption advisory level of 0.5 mg/kg, however the revised USEPA fish methylmercury criterion of 0.3 mg/kg eliminates that margin of safety. Given that controlling global sources is infeasible, however, our inability to resolve the contributions of global and local sources to deposition at Site 3A-15 suggests that we have underestimated the likely requisite local load reduction. When reasonable lower limits of global loadings are considered, our results indicate that virtually complete elimination of local sources is likely required to approach or achieve reductions in mercury concentrations in largemouth bass consistent with achieving a target level of 0.5 mg/kg.

5.4 Sources of Uncertainty

5.4.1 Aquatic Mercury Cycling Model – Conceptual Issues

One element of uncertainty analysis as applied to models is sensitivity analysis, i.e. understanding, in the present case, which variables in the E-MCM most affect predicted fish mercury concentrations at WCA 3A-15. Two types of sensitivity analyses were conducted to address this question. The first approach was to conduct a traditional type of analysis where each parameter is varied by the same relative amount, without regard to whether this value is actually likely to occur or is appropriate for the system of interest. The second approach considered the range of actual or (if such information was not available) likely values a parameter can assume. This latter approach is essentially a "minimum-maximum" analysis that examines sensitivity in the context of likely or actual parameter distributional ranges. It thus defines the bounds of uncertainty in model response related to a given variable. Details of the approaches and a presentation of the input parameter values used in the analyses are presented in Appendix II.

5.4.2 Traditional Sensitivity Analysis Results

Simulations were run varying inputs in isolation by a given amount, for example plus and minus 50%. In cases where a 50% change did not make physical sense, a lesser change was made, e.g. 10% or 25%. In addition, there were some inputs such as the fraction of fish in the diet that did not make sense to change in isolation. The following simultaneous changes were simulated:

- Fish growth rates and spawning sizes for all fish species were changed by the same percentage simultaneously.

- The areal coverage of the three macrophyte species, periphyton coverage, and quantities of suspended solids and detrital material in the water column were varied simultaneously. It is expected that a change in vegetation cover would affect the amount of settling material. Burial rates would be affected by these changes, since burial is calculated based on sources and sinks of particulate matter to the sediments.

- When the diet of largemouth bass was altered to increase or decrease the fraction of fish in the diet, it was necessary to also alter the fractions of the diet represented by other food items. The fractions added or subtracted from fish consumption were distributed evenly amongst other food items.

- Surface inflow and outflow rates (Qin and Qout) were varied simultaneously since it was assumed these rates were equal in simulations. This assumption is reasonable, given that estimated average flows in and out of WCA-3A over a 31-year period agreed within 12% (SFWMD, 2000).

- When atmospheric Hg(II) deposition was altered, surface inflowing Hg(II) and MeHg loads also were varied proportionately. Because the rates of atmospheric methylmercury deposition are so low compared to other major fluxes, atmospheric methylmercury deposition was not altered for this particular analysis.

To provide a common basis for comparing the effects of changes to model inputs on fish mercury, the concentrations in age 3 largemouth bass were used as the endpoint (**Figure 12**). Results are presented as absolute value of the ratio of the percent change in fish mercury concentration divided by the percent change in the input:

Ratio = |Percent change in fish Hg| / |Percent change in input value|

Predicted mercury concentrations in age-3 largemouth bass were most sensitive to factors associated with particle and vegetation fluxes, Hg(II) loading, methylation rates, and factors affecting fish diets and growth.

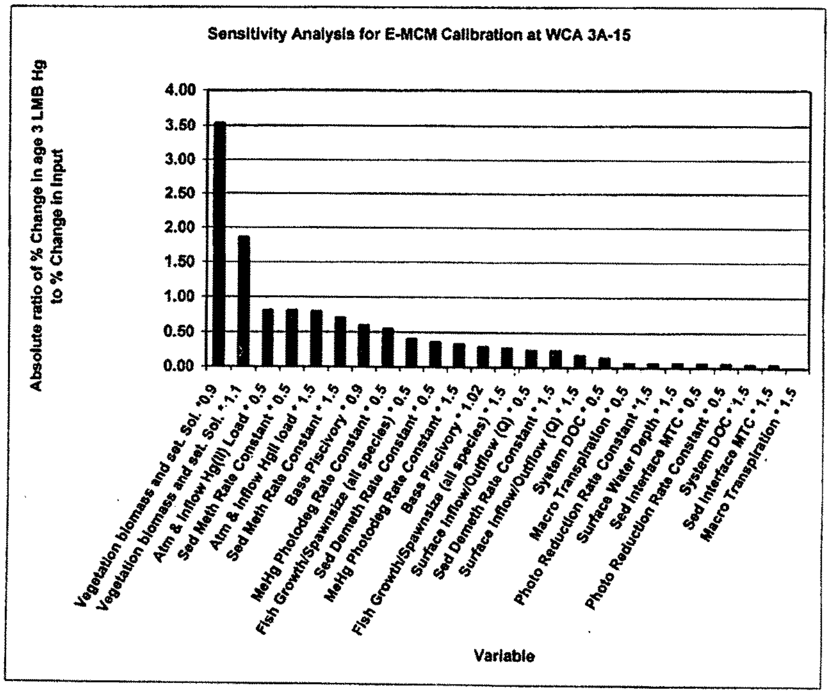

Figure 12. Predicted sensitivity of age 3 largemouth bass mercury concentrations in WCA 3A-15 to changes in various input values.

Another important conceptual issue is whether the relationship between biota response and external mercury loading rates to the system is linear. E-MCM predicts long term responses of fish mercury concentrations to changes in atmospheric Hg(II) deposition rates are virtually linear (but with a non-zero intercept) over practical time scales. The model predictions are governed, and to some extent made uncertain, by our current understanding of mercury cycling and the resulting assumptions in the model. Specifically, the following assumptions had a significant impact on the shape of the dose-response curve:

- Methylation occurs primarily in the sediments;
- Methylation depends on a bioavailable fraction of porewater Hg(II);
- Porewater Hg(II) concentrations are not currently at saturation. For example, it is plausible that additional Hg(II) loading could result in precipitation of the excess Hg(II) as cinnabar, with no change in porewater Hg(II). We do not have cinnabar forming in any of the loading scenarios we examined with our calibration; and
- Atmospheric methylmercury deposition, inflowing methylmercury loads, and inflowing Hg(II) loads were assumed to be reduced by the same percentage as Hg(II) deposition in scenarios with load reductions. In other words, no watershed-based upstream sources, i.e. geologic or anthropogenic, within the watershed are assumed to exist. In effect this means all upstream surface water loadings are derived from atmospheric deposition influenced to the same extent by variations in emissions as direct atmospheric inputs to WCA 3A-15. To put this assumption in perspective, given that atmospheric deposition to the Everglades constitutes >95% of the annual mercury load, the upper bound of watershed based sources is at most only a second order consideration.

Thus, we interpret the predicted response of fish mercury concentrations to load reductions in this study to reflect the current level of understanding. This level of understanding is currently inadequate, however, to support strong confidence in the absolute values of predicted fish mercury levels. Nonetheless, we are relatively confident in our ability to predict the percentage change in fish mercury concentrations from the percentage change in atmospheric loading. We recognize, of course, that the relationship between emissions and atmospheric deposition is dictated by a number of factors, including speciation of emissions and other source characteristics. Thus, while we can state that our analysis indicates that a desired percentage reduction requires a commensurate reduction in atmospheric loadings, the desired percentage change in atmospheric loadings does not necessarily equate to a similar reduction in overall emissions.

5.4.3 "Minimum-Maximum" Sensitivity Analysis Results

To conduct the "minimum-maximum" analysis, E-MCM was first run for the i^{th} parameter at its high and low limits, while all other parameters were held constant at their nominal values. As in the more traditional sensitivity analyses presented earlier, the end-point for the analysis was the MeHg concentration in age 3 largemouth bass. The sensitivity index for the i^{th} parameter (SI_i) (Hoffman and Gardner, 1983) is calculated as:

$$SI_i = 1 - \frac{E_{i,low}}{E_{i,high}}$$

where $E_{i,low}$ and $E_{i,high}$ are the predicted age 3 largemouth bass mercury concentrations for the low and high estimates for the i^{th} parameter respectively. Note that, as SI_i approaches 1 (i.e., the larger the difference between the high and low results), the model is increasingly more sensitive to the range in parameter uncertainty.

Results from the "minimum-maximum" analysis are shown in **Figure 13**. The analysis demonstrated that predicted concentrations of mercury in age 3 largemouth bass at WCA 3A-15 are most sensitive to uncertainties associated with inputs related to the *in situ* production and destruction of methylmercury. This is because: (1) *in situ* methylation is predicted to be a major source of MeHg for fish at WCA 3A-15; and (2) there is considerable uncertainty regarding true rates. This result is consistent with previous assessments indicating that future R&D efforts need to better elucidate factors affecting fish mercury concentrations in Everglades marshes, and aquatic systems in general.

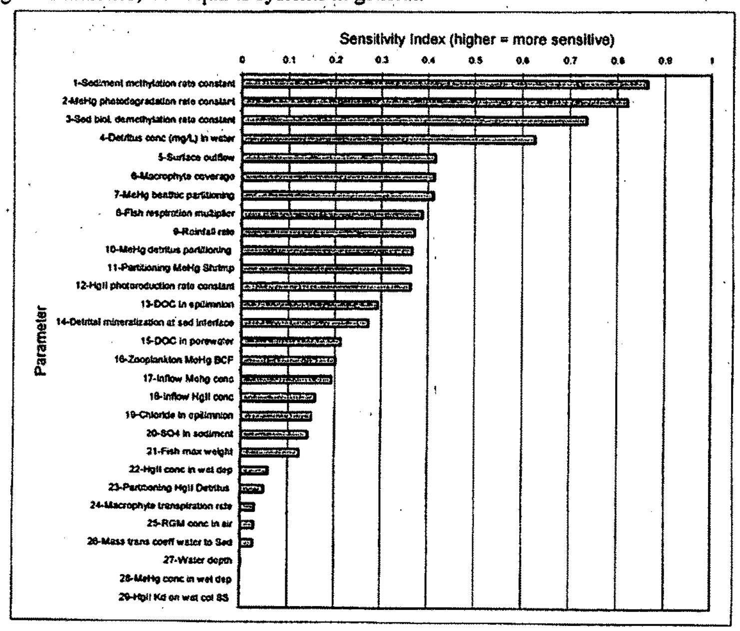

Figure 13. Calculated SI values for different E-MCM model parameters analyzed using the 'minimum-maximum' sensitivity analysis approach.

In addition, uncertainties associated with particle-based mercury fluxes also significantly affected predicted fish mercury levels. There is a need to better constrain/estimate the production and fate of particulate matter via macrophytes and periphyton for the purposes of better constraining E-MCM predictions. Uncertainties regarding hydrologic inputs had a moderate effect on predicted fish mercury concentrations. Because these parameters were altered individually, this result was anticipated and the full impacts of hydrological changes and uncertainties are likely not reflected in this analysis.

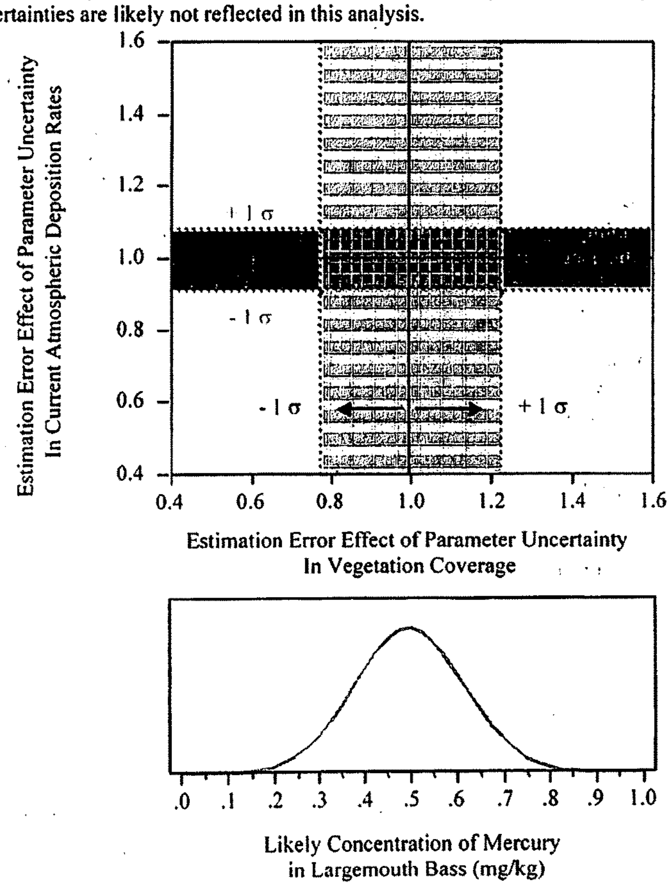

Figure 14. The effects of parameter error on predicted mercury concentrations in largemouth bass (LMB) following a reduction in current atmospheric loading rates by 17.7 μg/m^2/yr. (assumed current rate = 35 μg/m^2/yr.). Analysis assumes that the initial predicted concentration in LMB in the absence of error is 1 mg/kg. See text for explanation.

5.4.4 Effects of Parameter Uncertainty

The sensitivity index approach, as currently used, treated only one parameter at a time. An improvement to this approach would be to simultaneously vary groups of interdependent inputs to their minima or maxima (positive or negatively correlated).

Figure 14 presents an example of Monte Carlo analysis. In this analysis, the estimated uncertainty in modeled atmospheric deposition was combined with the uncertainty of a single parameter set within E-MCM – vegetative cover and settling solids. For the sake of simplicity, the analysis assumes that current largemouth bass concentrations average 1 mg/kg in the absence of error. In the upper panel, the effect of parameter error on LMB concentrations is delineated by reference lines showing the standard deviation of the predicted LMB concentrations. For example, the X-axis shows via dotted lines the relative standard deviation in predicted largemouth bass (LMB) mercury concentrations due to an assumed variability in vegetation turnover rate of 10%. Resultant variability in predicted LMB due to this factor alone is approximately 23%. Likewise, the Y-axis shows the relative standard deviation in predicted LMB mercury concentrations due to errors in the total deposition rate (8.3%).

The effects of the joint error distribution in these two parameters can be readily calculated by assuming the effects of the two errors are multiplicative which, based on model testing, is a reasonable assumption. The resulting uncertainty can then be used to assess the uncertainty in predicted largemouth bass mercury concentrations given a particular atmospheric load reduction. This is illustrated in the lower panel of **Figure 14**, which shows the resultant probabilistic distribution of predicted LMB mercury concentrations for a load reduction of 17.7 $\mu g/m^2/yr$. (and a current assumed rate of 35 $\mu g/m^2/yr$.).

Note that as more dimensions of parameter uncertainty are included, the likely predicted steady state or long-term response of largemouth bass to the given mercury load reduction becomes increasingly more uncertain.

5.4.5 Atmospheric modeling – Conceptual Issues

The Florida Everglades ecosystem extends over 3,000 square miles and is comprised of many habitat types, thus it was not realistic use the E-MCM to simulate the entire ecosystem. Because the extensive and intensive monitoring studies in the Everglades by USEPA and the US Geological Survey have focused on a mercury "hot spot" in central Water Conservation Area 3, this site was also chosen as the deposition receptor for this analysis. Extensive data were available for 1995-1996; as a result, this period (22 June 1995 to 21 June 1996) was selected as the period of study. Atmospheric deposition rate for 1995-1996 is referred to as "current" deposition rate in this report.

The atmospheric modeling did not attempt to deal with the inferred but ill-characterized long-distance transport of mercury from the global background into Florida. Clearly, long-distance transport from the global background must be presumed to be non-zero, but neither present-day models nor measurements are adequate to estimate the magnitude of this source of mercury to Florida. Only local emissions sources were modeled.

As described in Appendix I and in recognition that there are limits to our understanding, tools and data available to support modeling of the global transport of a pollutant, source-receptor modeling relied primarily on local sources to estimate deposition to the Everglades. This has led to no little controversy and comment over the contributing role of local emissions in south Florida to *wet* deposition rates in the Everglades, and has fueled debate as to whether the estimate of the global or 'long distance transport' source to the *total* deposition signal is too uncertain to conclude that local sources are indeed important. The widely divergent estimates of the 'local vs. global' contributions to deposition derived from the FAMS (Guentzel, *et al.*, 2001) and SoFAMMS (Dvonch, *et al.*, 1998) have both illuminated and fueled this debate. It is, however, possible to draw upon the several lines of evidence available to set reasonable bounds around the likely contributions of mercury in Florida.

- Using multivariate receptor modeling, Dvonch, *et al.* (1998) concluded that 71 ± 8% of the wet deposition signal measured at five sites in the Everglades could be accounted for by local sources. Conversely, Guentzel, *et al.* (2001) based on their analysis of seasonal patterns in wet deposition of mercury and the uniform nature of summertime mercury concentrations in rain across the south Florida, as well as source apportionment calculations based on a relatively simple mass balance box model on atmospheric fluxes of reactive gaseous mercury in south Florida, concluded that local sources can account for only 30 to 46% of the wet deposition signal.
- An Everglades-wide sediment coring study begun in 1992 (Rood, *et al.*, 1995) yielded estimates of historical mercury accumulation rates in Everglades soils spanning the period 1900 through *ca.* 1990. Comparison with recent deposition estimates (as $\mu g/m^2/yr$) among comparable Everglades sites from that time to the present are given in the table below:

Rood, *et al.*, 1995	*ca.* 1990	NADP MDN 2002	2001
WCA-1	79	ENR Project	21
WCA-2	59	NA	--
WCA-3	39	Andytown	24
ENP	40	ENP	18

The average mercury accumulation rate in sediment Everglades-wide was 53 $\mu g/m^2/yr$ *ca.* 1990 vs. 21 $\mu g/m^2/yr$ from atmospheric deposition in 2001. These data suggest a decline in deposition of ~ 60% overall since *ca.* 1990.

- Everglades largemouth bass (fillet) and great egret (feather) mercury concentrations have declined *ca.* 75% from the mid-1990's to the year 2002.

- Data on potential trends in the 'global background' indicate a "very small downward trend from 1995 through 2000" at Alert, Canada (Schroeder, Pers. Comm., 2002) and there are similar results from Mace Head, Ireland (Ebinghaus, from Schroeder, Pers. Comm., 2002). Both are relatively remote background sites. Published data indicate a decline over the northern Atlantic of ca. 20% by the mid-1990's. (Langer & Slemr, 1991; Slemr, *et al.*, 1995; Slemr, 1996; Slemr & Scheel, 1998; Ebinghaus & Slemr, 2000). It is apparent that long-term trends of elemental mercury in the atmosphere at background sites are not of similar magnitude to the declines evident in the Everglades ecosystem.
- An independent analysis by the Florida Electric Power Coordinating Group on trends of mercury emissions and concentrations in south Florida biota (per above) concluded that at this juncture *"...it is clear that the fundamental hypothesis that changes in local emissions of mercury [in southeast Florida] have been the primary agent for recent biota changes in mercury concentrations in the Everglades cannot be rejected."* (Pollman & Porcella, 2002).
- Receptor modeling applied to source and ambient data during the intensive SoFAMMS field study in 1995 indicated that 92 (± 30)% of the total mercury deposition measured at the Davie site near Ft. Lauderdale could be accounted for by local sources (Dvonch, *et al.*, 1998).
- The approximate magnitude of the global background contribution can be bounded from the *ca.* 300 rain samples from 17 sites in Dade and Broward counties during the August 1995 SoFAMMS project. Observed minima in background rainfall mercury concentrations at coastal sites in south Florida approximated 5 ng/L. Assuming annual rainfall rates of 130 cm/yr., these concentrations would result in background deposition rates of about 6.5 $\mu g/m^2/yr.$, or about 21% of rainfall deposition.
- As reported in herein, comparative model analyses of transport of mercury from all point sources in Florida and adjoining states vs. the 38 point sources in the south Florida modeling domain alone, indicated a contribution to the Everglades from regional sources within the southeastern US of less than 5% of total deposition.
- Contrastingly, the FAMS investigators (Landing, *et al.*, 1995, Guentzel, *et al.*, 1997, 2001) concluded from the weak trace element signatures in rainfall samples and a box model of mercury fluxes into and over Florida, that local sources alone could not account for the amounts of mercury in measured in rain.

We view the FAMS and SoFAMMS projects as having been complementary, not contradictory. Combined with other information they support the notion that the dominant source term signal contributing to total mercury deposition in south Florida are local emissions.

By our analysis, estimated total deposition for June 1995 – June 1996 was 35.3 $\mu g/m^2/yr$ (DEP, 2002), of which 23 $\mu g/m^2/yr$ was measured by FAMS as wet deposition and 12.2 $\mu g/m^2/yr$ modeled as derived from dry deposition. Dry deposition in south Florida expectedly is greatly dominated by RGM. Since the removal rate of RGM from the lower troposphere is rapid, and because the production rate is low, it is reasonable to assume that the predominant fraction of the dry deposited mercury in the Everglades is local in origin. If we assume that this fraction is 80%, then this equates to a local contribution of 9.8 $\mu g/m^2/yr$. We then take the lowest estimate of 30% from Guentzel, *et al.* (2001) to describe the local emissions contribution to the annual wet deposition of 23.12 $\mu g/m^2/yr$. This equates to a lower limit contribution of 6.9 $\mu g/m^2/yr$ from local emissions.

Combined, the total estimated contribution from local emissions to wet and dry mercury deposition is 16.7 $\mu g/m^2/yr$, or 47% of the total signal. If we ascribe a contribution of 6.5 $\mu g/m^2/yr$ to the global background (as described above), then the maximum that other regional and larger scale sources other than global background can contribute is 34%. If we use the midpoint of the Guentzel, *et al.* (2001) estimate of local contributions to wet deposition (38%), the contributions of each major source category to total deposition are:

- Local sources – 52.5%
- Global background – 18.4%
- Other regional sources – 29.1%

Regardless of whether the FAMS or SoFAMMS analyses discussed above ultimately proves to be closer to the truth, we can use their combined results to constrain a lower limit for the likely contribution of local sources to total deposition. It is our conclusion that the sum of these various lines of argument suggest that at a minimum local sources account for more than 50% of mercury deposited in southern Florida, and several other analyses suggest that the contribution may be substantially greater. Narrowing of these divergent estimates is one of the remaining goals of the SFMSP.

This issue, i.e. not explicitly treating global sources, was the subject of several review comments. The authors maintain, however, that given the present state of understanding of the global mercury cycle, it would be unduly speculative to attempt this. At this time, there are few data at present to constrain a global mercury modeling analysis! For example, it is only within the last two years that the phenomenon of mercury depletion events at polar sunrise has been convincingly established. The magnitude of this sink has been speculated to be important to the global cycle, and the recent nature of its discovery reveals how little we understand atmospheric mercury cycling on the global scale.

To address questions about the potential importance of global background contributions to mercury to south Florida, the UMAQL group evaluated two model scenarios to aid in bounding the potential magnitude. By modeling two regional emissions source scenarios: one included all sources within the Southeastern US (including Florida), the other included only the 38 sources in southern Florida. By difference between the two scenarios, this modeling analysis estimated that sources outside the south Florida region contributed approximately 5% to deposition at the receptor site in near Fort Lauderdale. Because of its estimated small size, sources in the Southeast region outside south Florida were excluded from subsequent analyses.

Three main sources of uncertainty are present in the atmospheric modeling component of this project: source characterization, meteorological variation, and the input parameters specified in the model.

The source emissions inventory is the major source of uncertainty in the atmospheric model. The inventory used was that developed for the USEPA Mercury Study Report to Congress (USEPA, 1997), which was the only comprehensive, self-consistent emissions scenario available. Other emission and speciation scenarios were examined to evaluate their effects on total deposition (see Appendix I). Incorporation of point-source specific data on emission rates and mercury speciation for only two sources in the south Florida region would result in a significantly lower annual deposition rate (Appendix I, **Figure 12**). The apparent discrepancies among emissions data and the emissions scenarios evaluated in all likelihood reflect the rapid decline in mercury emissions occurring during the period of 1985 – 1995. **Figure 15** shows the results of various emissions scenarios on the resulting wet deposition estimates.

Meteorological variation also represents an important source of uncertainty in the model. In the modeling, for each meteorological cluster, two wet days and two dry days were selected for use in the modeling exercise (**Table 8**). Where possible, these days were chosen such that they represented extremes in the spatial nature of the atmospheric transport and deposition for the given cluster. It was believed that in doing so, potential biases from choosing two days with nearly identical deposition patterns would be minimized.

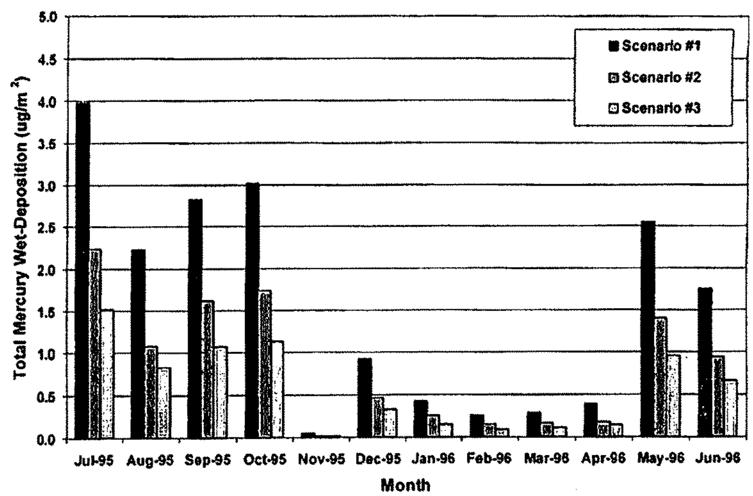

Figure 15. Comparison of the modeled monthly wet deposition to SFWMD WCA 3A-15 as a function of emissions scenario. Scenario #1 corresponds to the emissions inventory derived from the USEPA Mercury Study Report to Congress; Scenarios #2 and #3 reflect adjustment for measured MWC & MWI speciation.

Figure 16 presents the modeled 24-hour total wet deposition estimates for WCA 3A, as a function of atmospheric transport cluster (similar data are discussed in Appendix I for dry deposition). Clusters with predominant offshore flows result in little wet or dry deposition. In contrast, clusters with onshore flows – where the air mass moves over the southeast Florida metropolitan area – produce significant, although variable, deposition. Lack of precision in estimates of wind direction and wind speed could lead to relatively larger errors in estimated deposition to a specific location such as WCA 3A-15. Another factor in the between-cluster variability is the location and magnitude of the emission sources relative to WCA 3A.

Other sources of uncertainty are the values used as inputs for dry deposition rates and the Henry's Law constant. These parameters were used to calibrate the model. Their effects and use in the calibration procedure are discussed in Section 4 of Appendix I.

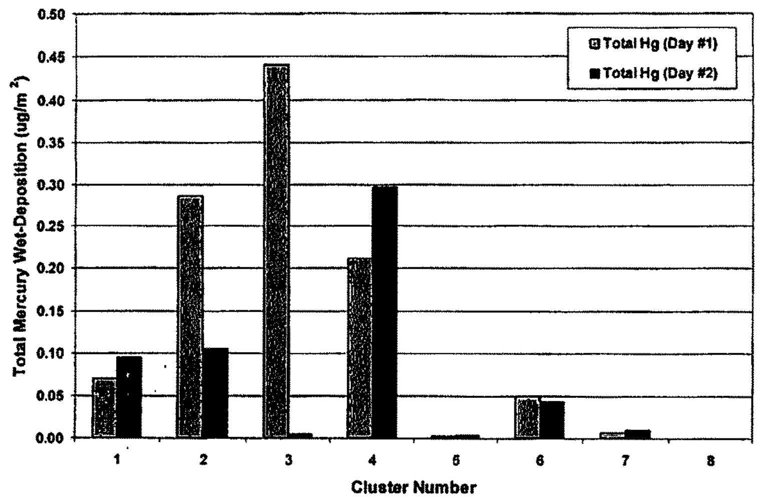

Figure 16. Comparison of the modeled 24-hour wet deposition to SFWMD WCA 3A as a function of atmospheric transport cluster and day within cluster. Days 1 and 2 represent spatial extremes for deposition within a given cluster.

5.4.6 Effects of Uncertainty on Endpoint Predictions

As stated earlier in this section, the treatment of the uncertainties will give us an indication of the power of our present knowledge and, more constructively, guidance for the final phase of SFMSP studies to reduce these uncertainties to acceptable levels. To reiterate, uncertainties in this analysis can be lumped into three broad categories: (1) characterization of emission source rates and speciation, including both local sources and background (hemispheric and global) inputs; (2) the transport, reaction, and deposition of mercury from source to receptor; and (3) the aquatic cycling and fate of mercury once it enters the Everglades.

We evaluated the effects of uncertainty in the estimated wet and dry deposition rates to determine whether errors in the deposition rate used in model calibration to current conditions would fundamentally change the response between assumed changes in atmospheric loading and the endpoint of greatest interest, concentrations of mercury in 3-year old largemouth bass. There is uncertainty inherent in our estimates of average annual wet and dry Hg(II) deposition arising from (but not limited to) analytical and field collection errors, errors induced from extrapolating from sites where mercury wet deposition has been measured to site 3A-15, and errors in modeling source-receptor relationships, including errors in emission estimates and errors in simulating meteorological conditions.

To accommodate uncertainty in the current Hg(II) deposition rates, we calibrated E-MCM separately for three loading scenarios:

- The current mean annual load estimated from the UMAQL hybrid modeling analysis: 31 $\mu g/m^2/yr$. (modeled wet + modeled dry).
- The upper and lower limits encompassing 95% of the likely estimates for the current modeled total deposition rates: 36.7 and 25.1 $\mu g/m^2/yr$., respectively.

The UMAQL modeled estimates of total deposition were used for the purposes of this analysis because of the availability of uncertainty in the deposition estimates from the UMAQL analysis. This range of values encompasses the current estimates of total deposition derived from measured wet deposition and modeled dry deposition used in E-MCM simulations, and was thus considered adequate for the purposes of this exercise.

Table 11 summarizes the annual (propagated) uncertainties in wet, dry, and total deposition modeled by UMAQL. These uncertainties were coupled with uncertainties inherent in the estimates of annual wet deposition derived from the FAMS to develop an estimate of the total uncertainty in the wet and dry deposition rates, viz., 9.6% (Appendix II, Section 5.6)

Table 11. Modeled annual wet and dry deposition rates developed by UMAQL and the associated annual uncertainties (standard deviation). Values computed from monthly estimates of each flux component and its inherent uncertainty.

Flux Component	Deposition ($\mu g/m^2/yr$.)	σ ($\mu g/m^2/yr$.)
Modeled Wet Deposition (UMAQL)	18.74	1.57
Modeled Dry Deposition (RGM & particles, UMAQL)	12.20	2.03
Total Deposition	30.94	2.57

For each of the three loading rates, E-MCM was calibrated to achieve the current observed total and methylmercury concentrations in the marsh, including fish. Thus, the predicted fish mercury concentrations were nearly identical in each calibration, but some rate constants by necessity were altered between scenarios to yield reasonable calibrations. Once the model was calibrated for each of the loading scenarios, we tested whether different calibrations yielded substantially different response curves. The comparisons were based on examining whether the same fractional reductions in deposition yielded the same long-term response. As shown in **Figure 17**, the uncertainty regarding the true loading rate has little effect on the timing or magnitude of the response of age 3 largemouth bass to load reductions of 50%. Results were similar for load reductions of 15% and 75%.

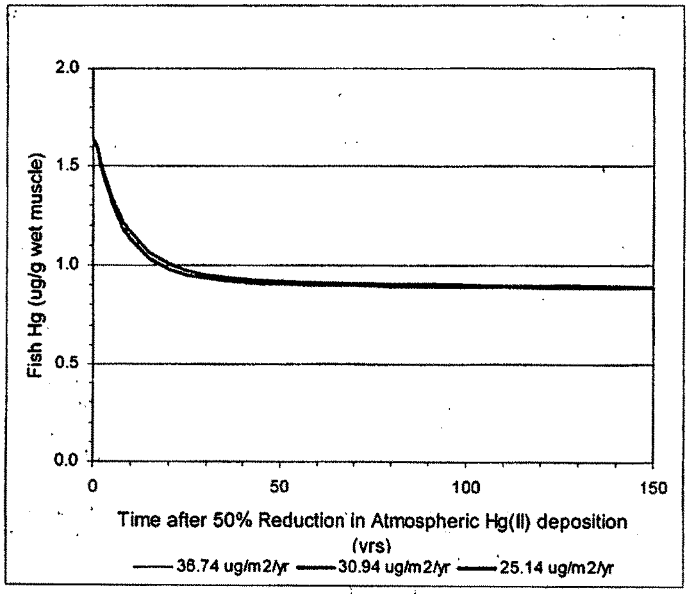

Figure 17. E-MCM predictions on the dynamic response of age 3 largemouth bass mercury concentrations to a 50% reduction in atmospheric Hg(II) deposition. Results are shown for three calibrations: lower 95% estimate, best estimate from UMAQL hybrid modeling analysis, and upper 95%.

The effects of uncertainty in our current modeled estimates of atmospheric deposition of mercury thus appear to have little or no effect when we examine how changing the *total* atmospheric load by a fractional amount[10] will influence the dynamics and magnitude of biotic response. It is important to realize that this conclusion is only valid within the framework of the underlying assumptions used to conduct the analysis. Perhaps most important is the assumption that upstream loads are changed fractionally in the same way and at the same rate as the atmospheric load. Clearly, the temporal response of the watershed is slower than the atmospheric pool to changes in emissions and loading. As of this writing, there are currently few data from dose-response experimental studies on catchments and wetlands (including the Everglades) in North America. Studies to elucidate the likely temporal response to changes in loading will be a major focus of the *Mercury Experiment To Assess Atmospheric Loading in Canada and the United States* (METAALICUS) in the

[10] To reiterate, the focal point of this conclusion is that depending upon the assumed atmospheric deposition rate used to calibrate the model, E-MCM will yield different responses in fish tissue mercury to identical (i.e., mass) magnitudes of reductions of mercury loading. Thus reducing regional emissions by 10 $\mu g/m^2/yr$ for the low deposition estimate scenario would result in a larger percentage reduction in fish tissue mercury than that predicted for the high deposition estimate scenario.

Experimental Lakes Area in northwestern Ontario, and the stable isotope mesocosm studies conducted *in situ* by ACME in the Everglades. Both studies are currently underway. Preliminary data for the Everglades indicate that an increase in Hg(II) loading produces a linear increase in MeHg in surface sediments and in fish. However, the slope of the response was highly variable among sites. Finally, this analysis does not resolve the question of how our uncertainty about the nature of all the sources contributing to mercury deposition in the Everglades affects the local source-receptor relationships developed in this analysis.

This analysis also illustrates another issue reflecting the state-of-the-art of calibration of E-MCM: *viz.*, given that nearly identical simulation results can be obtained for three significantly different source loading rate scenarios (the upper loading rate estimate differed from the lower estimate by a nearly a factor of 50%), the model is not as well-constrained or robust as desired. The greatest difficulty when calibrating the Hg(II) component of the model lies in our uncertainty of sedimentary mercury accumulation rates. Once the Hg(II) component of the model is calibrated, the methylmercury cycle is not as well constrained as desired. For example, the rates of methylation and demethylation are still inadequately quantified, and different combinations of these two fluxes could still be combined to ultimately result in the same concentrations in fish. The major removal mechanism for total mercury from the study site was burial in the deep sediments, and our uncertainty in these rates based on available measurements is easily greater than 50%. Other variables in the model help constrain the calibration, but there is still too much uncertainty in this key loss pathway to ensure a more robust calibration.

5.4.7 Effects of Annual Variability in Atmospheric Deposition Rates on Endpoint Predictions

Even if the relationship between emissions and deposition was known exactly, and emissions remained unilaterally constant with time, year-to-year variability in mercury deposition will occur due to changing meteorological and precipitation patterns. This in turn expectedly would produce year-to-year variations in largemouth bass mercury concentrations. To address the effects of this variability, an artificial data set of atmospheric deposition of mercury was synthesized based on annual variability observed at three Everglades sites during FAMS (Appendix II, Section 4.5 describes the approach and Section 6.5 describes the results). These sites had comprehensive deposition data spanning 2 - 4 year periods. The synthesized data set, which comprised 500 annual values for total mercury deposition, had log normal distribution characteristics with the desired mean and standard deviation values derived from the FAMS sites.

Inherent in this approach were several key assumptions:

- Deposition is constant over the long-term but varies annually about some mean value, and can be described statistically as a lognormal distribution.
- Wet deposition rates measured at the Florida Atmospheric Mercury Study (FAMS) south Florida sites between 1993 and 1996 are adequate to describe the variance of this distribution.
- The coefficient of variation for total deposition is similar to values measured for wet deposition rates.

- Inflowing (upstream) MeHg and Hg_{tot} loads vary in proportion to wet Hg_{tot} deposition.

An average coefficient of variation of 26.4% was calculated for the three FAMS sites. The synthetic total deposition data set was then constructed based on the estimated annual average total mercury deposition rate of 35 μg/m²/yr. (FAMS wet + modeled dry) developed in Appendix I. Variations in largemouth bass mercury concentrations were then computed by first running E-MCM with a fixed deposition rate of 35 μg/m²/yr. for 200 years to achieve steady state conditions. Using the synthesized total deposition data set to simulate annual deposition variability, the model was then run an additional 500 years, with fish mercury concentrations recorded each year.

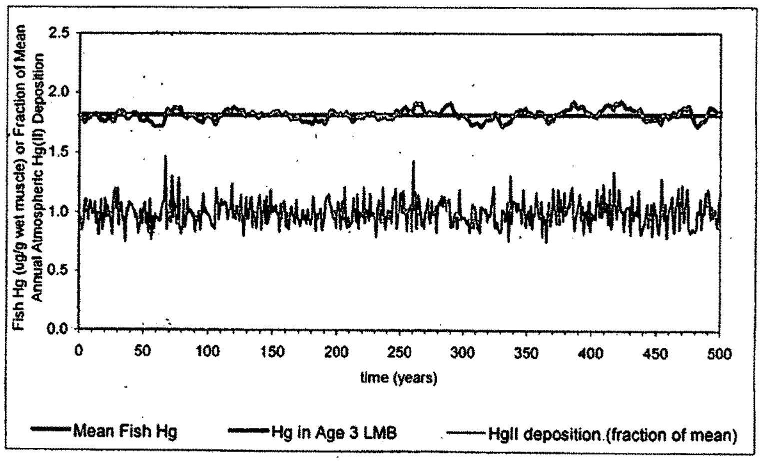

Figure 18. Input annual atmospheric Hg(II) deposition rates and predicted Hg concentrations in age 3 largemouth bass for 500 year simulation.

Figure 18 gives the results from a long-term simulation. Under current deposition, the model calibrated concentration for mercury in 3-year old large mouth bass is 1.81 mg/kg, with a coefficient of variation of 3.6%. Compared to the variance in the deposition rates, the response of the bass was considerably damped, and reflects: (1) buffering against short-term changes by the sediment pool of mercury, which greatly exceeds the amount of mercury entering the system on an areal basis any given year; and (2) the fact that fish tissue concentrations reflect an integrated response over the 3 years of varying exposure, rather than simply reflecting the current year deposition rate.

6 CONCLUSIONS, RESEARCH NEEDS AND PLANS

The primary objective of this pilot study was to explore how a TMDL or critical loading analysis could be conducted when the pollutant of interest enters aquatic ecosystems largely through atmospheric deposition. In brief, a hybridized approach concatenating an atmospheric model with an aquatic mercury cycling model was used to predict the relationship between local emissions, deposition and, ultimately, mercury concentrations in largemouth bass at an Everglades site known to have elevated mercury concentrations in fish tissue.

This study synthesizes and integrates data from arguably one of the most comprehensive field measurement and monitoring programs conducted on the fate and transport of an environmental pollutant. Nonetheless, we recognize that numerous areas of uncertainty remain in the models' formulations and the data they rely on, and both the model and data uncertainties identified in this report are guiding future research of the South Florida Mercury Science Program.

This combined modeling analysis successfully integrated a multimedia modeling approach with extensive field data to produce simulations that reasonably agree with conditions and changes seen in the south Florida region. For example, since the mid-1980's emissions of mercury have declined dramatically. Similarly, monitoring data from the mid-1990's to the present show significant declines in mercury in Everglades fish and wading birds. The timing of trends and rapidity of response seen in the biota appear consistent with: (1) the role of local sources as an important driver of atmospheric deposition as indicated by the UMAQL modeling; (2) the apparent decline in local emissions in south Florida inferred from limited municipal solid waste incinerator emissions data compiled by DEP; and (3) E-MCM modeling of the timing of change.

Overall, E-MCM was calibrated to fit observations for total and methylmercury at WCA 3A-15. Regarding the model simulations:

1. The E-MCM model predicts a linear relationship between atmospheric mercury deposition and mercury concentrations in largemouth bass, with a small residual mercury

concentration in fish at zero atmospheric mercury deposition (Figure 9). In other words, for any reduction in mercury inputs there may be a near 1:1 reduction in fish mercury concentrations. Furthermore, error analysis shows that the E-MCM predicts equivalence between the percent decrease in atmospheric mercury deposition rate and the percent decrease in largemouth bass mercury concentration over the likely range for current estimates of atmospheric deposition of mercury. The slight offset from a 1:1 relationship is a result of movement of historically deposited mercury from deeper sediment layers to the water column. Until this mercury is buried below the active zone, it can continue to cycle through the system. In addition, because mercury is a naturally occurring element, fish tissue mercury concentrations can never be reduced to zero.

2. In the absence of changes to the system other than mercury loading (e.g. changes in sulfur cycling, nutrient cycling, or hydrology), a reduction of about 80% of current total (1995-96) annual mercury atmospheric deposition rates would be needed for the mercury concentrations in a 3-year old largemouth bass at WCA 3A-15 to be reduced to less than Florida's present fish consumption advisory action level of 0.5 mg/kg (parts per million). This modeling did not attempt to deal with long distance transport of mercury from the global background into Florida. Clearly, long-distance transport from the global background must be presumed to be non-zero, but neither present-day models nor measurements are sufficient to estimate the magnitude of this source of mercury to Florida. From the 1995 SoFAMMS project, we can estimate that background mercury concentrations in rainfall at coastal sites in south Florida approximate 5 ng/L. Assuming annual rainfall rates of 130 cm/yr., these concentrations would result in background deposition rates equal to 6.5 $\mu g/m^2/yr$. If, as predicted by the UMAQL hybrid model/FAMS analysis, current loading rates are indeed *ca.* 35 $\mu g/m^2/yr$., this rate of background deposition (i.e., 21% of total loading) suggests that to reach a target of age-3 largemouth bass average concentrations not exceeding 0.5 mg/kg wet muscle for an average year would require virtually complete elimination of local atmospheric deposition sources of mercury.

3. Mercury concentrations in age-3 largemouth bass are predicted to achieve 50% of their long-term, steady state response within approximately 10 years and 90% within *ca.* 30 years following sustained mercury load reductions. The time it should take to reach 50% or 90% of final steady-state fish mercury concentrations following a reduction in mercury deposition is independent of the actual magnitude of the decrease. In other words, it takes about 10 years and *ca.* 30 years to reach about 50% and 90% of the ultimate steady-state fish mercury concentration, respectively, whether the reduction is 85% or 25% of the current mercury deposition rates. The time scale of this response is quite sensitive to the turnover rate of mercury in the surficial sediments. Factors which increase the flux of detrital material to the sediments (e.g., eutrophication) will result in a faster response time as elevated mercury in the sediment pool is buried deeper and more rapidly.

Further Work in Progress or Planned

There are a number of research efforts underway or planned to improve the capability of the combined atmospheric modeling and aquatic modeling approach.

The mercury contribution from background (hemispheric or global) sources is unknown, and directly affects both the estimates of atmospheric deposition to the study site, and the response of the system to given changes in the magnitude of the current load. The present analysis excludes consideration of long-distance transport of mercury into Florida because the present state of global models and measurements do not give us any basis for doing so. When this modeling study was performed, there were no measurement data of mercury species at several altitudes to incorporate long-distance transport in a quantitative manner. Until measurements or models allow us to constrain the uncertainties in the long-distance transport phenomenon, there is no objective basis for addressing this question.

Note: USEPA, DEP and NOAA-ARL conducted winter and summer aircraft campaigns to measure the relevant mercury species in and above the marine boundary layer off the east coast of Florida which should allow parameterization of this source term. Results of this investigation should be completed in 2002.

Previous research has suggested that the atmospheric deposition of mercury to south Florida is dominated by wet deposition, with the majority of this deposition associated with summertime convective precipitation events (Guentzel *et al.*, 1995, 2001; Dvonch *et al.*, 1999). The modeled analysis of dry deposition conducted as part of this study, however, suggests that dry deposition is important as well, comprising perhaps 34 to 40% of the total mercury deposition signal. Currently, only very limited data are available to assess this component more directly.

Note: The Florida Everglades Dry Deposition Study (FEDDS) conducted winter and summer field campaigns in 1999 and 2000, respectively, and when data analysis and modeling is completed, these results should improve both knowledge of depositional processes and parameterization of models.

If all current atmospheric loadings of Hg(II) to the marsh surface were eliminated, regardless of source, our analysis suggests that fish mercury concentrations would still be *ca.* 6 % of current values, at least over the next 100 years. Only a fraction of this is due to continued deposition of MeHg, which, based on limited measurements, appears to comprise less than 1% of the estimated current total atmospheric mercury load. Most of the continued supply of mercury appears to be internal through remobilization of Hg(II) and methylmercury from deep sediment layers via porewater uptake by macrophytes. Over the course of 100 years, Hg(II) and methylmercury concentrations in these deeper sediments are not significantly affected by changes in atmospheric mercury deposition in the simulations. This in essence adds another source of mercury to the overlying active marsh system, a source which would slowly diminish in the absence of atmospheric

Hg(II) deposition. This assumption should be critically reviewed in any future assessments.

Note: DEP and USEPA have initiated further analyses of potential sources of MeHg in rain and of MeHg in rainfall at multiple sites in the Everglades to confirm initial estimates of rainfall MeHg from FAMS. This will allow better parameterization of this term in future assessments. The stable isotope mesocosm studies currently conducted by USGS ACME team (Krabbenhoft & Gilmour, 2002) should further identify the nature of the dose-response relationship and the role of internal remobilization of legacy mercury on recovery.

A second major objective of this study is to identify major sources of uncertainty in our model predictions that would adversely influence our ability to reliably assess the relationship between local mercury emission sources and biotic response. Excluding errors relating to source characterization, modeled annual total mercury deposition rates had an estimated error of 8.3%. As illustrated earlier, the large uncertainties in source emission characterization (quantity and speciation) have a very pronounced effect on modeled deposition rates.

Note: It is clear that one of the most critical areas for future investigation is resolving the divergences in present mercury emissions inventories. Further work in this area is underway.

A number of aquatic cycling process and other factors presently are not well understood and are not fully developed in the E-MCM. For example, the sulfur cycle, e.g. sulfide-mercury interactions, in the Everglades is anthropogenically perturbed and poorly understood. Proper representation of sulfur chemistry in sediments could change the shape and the slope of the atmospheric loading-biotic response curve). The response curve slope produced in this analysis differs from unity regarding relative response to relative changes in loading largely because the model predicts that "legacy" mercury stored deep in the sediments (5 to 20 cm below the sediment-water interface) is mobilized and brought into the water column by macrophyte roots. Based on current sedimentation rates, this material will not be removed from the system for perhaps hundreds of years.

Note: An improved representation of sulfur cycling and chemistry is presently being developed for the E-MCM and will be available for subsequent analyses.

The E-MCM model also has inherent uncertainties that affect the predicted response of largemouth bass to changes in mercury loadings. Sensitivity analysis identified a number of key parameters to which the model is quite sensitive, including particulate fluxes relating to vegetation cover and suspended solids, sediment methylation and demethylation rates, and factors affecting fish diets and growth. Based on current limits of uncertainty in parameter values, the E-MCM is most sensitive to the uncertainty in parameters that relate to methylation and demethylation. However, to fully assess the effect of parameter uncertainty in E-MCM, including inputs for mercury loading from atmospheric deposition, a Monte Carlo analysis ideally would be conducted in which each model parameter is varied according to its likely distribution. Such capabilities in E-MCM were not available for this study. Nonetheless, the joint or combined effect of uncertainty in just two parameters (Figure 14) can be illustrated for predicted responses of largemouth bass to changes in atmospheric loading.

Note: Monte Carlo analysis routines are being developed for the E-MCM and will be available for subsequent analyses.

Based on the analyses presented herein it is evident that there is great potential for combining such air and water modeling approaches for TMDLs involving air deposition of mercury for other aquatic ecosystems. Although mercury was used as the 'model' pollutant for exploring how this type of TMDL analysis could be conducted, many of the limitations and successes that emerged in the application of the method for mercury likely are applicable to analyses that may be conducted for other impaired waters where the pollutants of concern are significantly of atmospheric origin (e.g. NOx, PCBs).

The progress represented in these demonstrations of a unique combination of atmospheric and aquatic cycling models is gratifying. Because this document represents the drawing together of many elements of monitoring and research programs, the preceding discussion has identified and dwelt on a number of areas where uncertainty remains. There is reason to believe that, with modest additional effort, these remaining uncertainties can be reduced to levels that will allow reasonable allocation of mercury emissions so as to protect the designated uses of affected waters.

6.1.1 Conclusions

This study has demonstrated the utility of using linked atmospheric and aquatic mercury cycling models to evaluate critical loading rates for an atmospherically derived pollutant (i.e., mercury). Important, if preliminary, information from this modeling indicates that the aquatic cycling of mercury is strongly influenced by changes in the atmospheric load, and that the ecosystem responds in a direct and rapid fashion to changes in load. This study also constructively reveals where uncertainties remain in the state-of-the-art for both the atmospheric and aquatic cycling models, and show what additional information is needed to improve subsequent analysis:

1. Based on the E-MCM model, the fundamental response of largemouth bass to long-term changes in atmospheric deposition of mercury appears insensitive to estimation errors of current levels of wet and dry deposition used during model calibration. This lack of sensitivity largely reflects our uncertainty in actual sedimentary mercury burial rates, coupled with the fact that this pathway is the major removal mechanism for mercury in the system. The predicted response is essentially linear, with calibrations to different assumed current atmospheric deposition rates yielding equivalent responses to imposed fractional reductions in deposition.
2. Sensitivity analyses indicate that E-MCM predictions are most sensitive to uncertainties associated with methylation and demethylation rates, particle and vegetation fluxes, loading rates of Hg(II), and factors affecting fish diet and growth.

Although the exercise of using differing calibrations based on uncertainties in current atmospheric deposition rates produced essentially equivalent mercury loading-largemouth bass response curves, we cannot extend that conclusion further. For example, changes in the assumed particle and vegetation fluxes may render model calibration problematic, and may suggest that other pathways for removing mercury from the system must be operating. The final calibration for E-MCM indicates that the primary removal mechanism for mercury at site 3A-15 is burial, and that sediment turnover rates govern the response time. Changing model calibrations that result in changes in sediment dynamics likely will have a profound effect on the predicted rate of response of the system to changes in atmospheric loading. Thus, further research on these model-sensitive parameters is required to more adequately define the relationship between loading and biotic response.

3. Year-to-year variations in atmospheric deposition to the Everglades are expected to be large (coefficient of variation = 26.3%), even if local emission rates remain essentially constant, due to year-to-year variations in meteorological and precipitation patterns. The impact of these variations on age 3 (and higher ages) largemouth bass mercury concentrations likely will be considerably dampened, both because of sediment buffering and because the concentrations of mercury in older fish reflect long-term integration of varying exposure levels. The lack of a long term Hg(II) deposition data set required us to synthesize a data set to estimate the effects of year-to year variations in Hg(II) deposition. Longer periods of record will be helpful for any future assessments.

4. The E-MCM model was calibrated by assuming current conditions reflect a quasi-steady state. There is accumulating evidence from studies both on mercury concentrations in largemouth bass and wading birds in the Everglades that this is not true – that the system appears to be undergoing a declining trend in mercury concentrations in fish and birds. Under ideal circumstances, E-MCM would have been calibrated to a long-term data set. Unfortunately, such long-term water chemistry and biota data sets do not exist, nor do high-quality, high-resolution mercury deposition and sediment accumulation rate data. This currently precludes a long-term, historical calibration, and was the impetus for choosing a quasi steady-state calibration.

5. Local emission rates and speciation used to predict atmospheric loading rates to the Everglades have a profound effect on the predicted results. The hybrid model simulations (which used south Florida point source emissions derived from the USEPA Mercury Study Report to Congress emissions database) resulted in a modeled total deposition rate of 31 $\mu g/m^2/yr$. Simply changing the emission rate of the two significant sources in Dade county to reflect actual stack testing speciation and rate data measured by Dvonch, *et al.* (1999) resulted in a 43% lowering of the modeled total deposition rate. These results would suggest that any attribution of hemispheric and global sources is very sensitive to parameterization of emissions speciation and atmospheric conversion. This uncertainty has obvious implications regarding the efficacy of controlling local sources to mitigate the current mercury problem in the Everglades. Thus, additional efforts to both assess source magnitudes and speciation,

and to characterize background rates of deposition, are critical if the TMDL process is to be successful.

7 RECENT TRENDS IN MERCURY EMISSIONS, DEPOSITION AND CONCENTRATIONS IN BIOTA

Over the past decade, progressive, statistically significant declines in mercury concentrations have been observed in both largemouth bass and great egret nestlings in a number of sites located throughout the Everglades (Pollman et al., 2002; Frederick et al., 2001). Coincident with these declines have been marked declines in local emissions of mercury (RMB Consulting & Research, 2002; Husar and Husar, 2002). Given that atmospheric deposition is the major source of Hg to the Everglades (Stober et al., 2001), and because local emissions have been postulated as the predominant source of mercury deposited in south Florida rainfall, including the Everglades (Dvonch et al., 1999), the question arises whether the observed declines in biota Hg concentrations can be related to declines in local emissions. This chapter reviews the existing data on mercury emissions, deposition, and biota trends in south Florida in order to address this question. Much of this discussion is based on work previously published by Pollman et al. (2002) and Pollman and Porcella (2003), but extends that work by including more recently available, longer time series for biota concentrations, as well as incorporating new analyses on wet deposition trends for mercury and some exploratory model hindcasting to examine the relationship between emissions and deposition, and aquatic biota response.

Trends in Mercury Emissions

Two fundamentally different types of analyses have been conducted to reconstruct recent trends of mercury emissions in south Florida. The first was a direct approach where a historical emissions inventory was compiled for the period 1980 to 2000 for Broward, Dade and Palm Beach Counties (RMB Consulting & Research, 2002). Emissions were estimated from plant operational data and emission factors typical for the source under consideration. These counties were selected as the region containing sources most likely to be important local contributors to mercury deposition in the Everglades and south Florida. The second approach was an inferential or indirect approach, where the trend in local emissions was inferred by reconstructing a mass balance on the flows of Hg ascribed to various use categories or major economic sectors (Husar and Husar, 2002). This latter analysis first focused on Hg use on a national scale, beginning in 1850 and continuing to 2000, then reduced the scale of analysis to the state level for Florida, and finally concluded with a regional analysis for the Broward, Dade, and Palm Beach counties for the period 1950 through 2000.

The emissions estimates compiled by RMB Consulting & Research (2002) indicated very large changes occurred between 1980-2000 as a function of the major combustion sources in south Florida (power generation, sugar industry, incineration of municipal and medical wastes; Figure 19). Total emissions were quite low between 1980-1982, and then increased in 1983 by 3.5 times above 1982 levels as both municipal waste combustors (MWC's) and medical waste incinerators (MWI's) came on line. Local emissions continued to increase through the 1980's until 1991, when a peak emission flux of nearly 3,100 kg/yr of total Hg was estimated. Throughout the peak emission period of 1983-1991, local Hg emissions originated primarily from MWI's (54 to 76% of the total), and MWI 's and MWC's combined comprised 92 to 96% of the total. Power generation was never above 0.4%, while sugar processing accounted for 4 to 8% of the estimated emissions.

As more stringent regulatory requirements took effect in mid-1992, many MWI's ceased operations, and medical waste was either sent offsite for processing, autoclaved, or landfilled. As a result, local emissions declined sharply through 1993 (65% compared to 1991 levels), followed by a slower and nearly monotonic rate of decline through 2000. The total estimated decline in local emissions between 1991 and 2000 is 2,846 kg/yr, which equates to a total reduction of 93%.

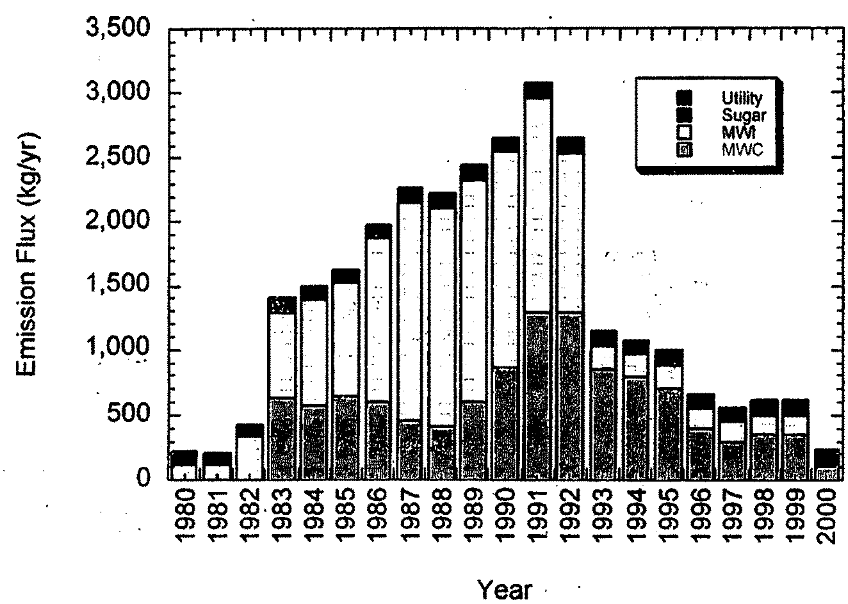

Figure 19. Annual mercury emissions in south Florida, 1980 – 2000, estimated by RMB Associates & Consulting (2002) as a function of major combustion source category. Sources include power generation facilities (Utility), municipal waste combustors (MWC), medical waste incinerators (MWI), and sugar refineries (Sugar).

Figure 20 shows the results from the materials flows analysis conducted by Husar and Husar (2002) for Broward, Dade, and Palm Beach counties. Use categories that contributed most greatly to the flow of mercury through south Florida included electrical (e.g., batteries, lighting, and switches), laboratory use, and control (measuring and control instruments) categories. Although coal is the largest source (45%; 65 Mg/yr) of Hg emissions for the US (144 Mg/yr), no coal combustion occurs in south Florida and only oil and product-related emissions occur.

The total mercury mobilization from electrical, laboratory use, and control categories is depicted in Figure 20 as a solid line ranging from a high of about 18,000 kg/yr in the 1980s and decreasing to <2,000 kg/yr in 1997. A somewhat uncertain fraction of this mobilized mercury is emitted to the atmosphere and, as a result, inferred emission fluxes based on assumed incineration rates of 15 and 30% of the total usage flux are included in the analysis. Also shown in Figure 20 are the direct emission estimates for MSW's and the combined flux from MWC's and MWI's from the RMB analysis. Both analyses show large declines in local emissions approximating 90% relative to peak emissions and the conclusion that local emissions have declined significantly appears reasonably robust. Estimated emissions from both studies agree well after 1993, but differ with respect to the timing of peak emissions.

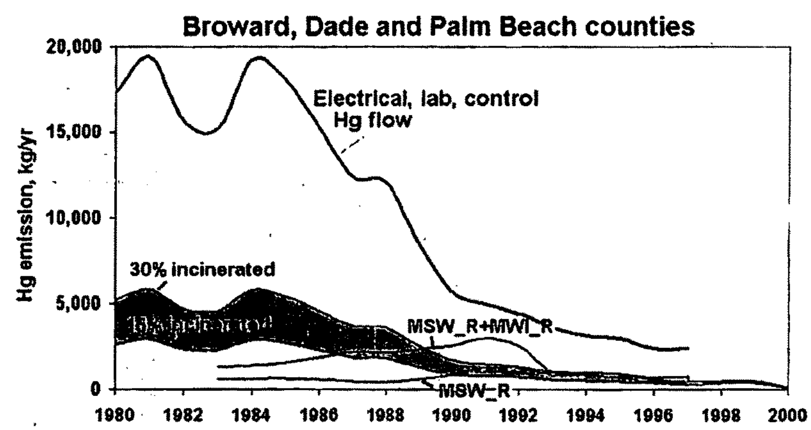

Figure 20. Waste incineration emissions for Dade, Broward, and Palm Beach counties inferred from analysis of mercury usage, 1980 to 1997. Upper line shows annual total mercury usage based on different usages. Emission fluxes are based on 30% and 15% incineration rates (complete mobilization of combusted fraction). Plot also shows emissions for MSW and combined MSW and MWI sources estimated by RMB Associates & Consulting (2002). From Pollman et al. (2002).

Trends in Atmospheric Deposition of Mercury

An essentially continuous record of wet deposition fluxes and concentrations are available from November 1993 through December 2002 at the Beard Research Center in Everglades National Park as part of the Florida Atmospheric Hg Study (FAMS, 1993-1996) and as part of the Mercury Deposition Network (MDN, 1996-2002; http://nadp.sws.uiuc.edu/mdn). The FAMS data consist of integrated monthly wet deposition measurements (Guentzel et al., 2002), while the MDN data consist of integrated weekly samples. During 1996, monitoring from both studies overlapped for the entire year, and comparison of monthly results demonstrated excellent agreement between the two programs (Pollman and Porcella, 2002). As a result, we combined the two studies to form a period of record of eight full years.

Smoothed time series were constructed for Hg deposition, rainfall depth, and volume weighted mean (VWM) Hg concentrations in wet deposition using 12-month running averages derived from the integrated FAMS-MDN data set (Figure 21 and Figure 22). As illustrated in Figure 21, rainfall depth and deposition flux are very closely related[11], and it is difficult to discern without further analysis whether any declines in wet deposition fluxes have occurred unrelated to changes in precipitation. Changes in VWM Hg concentrations are a less ambiguous indicator of whether changes in the atmospheric mercury signal have occurred, although precipitation depth does exert some influence on wet deposition concentrations through washout, particularly when the sample integration period is short. Plotting the running average annual VWM as a function of time indicates that VWM Hg concentrations have declined by 25% since late 1993.

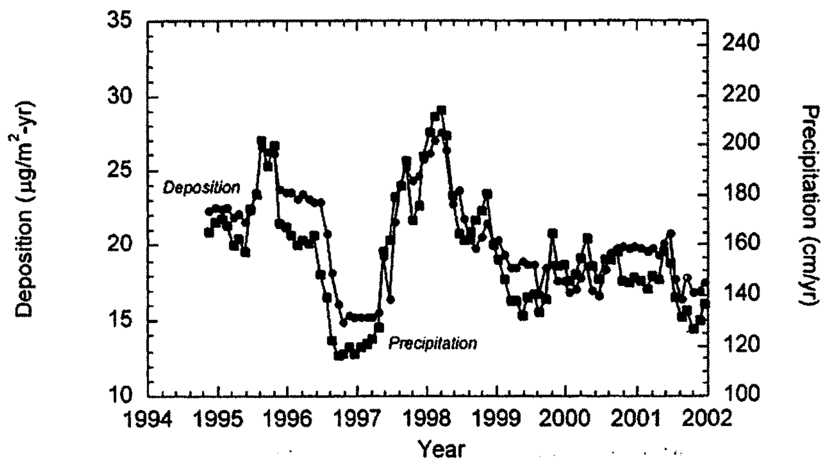

Figure 21. Annual precipitation depth and wet deposition fluxes of mercury measured at Beard Research Station in Everglades National Park, 1993 – 2002. Data are plotted on a monthly basis as the 12-month running total flux or depth. Data are from the FAMS study (Guentzel et al., 2002) and the MDN network.

An alternative analytical approach using analysis of variance (ANOVA; SAS, 1995) was used to eliminate possible confounding effects of both rainfall depth and seasonal dynamics on wet deposition concentrations. Guentzel et al. (2002) demonstrated that very strong seasonal dynamics consistently underlie wet deposition mercury concentrations in Florida within any given year; as a result, a seasonal dummy variable based on a sinusoidal transformation on the month of year the sample was collected was created and input to the model. The dummy variable had the following form:

[11] This is, of course, because deposition fluxes are the product of the weekly volume-weighted mean concentration and the rainfall depth.

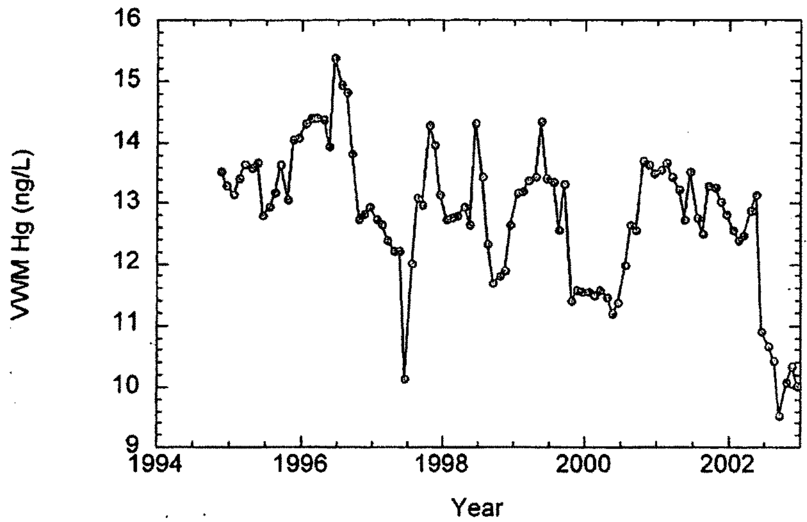

Figure 22. Annual volume weighted mean (VWM) Hg concentration in wet deposition at Beard Research Station in Everglades National Park. Plotted on a monthly basis is the 12-month running average VWM concentration. Data are from the FAMS study (Guentzel et al., 2002) and the MDN network.

$$D_{month} = A \cdot \sin(\frac{M' \cdot \pi}{12}) + B$$

where A and B are fitted using non linear least squares regression (SAS, 1995) and are equal to 8.8827 and 6.6954, respectively, and M' is the number of the month (*viz.*, 1 through 12), adjusted using a one month offset so that predicted and observed peak values occurred during the same month. Residuals from the ANOVA model for VWM Hg plotted as a function of time are shown in Figure 23 and demonstrate that a statistically significant decline (p = 0. 0413) in VWM Hg concentrations occurred over the period of record. Between 1994 and 2002, the analysis indicates that VWM Hg concentrations declined by approximately 3 ng/L due to factors other than seasonal dynamics and precipitation.

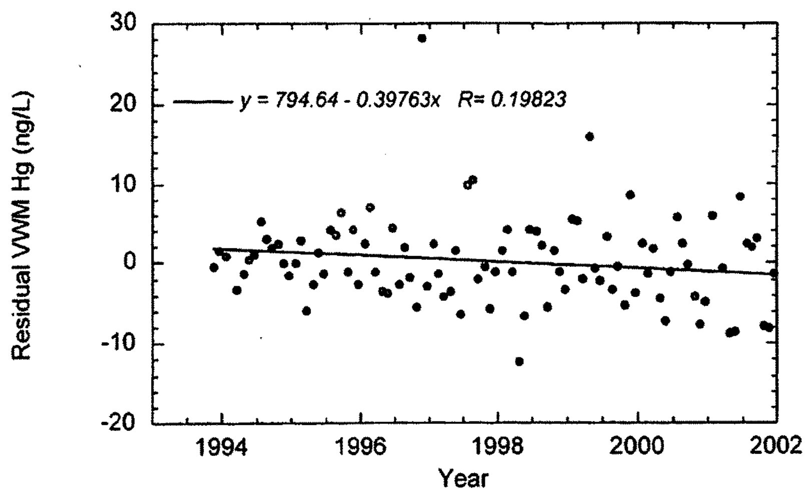

Figure 23. Plot of monthly residuals of ANOVA model of Hg deposition as a function of time. Slope of regression line is significant at $p = 0.0413$.

The declines in measured VWM concentrations are considerably smaller than the overall decline in local emissions estimated to have occurred since the late 1980's and early 1990's (Figure 19 and Figure 20). However, most of the decline in emissions occurred prior to late 1993 when monitoring of mercury concentrations in wet deposition first began. Indeed, the relatively modest change in VWM concentrations agrees reasonably well with the emissions declines after 1993 (Figure 24).

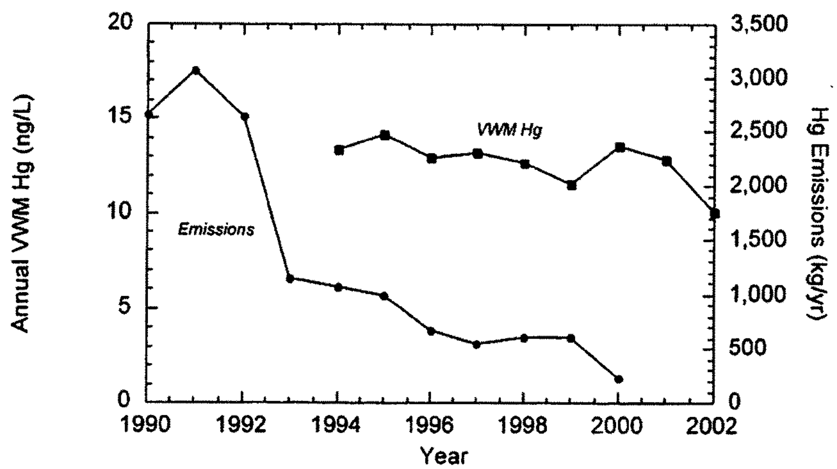

Figure 24. Annual VWM concentrations of mercury measured in wet deposition at Beard Research Center, Everglades National Park, and estimated mercury emissions from Dade, Broward, and Palm Beach counties. Emissions estimates from RMB Consulting & Research (2002).

Trends in Mercury Concentrations in Biota

Two different data sets are available to examine recent trends in mercury concentrations in biota in the Everglades: (1) the unpublished data of Lange et al. (T. Lange, pers. comm.), who have collected and analyzed largemouth bass for tissue concentrations of Hg from sites throughout Florida; and (2) the data of Frederick et al. (2001), who examined Hg concentrations in the feathers of great egret chicks, also throughout Florida and including seven sites in south Florida. Pollman et al. (2002) analyzed the significance of biota temporal trends using the Mann-Kendall Slope Test-of-Sign. This method is a non-parametric test for zero slope that calculates the slope for each possible pairwise combination of observations in the data set, and then ascribes a value of 1, 0, or −1 to the result based on the whether the slope is positive, zero, or negative.

Largemouth bass concentrations for 12 sites across Florida (including 9 sites in the Everglades) were analyzed for trend significance. The period of record analyzed extended from as early as 1988 to as late as 2000. The data were stratified according to age class since different age classes in any given year reflect different exposure histories. Of a possible 120 categories (i.e., 10 age classes x 12 sites), 66 had sufficient data to test for sign significance (Table 12). The results were split relatively evenly between a significant decline at the 95% confidence level (29 site-cohort combinations) and no trend (34 site-cohort combinations). Significant declines were observed across the state, suggesting a regional effect (e.g., atmospheric deposition), with the most consistent declines across cohorts observed for the two Everglades canal sites, L-67A and L-35B (and East Lake Tohopekaliga. The three sites in Water Conservation 3A near site 3A-15 (located near the so-called "hot spot" of high fish tissue concentrations in WCA-3A) also showed some cohorts with significant declines, although nearly as many site-cohort combinations also showed no change. Only three site-cohort combinations showed a significant increasing trend, and these all were observed at the U3 site in Water Conservation Area 2A. This increase likely reflects a highly localized effect both in time and space, such as peat burning and oxidation that occurred in the Everglades following the intense drought and drydown in May and June 1999 (Pollman et al., 2002). This period of peat oxidation induced a series of short-term but substantial changes in Hg biogeochemistry, including large scale increases in mosquitofish Hg concentrations at site U3, while the response at 3A-15, which remained wet during this period, was more muted (Krabbenhoft and Fink, 2001).

Table 12. Summary of Mann-Kendall Slope Test-of-Sign for trends in mercury concentrations in largemouth bass. Test results are given for individual sites and age cohorts. (-) indicates significant declining trend; (0) indicates no significant trend; and (+) indicates significant increasing trend. Site-cohort combinations with insufficient data are left blank. All results reported at the 95% significance level.

Location\Age Class	0	1	2	3	4	5	6	7	8	9
Northern Florida										
Fowlers Bluff		0	0	-	0	0	-	0	0	
Central Florida										
Lake Tohopekaliga		0	-	0	-	0	0			0
East Lake Tohopekaliga		-	-	-	-	-	-	0		
Everglades										
Miami Canal and L-67A		-	-	-	-	-	0	-		
L-35B Canal		0	-	-	-	-	0			
Indian Camp Creek-Rogers		0	0		0	0				
Marsh-15	-	-	0	0	0					
Marsh-GH	0	-	0	-						
Marsh-OM		-	-							
Marsh-U3	+	+	+	0	0					
Big Lostmans Creek	0	0	0	0	0					
North Prong	0	-	0	-	-	0				

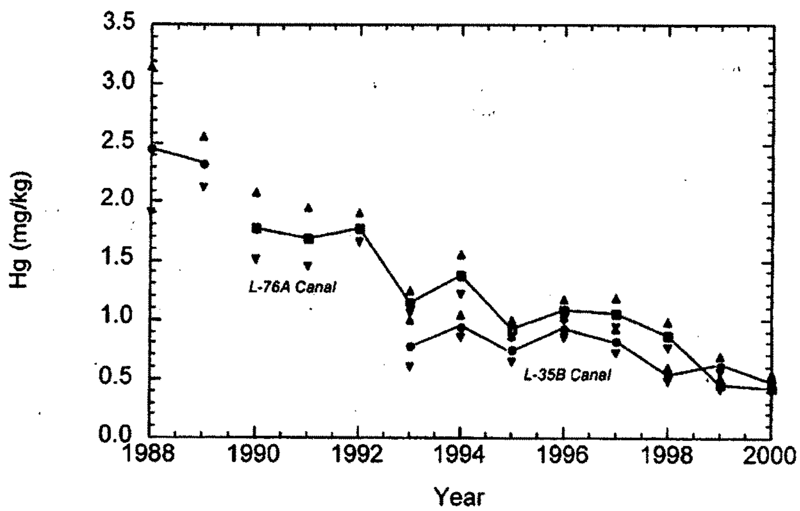

Figure 25. Tissue concentrations of mercury (wet weight) in largemouth bass in the L-67A and L-35B canals in the Florida Everglades. Filled circles show the geometric mean for each year; filled triangles show ± one standard error of the mean.

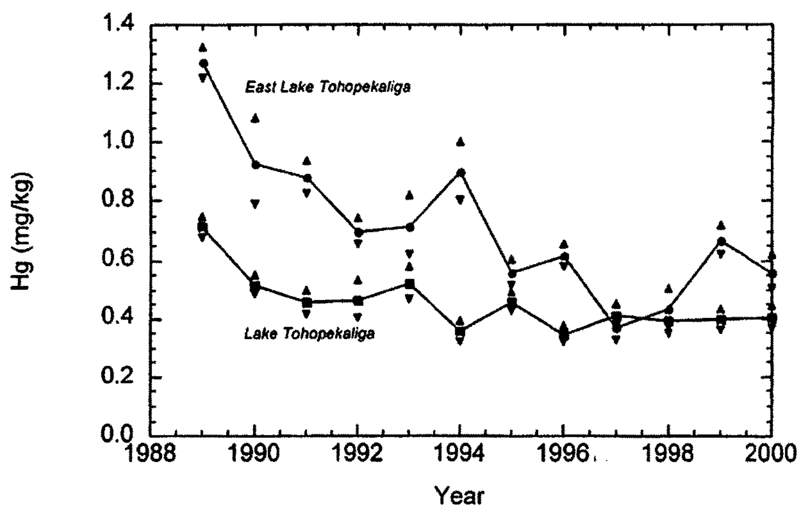

Figure 26. Tissue concentrations of mercury (wet weight) in largemouth bass in East Lake Tohopekaliga and Lake Tohopekaliga located in central Florida. Filled circles show the geometric mean for each year; filled triangles show ± one standard error of the mean.

Great egret chick data from all seven sites studied by Frederick et al. (2001) were tested for trend significance. When Pollman et al. (2002) conducted their trend significance analysis, the time frame spanned by the great egret study extended from 1994 to 2001. Additional data have since been collected, and the full period of record now extends to 2003 (Figure 27). Four sites (Alley, Hidden, JW1, and L67) showed significant downward trends through 2001 based on both the Mann-Kendall test and Sen's median slope analysis. The data from 2002 and 2003 further substantiate the overall robustness of the downward trend. Consistent with the largemouth bass results from the same region, results from colonies located in the mid-Everglades indicate over an 80% decrease in Hg concentrations over the period of 1994-2003.

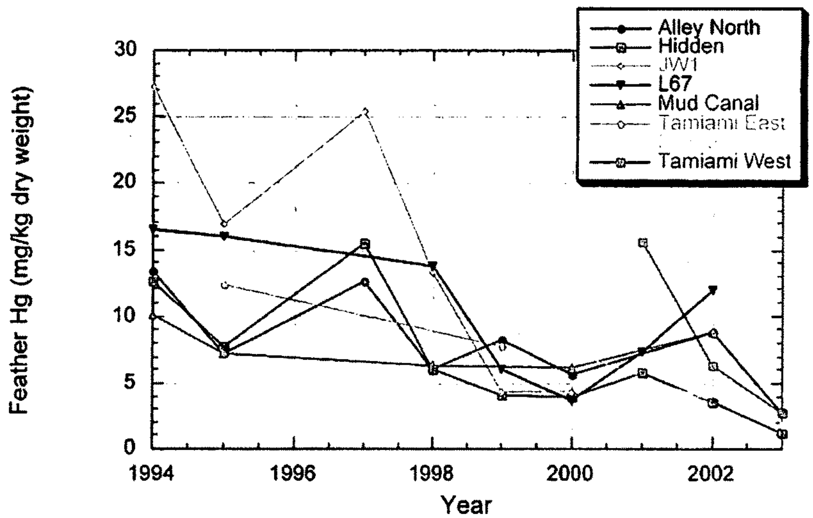

Figure 27. Mercury concentrations in great egret nestlings at various colony locations in the Florida Everglades, 1994 – 2003. Discontinuities in the period of record reflect years when a colony site was abandoned or otherwise not used. Unpublished data courtesy of P. Frederick (2003).

Model Hindcasting

E-MCM was used to predict changes in age 3 largemouth bass mercury concentrations in response to assumed changes in atmospheric loadings of mercury to site 3A-15. A simplified trajectory of changing deposition rates from 1900 through 2000 was developed with several assumptions or constraints imposed:

1. Based on Hg accumulation rates measured in soil cores in WCA-2A (Rood et al., 1995), an increase in modern deposition rates of 7.4-fold (1985 to 1991) over "pre-industrial" (ca. 1900) was assumed. Rood et al. measured an average accumulation rate of 8 $\mu g/m^2$-yr for ca. 1900 compared to 59 $\mu g/m^2$-yr for 1985-1991.
2. We assume that, superimposed upon the long-term background deposition of 8 $\mu g/m^2$-yr inferred from Rood et al., there has been a deposition signal derived from anthropogenic sources (local and larger geographic scale) that tracks the 1970-2000 Hg trend in the municipal solid waste (MSW) inventory compiled by Kearney and Franklin Associates (1991). This inventory shows that Hg in MSW peaked between 1985 and 1990, with a comparatively sharp decline through 1995, followed by relatively stable inventory quantities. As a first order analysis, we also assumed that anthropogenic emissions and associated deposition fluxes increased linearly from 1900 through 1985.
3. After emissions and deposition reached peak levels in 1985, we assumed that deposition declined linearly until 1996, with total mercury deposition reduced to 35 $\mu g/m^2$-yr. Following 1996, we assume that anthropogenic emissions remained constant (although there is evidence of continuing emissions declines). Figure 28 shows the mercury deposition trajectory that resulted from these assumptions.

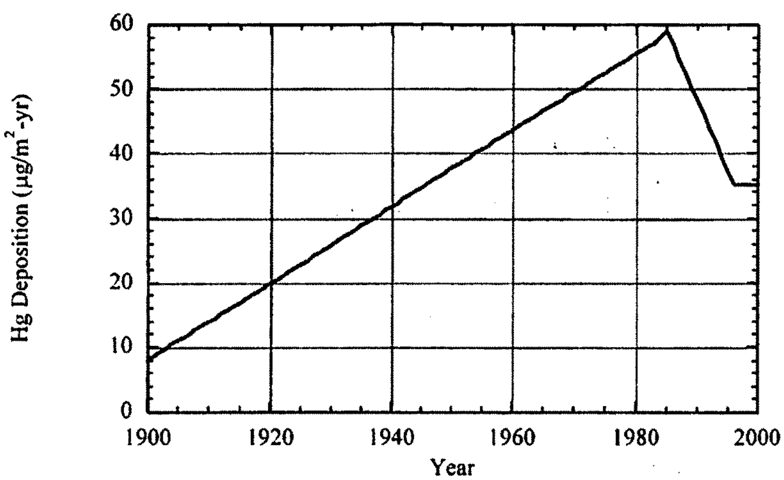

Figure 28. Total (wet + dry deposition) mercury deposition trajectory used in E-MCM model hindcast.

The mercury deposition trajectory was then used as the input forcing function to reconstruct a predicted time series of biotic (largemouth bass) response in south Florida using the E-MCM model. E-MCM had previously been calibrated for a site (site 3A-15) in the Florida Everglades regarded as a "hot spot" for high fish Hg concentrations (Appendix 2). E-MCM was initially run at pre-1900 deposition conditions until steady-state was achieved in all the model compartments (water, sediments, biota). The model then was perturbed by imposing the reconstructed deposition time series, and the predicted biota response compared to the observed trends for ca. 1990-2000. Results are shown in Figure 29. The hindcast simulation predicts a monotonic decline in largemouth bass concentrations on the order of 20% beginning ca. 1989 and continuing through 2000. Although the timing of the response is generally consistent with the observed biota, the magnitude is only about 1/3 the observed decline of ca. 60% (average of all data for south Florida).

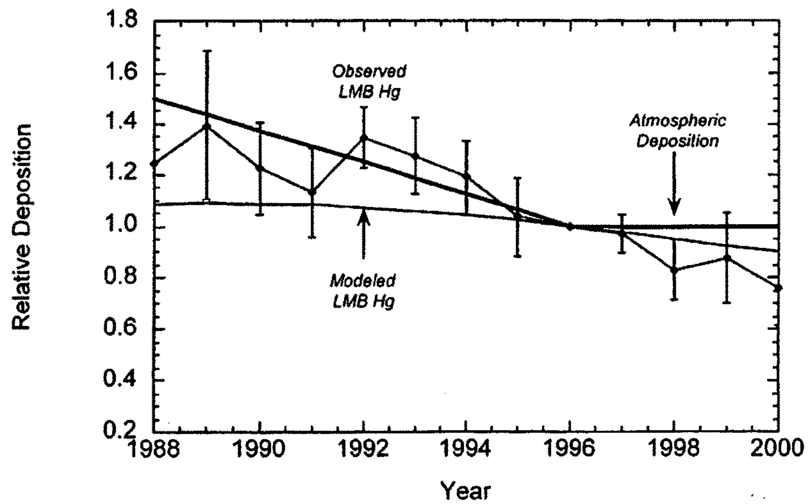

Figure 29. E-MCM simulation hindcast of changes in mercury concentrations in age 3 largemouth bass at 3A-15 in response to assumed changes in atmospheric deposition (see Figure 28). Analysis assumes that the depth of surficial sediments actively exchanging Hg(II) is 3 cm. Shown are normalized (relative to 1996) changes in atmospheric deposition inputs, observed concentrations in largemouth bass, and model results. Error bars are ± 1 standard error of the mean.

Mesocosm experiments currently underway in the Everglades indicate that mercury methylation rates and transfer to the aquatic food chain respond very rapidly in response to new inputs of Hg(II) (D. Krabbenhoft, pers. comm.). These experiments are being conducted using isotopic tracers to elucidate the magnitude and timing of changes in mercury cycling to changes in mercury inputs. Similar results are emerging from the Mercury Experiment To Assess Atmospheric Loading in Canada and the United States (METAALICUS; R. Harris, pers. comm.), which also is using isotopic tracers. E-MCM predicts that the primary pathway for introducing Hg into the foodchain at site 3A-15 is via methylation in the sediments and the benthic foodweb. Thus, the magnitude of the predicted response is governed by the residence time of bioavailable Hg in the sediments, which in turn is governed largely by the mixed depth of actively exchanging surficial sediments. The current assumption is 3 cm and, in light of the recent isotopic tracer experimental results, may prove to be a large overestimate of the size and residence time of the Hg(II) pool available for methylation.

To test the effect the assumed size of the pool of bioavailable Hg in the sediments exerts on the timing and magnitude of biotic response, we ran an additional simulation where the sediment exchange depth was reduced by an order of magnitude to 0.3 cm. The resultant hindcast agrees extremely well with the observed trends in largemouth mercury concentrations, both with respect to timing and the magnitude of change.

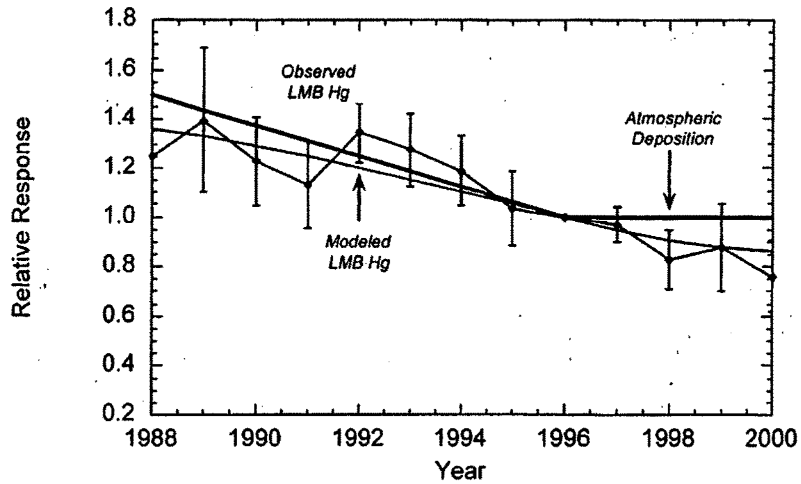

Figure 30. Same as Figure 29, except that the depth of surficial sediments actively exchanging Hg(II) is 0.3 cm.

Discussion and Conclusions

Local emission rates of mercury in south Florida appear to declined by over 90% since peak levels occurring in the late 1980's to early 1990's. This estimate is supported by two completely different approaches towards estimating emissions. Whether these changes in emissions have had a corresponding effect on local deposition rates of mercury in part is a function of the chemical speciation of the emissions. There are two major types of gas phase Hg species present in emissions from combustion sources: elemental Hg or Hg(0), and reactive gaseous mercury (RGM) or Hg(II). Speciation of emissions is critical because it influences greatly how far emitted Hg likely will be transported. Hg(0) reacts in and is deposited from the atmosphere only very slowly, and has a characteristic residence time in the troposphere on the order of 1 year. RGM, on the other hand, is highly reactive, and is scavenged rapidly from the lower troposphere by either wet deposition or by adsorption to settling particles and surfaces. If, for example, there has been a decline in Hg(0) emissions from south Florida, but RGM emissions have remained constant, we would expect little or no change in biota concentrations in the Everglades as a result. On the other hand, if local RGM emissions have declined, but Hg(0) emissions have remained constant, we would expect to see more of a biotic response. By not considering speciation, we risk misinterpreting the true significance of the relationship between local emissions and biotic response. This would be particularly true if Hg(0) emissions greatly predominate. Unfortunately only limited data are available on the speciation of Hg emissions as a function of source, including speciation measurements conducted by Dvonch et al. (1999) from a municipal waste incinerator (8 measurements), a medical waste incinerator (3 measurements) and a cement kiln (3 measurements) in Dade and Broward counties. The fraction of Hg(II) emitted ranged from 25% of the total (cement kiln) to nearly 95% for the medical waste incinerator. The fraction of Hg(II) emitted by the municipal waste incinerator averaged ca. 75%. Since the local emissions inventory for Dade and Broward counties in 1995-96 was dominated by municipal waste and medical waste incineration (ca. 86% of total emissions), it appears likely that Hg(II) emissions were predominant, at least for 1995-96. If these speciation results are similar for historical emission patterns (and there is no reason to expect that Hg(0) emissions were more important), then our approach of examining total emissions and linking the trends to local biota response appears reasonable.

Coupled with changes in local emission rates is evidence that mercury concentrations in wet deposition (annual VWM) in south Florida have declined by about 25% since late 1993. Statistical analysis indicates that the trends are significant, and are due to factors other than seasonal dynamics and changes in precipitation rates. Although the declines in measured VWM concentrations are considerably smaller than the overall decline in local emissions, most of the decline in emissions occurred prior to late 1993 when monitoring of mercury concentrations in wet deposition first began. Indeed, the relatively modest change in VWM concentrations agrees reasonably well with the emissions declines after 1993.

Statistically significant declines in mercury concentrations in both largemouth bass and great egret chicks have been observed for a number of sites in the Everglades. Declines over approximately the past decade for both species are on the order of 80%. Model hindcasting using the E-MCM model calibrated for 3A-15 indicates that changes in atmospheric deposition inferred from sediment core analyses may account for the recent changes in largemouth bass mercury concentrations, both in terms of timing and magnitude of change. For this to be true, however, requires modifying the current model paradigm with respect to the size of the pool of Hg(II) that is readily bioavailable in surficial sediments for methylation (*viz.*, reducing the size and residence time of the Hg[II] pool). Such a paradigm shift is consistent with recent isotopic tracers experiments indicating that mercury cycling in aquatic systems responds very rapidly to recent inputs.

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Senator CARPER. You were right on the money too.

Senator Barrasso, we don't see this every day.

Senator BARRASSO. No, we don't.

Senator CARPER. It is pretty impressive.

Secretary, I was mentioning to Senator Barrasso today is also June 13th, the last legislative day, the last day of the Fiscal Year for a bunch of States. In Dover, Delaware, this is really a big day for Governors and secretaries of the Natural Resource and Environmental Control. The legislature convenes at 2 this afternoon and I know there is a Governor back there who would like to have his Secretary by his side, so I am going to ask a question or two of Secretary O'Mara, and I said to Senator Barrasso if he has any questions to ask of you, to feel free. I think he is not going to, but at that point in time you would be excused to return in your personal helicopter. No, not really. We wish. They used to say to me when I was Governor, do you have your plane? I said, no, we have a glider in Delaware. All we need.

[Laughter.]

Senator CARPER. Secretary, a couple of questions, if I could, then you will be excused. Do I understand you and Dr. Shaw are contemporaries from your respective States? Is that pretty much it?

Mr. O'Mara. Absolutely.

Senator CARPER. Have you all met before?

Mr. O'Mara. No, not before.

Senator CARPER. Well, good. Secretary O'Mara, before you go, would you just comment on some of Dr. Shaw's concerns with EPA's rulemaking process that he has expressed?

Mr. O'Mara. I think one of the challenges that we do face is that, as you said in your opening remarks, that pollution doesn't really know State boundaries. So we need to have good science driving and look at what the attainment area should be. I obviously can't speak to the mechanics of what was noticed and what wasn't and the specifics, but I do think that adopting a regional approach to address a regional problem is absolutely critical, and having the science drive that.

One of the things that I didn't mention in my comments was having broader non-attainment areas make a lot of sense and just making sure that those boundaries are broad enough to actually be able to resolve the challenge. So while I can't speak to some of the mechanics of the administrative process, I generally agree that we need to make sure that we are looking beyond our State borders for reductions that improve the quality of life for folks in every individual State.

Senator CARPER. All right. Another question for you, if I could. Two of the witnesses on this panel believe that the emissions standards for the Transport Rule and the Air Toxics Rule are too tight and said it would need more time. Could you just take maybe a minute or two to highlight your experiences with our own regulations in Delaware and how companies have been able to respond to tighter emission standards?

Mr. O'Mara. In many ways Delaware is a great example of a real test case, rather than a theoretical model or some kind of abstract hypothesis because, like many other States, to achieve our air quality attainment plan, our SIP goals, we really needed to do everything we possibly could to reduce emissions in State. So we have had a very strong mercury rule in place for several years, and companies in our State found they were able to, through a fairly cost-effective carbon injection technology, go from 70, 80, 90 percent emission reductions for mercury.

Senator CARPER. Does that kind of thing cost hundreds of millions of dollars to have that kind of technology?

Mr. O'Mara. It is in the millions, but in the lower part.

Senator CARPER. OK, thank you.

Mr. O'Mara. And these are investments they believe they can recoup very quickly in the capacity markets and other types of investments in the PJM grade, of which Delaware is a part.

Senator CARPER. But do they find that they had confined in the work force people, tradesmen and women who could actually do the work, or is it hard to find them?

Mr. O'Mara. No, absolutely, because one of the—there is a series of improvements being made right now in the largest coal unit in Delaware, and under your leadership we were able to make that successful, about $300 million worth of improvements to actually put four or 500 tradesmen to work that are working right now that actually weren't employed otherwise because of other changes in the broader economy. So we found a good supply of skilled labor and actually the cost for implementation was a little lower because of that competition.

Senator CARPER. OK. Good. Thanks. One quick followup. Under the Clean Air Act States have few tools available to them to hold upwind States accountable. What if we took away these tools from the States and just had one standard that stood forever for utilities? How could that affect a State more like ours, or like New Jersey or Rhode Island, or some of the other States that are represented here, Maryland?

Mr. O'Mara. We fundamentally agree that the work that you have been working on in the multi-pollutant regulation of having some national standards, it is critical to have a baseline, a floor, if you will, of consistently. At the same time, we do believe that the States should have some flexibility to go above and beyond that floor. In many cases there are local factors that do require and that States will want to address, smaller cancer causes, more localized problems.

So we would love to see a national floor that had a rigorous base to make sure that there aren't these massive transport issues, while still giving the States some flexibility to address key issues that might be specific to their individual State.

Senator CARPER. OK.

Senator Barrasso, any questions of Secretary O'Mara?

Senator BARRASSO. No. Thank you, Mr. Secretary.

Senator CARPER. Do you think he is a keeper? What do you think?

Senator BARRASSO. The people of Delaware are fortunate to have both of you.

Senator CARPER. Oh, you are nice to say that. I would say you are least half right, with respect to him. Thank you, Senator.

OK, Secretary O'Mara, good luck. Tell the Governor I said good luck. Go get them.

Mr. O'Mara. We will give everybody your best in Dover.

Senator CARPER. Please do.

Let me yield now, if I could, to Senator Barrasso.

Senator BARRASSO. Thank you, Mr. Chairman.

Ms. Walz, it is my understanding Tri-State owns about 24 percent in Basin Electric, which in turn owns the Laramie River Station Power Plant, and it is the largest employer in the Wheatland area, about 300 well paid people, great benefits, good salaries, good jobs, and the taxes paid to the county, to Platte County, are over half of the county's budget.

What happens to a town, Wheatland, a county like Platte County, and it is not just them, hundreds of communities around the Country, if a power plant has to close because of a combination of EPA regulations? What happens to kids? What happens to the seniors in the small towns in terms of the school district, emergency services, police, fire services? What are the impacts when EPA regulations force the closure of a power plant?

Ms. WALZ. Senator, in my opinion, I will use the example of Laramie River Station. It is a very critical aspect for the town of Wheatland. It employs a large number of people with good paying jobs, good benefits, takes care of family, keeps produces and services flowing in the community. Basically, I think if the power plant there had to close, it would be devastating to that community. I would say significant people would have to move either out of the area, out of the State, and find other opportunities because it is a critical key aspect to the town of Wheatland, and similar to other rural communities where we have power plant locations.

Senator BARRASSO. In your written testimony you stated that, "Because we are a not-for-profit cooperative that is ultimately owned by our consumers, these new compliance costs are going to be passed on directly to cooperative member owners in the form of higher rates." Please describe for me and for the Committee how the cooperative member, who they are? Are they wealthy CEOs? Are we talking about Wall Street financiers? And will the folks at home feel the impact of higher costs?

Ms. WALZ. Yes, Senator. A cooperative is an electric utility owned by the residents in the communities. You have to be in a rural area to be considered a rural electric cooperative. So essentially the people that get the end-use electricity are farmers, ranchers, small businessmen in the small towns. Basically, in the event, again, rates were increased because of costs associated with these controls, all of those costs are passed on directly to those end-use customers. It is different than investor-owned, where you have shareholders and others to absorb the costs.

Additionally, they are absorbing more costs. An example I can give you for that is if you look at one mile of transmission line and you look at a cooperative across the Country, basically you have five consumers per one mile of transmission line. In Wyoming, it is actually 2.8 consumers, so even less population there.

Where you have an investor-owned utility, you have about 37 people that are served by one mile. That one mile of transmission line still has the same costs associated with it not only for capital investment, for operation and maintenance; and that is just the transmission line side. If you look at the generation stations and the cost of additional controls associated with that and you invest $100 million into a community where you only serving a much, much smaller population than like a Chicago or even a Denver, obviously the costs are more significant for those rural folks; they have a larger share, if that makes sense.

Senator BARRASSO. Do you feel the EPA really understands how rural co-ops operate, how they work, compared to company-owned?

Ms. WALZ. It has been my experience that we routinely have to explain the differences on both the Federal and State level, that I do not think they understand fundamentally the differences.

Senator BARRASSO. Dr. Shaw, in your testimony you said we question whether it is appropriate for EPA to establish energy policy for the Country. Could you elaborate a little bit further on this point and where this issue could be handled better?

Mr. SHAW. Sure. Clearly, the Clean Air Act gives certain authority to EPA, and specifically their intent is to derive the standards and programs to address those environmental issues. It appears in this rulemaking that EPA is more intent on changing what the energy fuel makeup of the Nation is through a misapplication, if you will, of the section of the Clean Air Act that they are using to justify this. A great deal of the concerns I have are exactly with that. EPA doesn't seem to be addressing those requirements for justifying the health-based concerns associated with the emissions; instead, it is looking at more trying to assert a different policy using this as a tool.

Senator BARRASSO. Thank you.

Thank you, Mr. Chairman.

Senator CARPER. You are welcome.

Two last questions, then I am all done.

Dr. Carpenter, if I could ask a question of you. In Chairman Shaw's testimony he questions the scientific knowledge that we have on health effects of mercury exposure. However, in Texas alone, where I used to live, I was a naval flight officer stationed at Corpus Christi, lived in Flour Bluff. The only guy I ever talked to from Texas who knew where Flour Bluff was George W. Bush.

However, in Texas alone, the Lone Star State has numerous health advisories against eating mercury-laden fish in Texas waters. Could you take a minute or two to give us a little more detail on what we know about airborne mercury particles; how they can get into our fish and how mercury exposure impacts developing children's health? And are U.S. coal-fired power plants a large source of that mercury, are they a significant source, a small source? Finally, is the scientific data robust?

You will hear us say from time to time we need good science; we need to work on good science. And when George Voinovich was here, he chaired this Subcommittee, he and I actually worked on a proposal to require somebody at a very high level at EPA to be like their science I won't say czar or czarina, but just somebody who was there to say we are using good science, we are just dedicated and committed to good science. So is the scientific data robust?

Dr. CARPENTER. Let me start with the second question you asked, which is what is the percentage of contribution from coal-fired power plants, and the best evidence—and I think the best evidence comes through reports of the National Academy of Sciences, which has done extensive reports on the issue of mercury—is that about 50 percent or a little more of the mercury in fish in U.S. waters comes from coal-fired power plants.

Senator CARPER. A little more than half?

Dr. CARPENTER. A little more than half.

Senator CARPER. OK.

Dr. CARPENTER. Now, mercury is a global pollutant. We get some mercury from China, because when coal is burned, the mercury goes into the air; it is the vapor phase of the elemental mercury and it can be transported for long distances.

On the other hand, there is clear evidence, particularly studies in Florida, where mercury releases from power plants were dramatically decreased and mercury levels in local fish followed over a period of time showed a dramatic reduction.

So while getting all the mercury out of the power plants isn't going to solve all of the problem—everyone would agree with that—it is going to solve the majority of the problem.

Now, is the evidence robust? The evidence is overwhelming. Mercury causes a reduction in IQ of children born through the mercury in their mother's body. It has been demonstrated in countries around the world. Again, the National Academy of Sciences reports are probably the most objective critical reports in that regard, but there are hundreds of scientific publications.

So I think it is simply not true that there is any question about the science, nor any question about the impact. And what we need here is the will to follow through and reduce the local mercury releases, which are the majority albeit not all of the problem.

Senator CARPER. All right, thanks.

My final question would be of Ms. Tierney, if I could. We had a hearing, Senator Brown of Massachusetts asked us to do a field hearing up in Boston and we focused on an issue involving Federal financial management up there, and there was a Congressman named John Tierney who testified. I think he is maybe from the Third District. Are you from Massachusetts?

Ms. TIERNEY. I am from Massachusetts. I am married to John Tierney, but not that one.

[Laughter.]

Senator CARPER. It is a small world, isn't it? OK. Well, in your testimony—I wonder if the other John, Congressman John Tierney is married to a woman named Sue. Wouldn't that be something?

Ms. TIERNEY. They are just all over the place.

Senator CARPER. They are. Up there they are.

In your testimony you State that reliability should not be an issue with the implementation of the Transport Rule or the Air Toxics Rule. However, in Chairman Dr. Shaw's testimony, he mentions that the Electric Reliability Council of Texas recently came out with a report contrary to your findings, I believe, and I would just ask are you familiar with that report and could you take a shot at explaining the differences, if there are any, please?

Ms. TIERNEY. I would be happy to. ERCOT, which is the Electric Reliability Council of Texas, very recently came out with a study, having been asked by the Public Utility Commission of Texas, to look at this question of whether the clean air rules would be adversely affecting reliability in Texas. The ERCOT analysts essentially ran a model of what the system would look like with these new regulations in place, with gas prices as they are today and expected to be in the future, and a number of other assumptions.

The interesting results were that ERCOT did not believe that coal plants would likely retire as a result of these rules. They said that some of the oldest thermal gas-fired power plants might retire and, if that were the case, ERCOT had not really looked at the question of what would be in place to replace them.

In Texas, which has one of the most vibrant markets for power in the Country, there is a tremendous amount of market interest and development of gas-fired power plants and wind power plants. There are many in process at the moment, and one of the interesting things that ERCOT discovered was that in order to address some of those potential retirements of gas-fired power plants in the Houston and Dallas-Fort Worth area, that would enable—when those units would be replaced, that would avoid transmission investment that would be required otherwise in that area and there would actually be savings for Texas consumers.

Senator CARPER. All right, thank you.

Senator Barrasso, last questions? Any closing comment, please.

Senator BARRASSO. Yes, thank you, Mr. Chairman, for holding this hearing.

Dr. Shaw, you said throughout your testimony the EPA rules are not technologically feasible, that they won't work. Assistant Administrator McCarthy was here earlier, testified in the first panel, that effective technologies for controlling emissions—mercury, NOx, SO2—from power plants "have been available for years." So what are you seeing that Assistant Administrator McCarthy isn't seeing?

Mr. SHAW. Thank you. Certainly, while these rules have been talked about for some time, what we are seeing more recently is the advent of these controls that they are looking to putting into a very tight timeframe. Some of what is missed in their analysis is the, for example, the ERCOT study that was just talked about did not consider that the Clean Air Transport Rule would include Texas, even though EPA was taking comment on that, the models that they applied did not consider those impacts.

So what we are looking at is, in the State of Texas, due to our resilient growth in both population and in job creation, the demand has increased such that even absent some of the early retirements associated with these rules, we are looking to not meet the increase in demand required to maintain reserve capacity. So I think what Ms. McCarthy is seeing is that it fails to look at some of the control technologies that are already in place and does not take full account of the costs associated with not only the capital investment, but also the operating and changes in infrastructure required for those.

Senator BARRASSO. Ms. Tierney, you work with utilities that seem to support the proposed EPA MACT Rule for the power sector, along with most of the other rules coming down the pike that, to me, increase the cost of doing business for coal-fired facilities. As I understand it, your clients don't use a significant amount of coal, so their own compliance expenditures under the rule wouldn't be very much. Those clients wouldn't need to stand in line for additional engineering resources for capital and the like. Yet, they kind of speak with confidence about the rule.

There was an editorial in the Wall Street Journal back in December that might shed some light on some of the motivation of those utilities. The Journal wrote, "Eight leading utility CEOs responded recently to one of our editorials with a letter defending the EPA, claiming that the coal retirements are 'long overdue' and that the regulations would 'yield important economic benefits.' "

What they didn't mention is that those benefits were mostly accrued to the businesses that they happen to head. The Journal cited actual transcripts of analyst calls with CEOs of those companies, notably John Rowe at Exelon, Lew Hay at NextEra. Essentially, they went on to say these companies say that the rules that are costly for their coal-fired competitors will cause more consumption of natural gas, thus significantly increasing the price that consumers can be charged for electricity in the markets that these two companies serve, without requiring either company to make any additional investment. It is called increasing the "clearing price" of energy.

So do you disagree that these clients have an economic and a competitive motive to embrace what to me are very costly EPA rules and regulations?

Ms. TIERNEY. I don't disagree that there will be companies such as those in the Clean Energy Group who have already made the investments and are already living in markets where they have a competitive disadvantage at the moment. That said, I also work for transmission companies, grid operators, oil electric co-ops, large and small energy consumers, environmental groups. I have a very diverse set of clients, and as a result of that I speak for myself in saying that all of the issues that I have described here today are based on analysis of what is going on in the industry. Among those things that I mentioned are the CEOs' testimony and statements from companies that are not among the group of companies that you just described who have coal units who have said that they are ready and well prepared to live with these new manageable rules.

Senator BARRASSO. Thank you.

Thank you, Mr. Chairman.

Senator CARPER. Any closing statement? Do you want just a quick closing statement?

Senator BARRASSO. No. I just continue to be concerned about an unemployment rate, Mr. Chairman, 9.1 percent, I think we will get new numbers out tomorrow, and I think that has a significant impact on the health of people who are looking for jobs, trying to raise families, trying to put food on the table.

And I think we can do a lot for people and for the Country and for the health of individuals by getting people back to work, and I think that has to be included in a lot of these discussions, and I wish that the Environmental Protection Agency would focus a little more on that and a little bit less on being fixated with eliminating any potential environmental risks, no matter how small and no matter how costly.

So thank you, Mr. Chairman.

Senator CARPER. I would just close, again, thanking all of you for being here and for preparing to be here with us today and for your testimony. Just to followup on what Senator Barrasso has said, the States that are along the Mid-Atlantic and the Northeastern part of our Country who end up having to spend more money for our energy because others create cheap energy and send the pollution our way impedes our ability to create jobs and retain jobs.

The fact that we may incur greater costs for health care because our air is dirtier because of the bad air that comes to us from folks that use, in some cases, old coal-fired plants to create electricity, that impedes our ability to maintain our own jobs. Several of our witnesses have said there is an equity question. There is really a fairness question. It really goes back to the Golden Rule; we ought to treat other people like we want to be treated, or, conversely, don't treat others the way you don't want to be treated. So that is at play here.

And for us the question is how can we address this question of fairness or unfairness, and it is the health care costs that underlie it all and the economic disadvantages for some States, particularly in the Mid-Atlantic and the Northeast. How do we do that in a way that is cost-effective? How do we do that in a way that maybe harnesses market forces and uses good science?

We just have to be smart enough to do that, and I think the two of us are. I think maybe our 98 colleagues are as well. One of the things, we have a lot of smart people working for us and we have to be able to figure this out. We tried legislatively for, gosh, my first 8 years in the Senate to do this legislatively and harness market forces.

Ultimately, we couldn't do it. We just couldn't summon the political will to pass what I thought was pretty legislation, bipartisan legislation. And it falls on EPA to do what we were unable to do legislatively, and my hope is that, using good science and taking a lot of comments and advice from folks around the Country, to use that.

At the end of the day the question is can we have cleaner air, can we have jobs that actually might be created from cleaning that air? I think we can do that. I think we can do that and history would show that we have been able to do that pretty well for some time.

The folks, our colleagues who haven't come and had the privilege of hearing your statements and to ask you questions, they will have a couple of weeks where they can submit questions, and we would just ask, if you do get those questions, if you would promptly respond to them, we would be most grateful. So wherever you have come from across this great land of ours, thank you for making the trek. It is great to be with all of you. Happy Fourth of July. Thank you so much.

With that, this hearing is adjourned.

[Whereupon, at 12:23 p.m. the committee was adjourned.]

[Additional material submitted for the record follows.]

STATEMENT OF SENATOR JAMES M. INHOFE, U.S. SENATOR FROM THE STATE OF OKLAHOMA

Chairman Carper, thank you for holding this hearing today to discuss EPA's proposed Transport and Utility MACT rules. I would also like to thank the witnesses for being here today.

Let me say at the outset that, when it comes to reducing real air pollution from power plants, the best way to accelerate environmental progress and institute certainty for businesses is through multi-pollutant legislation. And even though we have fallen short in recent years, it is increasingly clear that the Clean Air Act needs to be updated and the rules for electric utilities are the place to start.

This is not something new for me. I supported 3-P legislation when, as Chairman of EPW, I tried to advance the Clear Skies bill. Because that effort eventually failed, for reasons I won't get into now, we received regulations under the Clean Air Act that the DC Circuit ultimately rejected—something I predicted would happen. Here's what I said when the Bush administration's Clean Air InterState Rule was promulgated: "This Clean Air InterState Rule is significantly more vulnerable to court challenges than legislation and will undoubtedly be held up. Trying to litigate the way to cleaner air only delays progress, often yields little or no result and wastes millions in taxpayer dollars."

So here we sit, debating EPA's replacement regulations that are onerous and complex and vulnerable to the same lawsuits that stymied previous attempts to reduce emissions of sulfur dioxide, nitrogen oxides and mercury.

Most alarming is the effect the rules will have on our economy. Messy court rulings and bureaucratic overreach have produced regulations that will harm the economy. As the National Economic Research Associates (NERA) recently pointed out, these rules will likely result in electricity costs increasing by as much as 23 percent and 1.4 million lost jobs by 2020. Not a recipe for economic recovery.

Of course, these aren't the only hurdles the power sector faces. Known as the "train wreck," utilities also face moving and uncertain emissions targets as EPA further tightens National Ambient Air Quality Standards (NAAQS) for ozone and Particulate Matter (PM) over the next few years. Combined with rules for regional haze, new source performance standards, Acid Rain, and new source review requirements, the Clean Air Act presents a labyrinth of overlapping and redundant requirements that drive up electricity costs and hamper our economy.

In my State of Oklahoma, EPA's rules are causing substantial concern. And we're starting to see the effects already. Earlier this month, American Electric Power (AEP) announced it would be forced to close power plants in six states and lay off 600 workers as a result of EPA's rules. Two plants are being idled in Oklahoma.

All of this might be great for environmental lawyers who, incidentally, make money by exploiting the citizen suit provisions of the nation's environmental laws. That's right, your tax dollars being used to destroy jobs in your own community. So you can bet these rules will be challenged, and we'll be back here next year.

It might also be great for energy companies—who profit by rising electricity prices. Exelon CEO, John Rowe, has been quoted as saying that for every $5 dollar increase per megawatt of power generated, his company makes $700 to $800 million in additional annual revenue. The regulations we debate here today could raise electricity prices by as much as 20 percent in some markets.

But ultimately, it's working families that pay the price.

Of course, there are ways to reduce emissions and help keep electricity rates low. Perhaps the biggest one would be to update the Clean Air Act to stop the EPA "train wreck." Reducing emissions doesn't have to be this costly—the Obama EPA just wants it to be. Recall President Obama's pledge: "under my plan electricity rates will necessarily skyrocket."

Last year, Senators Carper and Alexander introduced "3P" legislation that began to look at many of the issues we address here today. I commend them for taking on that challenge. But that legislation failed to get widespread support because it did nothing to address the utility "train wreck." It simply added new requirements on top of old, increasing uncertainty and costs.

Now, with plant closures on the horizon, workers being laid off, and electricity prices sure to rise, a coalition of Congressmen and Senators is coming together to fix the Clean Air Act. I look forward to working with them. We can and should continue to reduce emissions, but we should do so in a way that protects families from skyrocketing electricity prices and businesses from unachievable requirements.

MARK H. AYERS, President
SEAN McGARVEY, Secretary-Treasurer

MICHAEL J. SULLIVAN, 1st Vice President
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November 5, 2010

Honorable Tom Carper
513 Hart Senate Office Building
Washington, DC 20510

Dear Senator Carper:

Thank you for your letter regarding the ability of skilled construction trade unions to respond to expected demand for workers involved in the installation of pollution control technology. As you know, the work involved in improving the air quality impacts of our nation's power generation fleet is a significant source of employment opportunities for a number of our Department's affiliated unions. There is no evidence to suggest that the availability of skilled manpower will constrain pollution control technology deployment. In fact, given the high levels of unemployment in the construction sector, these jobs are much needed.

The installation of equipment to control for SO2, NOx, mercury, and other hazardous air pollutants requires a wide range of skilled crafts, including pipefitters, boilermakers, electricians, ironworkers, heat and frost insulators, and laborers.

Recent modeling of the Environmental Protection Agency's Clean Air Transport Rule suggests that approximately 14 GW of flue gas desulfurization technology will be deployed as a result of the rule. Evidence suggests that previous environmental regulations, including those mentioned in your letter, resulted in more controls applied at coal-fired power facilities in a comparable time period than will result from the proposed Clean Air Transport Rule. Just as in prior years our unions were able to provide the skilled labor necessary for compliance, we have every confidence we will be equipped to enable regulated entities comply in this case.

The member unions of the Building and Construction Trades Department continually invest in the apprenticeship and skills training program to ensure an adequate supply of craftsman to meet contractor demand. Based on the most recent data available, union sponsored joint labor-management apprenticeship and training programs spent $560 million to ensure a continuing pipeline of high-quality construction craft workers. Further, our unions maintain strict journeymen to apprentice ratios that provide for a continuing supply of new apprentices in to our programs.

Finally, please know that our unions maintain a strong relationship with American Electric Power. We appreciate that AEP has sought to promote high-road employment opportunities for workers in the construction industry through the use of Project Labor Agreements and a commitment to collective bargaining. Rest assured, we will work with AEP and others in the utility sector to ensure our unions can continue to provide an adequate supply of skilled craft workers to respond to future air quality regulations.

Thank you, again, for your inquiry. As always, please keep me advised if I can be of assistance on this or any other matter.

Sincerely,

Mark H. Ayers

Mark H. Ayers
President

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Michael G. Morris
Chairman of the Board
and Chief Executive Officer

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The Honorable Barbara Boxer, Chair
U.S. Senate Committee on Environment and Public Works
410 Dirksen Senate Office Building
Washington, D.C. 20510-6175

The Honorable James M. Inhofe, Ranking Member
U.S. Senate Committee on Environment and Public Works
456 Dirksen Senate Office Building
Washington, D.C. 20510-6175

July 8, 2011

Dear Senator Boxer and Senator Inhofe:

I am writing to correct certain statements related to AEP's potential environmental compliance needs made by members of the Administration during hearings before the Senate Environment and Public Works Committee on June 14 and June 30. Specifically, it was reported that Environmental Protection Agency (EPA) Administrator Lisa Jackson described the plan AEP announced on June 9 as "misleading, at best and scare tactics at worse." Assistant Administrator McCarthy called AEP's announcement "confused" and claimed that unit retirements were attributable to market conditions and a "failure to comply with earlier required reductions." At both hearings, misinformation was placed in the record regarding AEP's 2007 New Source Review Consent Decree. I want to take this opportunity to correct those misstatements and clarify AEP's compliance record, our concerns and the impact of EPA's current proposals.

We respect and support the mission of the EPA. However, our concerns about the impact of the aggressive regulatory initiatives EPA is now pursuing are not idle predictions. They are based on our experience providing electric service to customers for 105 years, for much of that time operating one of the largest electric generating and transmission systems in the country. Directly relevant to the issues at hand, over the past decade we have implemented one of the largest pollution control retrofit programs in the U.S. AEP has also been a leader in technological development over much of its history, including in the area of environmental control. We recently completed the operation of a carbon capture and storage Product Validation Facility at our Mountaineer Plant in West Virginia, the world's first integrated CCS facility on an electric generating station. AEP has been an industry leader in the area of efficiency of operation across our generation, transmission and, increasingly, distribution operations.

Over the past 20 years, AEP has invested $7 billion in its generating plants to install state-of-the-art pollution control equipment to enable us to comply with the Acid Rain Program under the

1990 Clean Air Act Amendments, the NOx SIP Call, Clean Air Interstate Rule and other programs that EPA has put in place. We did so with cost-effectiveness as a priority in order to protect our customers and minimize as much as possible the impact on electric rates. I will be the first to admit that we invested this capital to comply with regulations that EPA promulgated, and that we actively participated in the rulemaking process and sometimes in litigation over those programs. However, there has been no failure to comply. Once the rules were final, we moved expeditiously to make sure we were in full compliance. Over that time period, SO2 and NOx emissions from AEP power plants have been reduced by about seventy-five percent. It is absolutely wrong to attempt to characterize AEP as a utility that has done nothing to reduce emissions for decades. That experience shows that obtaining regulatory approvals, designing, permitting, procuring and constructing these complex control systems in a cost-effective manner requires 42-56 months. It simply cannot be accomplished in as little as three years and requiring all companies to comply within such a short time frame will increase the cost and decrease the productivity, quality and safety on these jobs.

Second, it is true that some of the units anticipated to retire as part of our base plan are included in the compliance schedule in our 2007 New Source Review Consent Decree and that retirement is a compliance option under that decree. However, with the exception of two of those units, the proposed regulations will significantly accelerate those retirements, along with all the associated costs, job losses and economic impacts. This would happen at the same time that other units, which are not part of the settlement, would be forced to retire or be idled while controls are installed. More specifically, the Consent Decree includes two units totaling 615 MW that could retire before 2014 to comply with the Consent Decree. Another 1,440 MW (about seven units) have Consent Decree obligations before the end of 2018. All of those units and approximately 16 more would instead be retired early in order to satisfy the schedules in the proposed rules. In other words, of the nearly 6,000 MW facing retirements, roughly 5,400 MW would be retired sooner than would otherwise occur. Although many of these units would have phased out their useful lives over the course of the next decade, the abrupt loss of this much capacity in so many different locations over such a short period of time raises serious concerns. This includes potential reliability problems, significant increases in customer rates in a short period of time and, more broadly, negative impacts to the economy and jobs.

Third, Assistant Administrator McCarthy stated at the June 30th hearing "So what AEP was doing was confusing information by attributing market conditions and their failure to comply with earlier required reductions with the impacts of these rules". This statement not only says that we were out of compliance with "earlier required reductions" which is completely untrue, but also implies strongly that our announced retirements were only due to market conditions and not the "impacts of these rules". This statement is not at all supported by the facts. AEP in its assessment found that it would only retire two of its units prematurely in the absence of the EPA regulations before 2015. Virtually all economic studies (EIA, CERA, NERA etc.) have arrived at a similar conclusion - that there would only be a very small amount of retirements for utilities across the U.S. due to "market conditions" in the absence of EPA's new requirements. Record levels of customer demand were set in our western service region last year and the warm days this summer have required every available unit to be placed in service this summer in the eastern portion of our service territory.

More importantly, EPA claims that its own modeling takes into account planned retirements, natural gas prices, market conditions and the conditions of AEP's Consent Decree within the IPM modeling done in support of the proposed MACT rule. Yet EPA's analysis of the MACT proposal suggests that, in addition to 450 MW of "planned" AEP coal retirements, only 790 MW of additional AEP coal capacity would retire by 2015 in the MACT policy case. This 1,015 MW of coal retirements as calculated by EPA is substantially less than the 5,900 MW of retirements AEP has announced could occur by 2015 based on the combined impact of the Transport Rule, the MACT and other new rules for coal plants. If market conditions and Consent Decree limitations were truly responsible for AEP's unit retirements, EPA's own modeling should have shown this.

Finally, there have been statements to the effect that the industry has known about these standards for decades and should have been working toward compliance. This is not accurate. It is true that the 1990 Clean Air Act Amendments strengthened the hazardous air pollutant (HAP) program under Section 112 of the Clean Air Act. However, those amendments also included a specific provision that required the EPA to conduct a study of public health and environmental risks associated with emissions of HAPs from electric generating units. They also directed the EPA to establish an emissions control program if that study concluded there was sufficient justification for doing so. The EPA completed the study in 2000 and concluded that the only HAP that merited further control was mercury. A final mercury rule was adopted in 2005, but was challenged in court by environmental organizations and others. AEP and other utilities were taking steps to comply with that rule when it was vacated and remanded in 2008. It was not until March, 2011 that the EPA issued proposed rules that, for the very first time, proposed emissions limits for all utility HAP emissions, including acid gases and non-mercury heavy metals, as well as revised mercury limits. Only when this proposed rule was issued – just a few months ago – did AEP and the industry have any knowledge of what specific standards EPA would apply to utility HAP emissions. Throughout this entire period, the installation of control devices to reduce SO_2 and NO_x emissions has continued and those same controls have been reducing mercury and non-mercury HAPs emissions as well. It is wrong to assert that the industry has done nothing, even in the absence of a final HAPs rule.

As AEP analyzed the potential impacts of EPA's regulatory agenda, beginning with the proposal of the Clean Air Transport Rule and Coal Combustion Residual Rule last year and followed by the proposals of the HAPs and 316(b) rules this year, our concerns about our ability to comply within the accelerated schedules and the associated impacts on customer rates, jobs and local communities and electric system reliability have been heightened. The release of the Final Transport Rule yesterday heightened that concern even further, as the proposed emission budgets in 2012 have been significantly reduced in several of our states, making the prospect of premature retirements occurring as early as next year a hard reality. We have reached out to many organizations to share these concerns, including PJM, SPP, NERC, labor unions and local and state community leaders. We appreciated the opportunity to meet with Assistant Administrator McCarthy and members of her staff in early May, and will continue to look for opportunities to engage with key policymakers on these issues.

We know that the issues we are raising are very real and that our transition plan is technically sound and based on accurate data. We will continue to refine our plans based on the requirements of the final rules. We are concerned that without a realistic assessment of the cumulative impact of these imminent environmental requirements, the unintended consequences on electric reliability, local communities, jobs and the broader economy will be staggering. We all share the objective of continuing environmental improvement and a robust economy. That goal is not served by empty rhetoric. We would welcome the opportunity to participate in a serious conversation about the potential implications of EPA's regulatory schedule, and to work together toward a practicable solution.

Sincerely,

Michael G. Morris
Chairman & CEO
American Electric Power

C: Lisa Jackson, Administrator, U.S. Environmental Protection Agency
Regina McCarthy, Assistant Administrator for Air & Radiation, U.S. Environmental Protection Agency

Honorable Thomas R. Carper
Honorable John Barrasso
Honorable Max Baucus
Honorable Frank R. Lautenberg
Honorable Benjamin L. Cardin
Honorable Bernard Sanders
Honorable Sheldon Whitehouse
Honorable Tom Udall
Honorable Jeff Merkley
Honorable Kirsten Gillibrand
Honorable David Vitter
Honorable Jeff Sessions
Honorable Mike Crapo
Honorable Lamar Alexander
Honorable Mike Johanns
Honorable John Boozman

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Senator Thomas Carper
513 Hart Building
Washington, DC 20510

November 3, 2010

Dear Senator Carper:

Thank you for your letter of October 6, 2010 requesting the Institute of Clean Air Companies' (ICAC) insights and perspective regarding the questions of labor availability and the capacity of the electric power industry to install air pollution control systems on a timely schedule and the types of jobs these installations create. As you recognize in your letter, this is not a new concern. In fact, industry stakeholders raised this exact concern when EPA proposed the NOx SIP Call rule in 1998 and, again, when EPA proposed the Clean Air Interstate Rule (CAIR) in 2005. Notably however, these were concerns raised primarily in advance of the finalization of rules, and in both cases proved unfounded as the stationary source air pollution control and measurement (APC) industry satisfied demand for labor and other resources placed upon us and related industries. These concerns and doubts are being raised again; however, based on a history of successes, we are now even more resolute that labor availability will in no way constrain the industry's ability to fully and timely comply with the proposed interstate Transport Rule and upcoming utility MACT rules. Contrary to any concerns or rhetoric pointing to labor shortages, we would hope that efforts that clean the air also put Americans back to work. We appreciate your efforts to more fully understand this issue and we offer the following responses to the specific questions you raise:

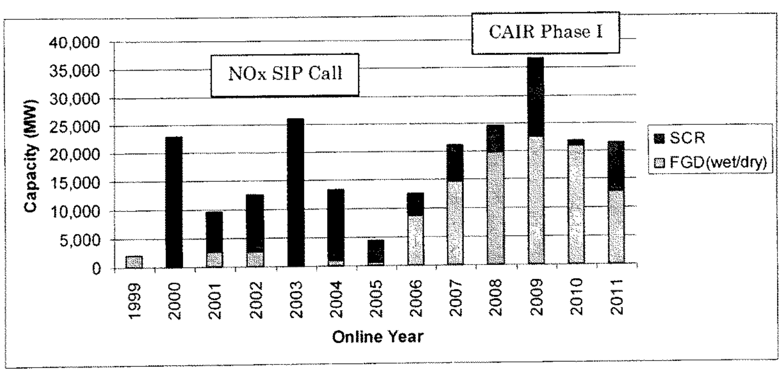
- The APC Industry is able to meet future demands for emission control technology due to our overwhelming experience in meeting requirements for selective catalytic reduction (SCRs) and flue gas desulfurization (FGDs) under the NOx SIP Call and CAIR.
- Less resource and time-intensive technologies are available to be quickly deployed offering the electric generating industry the needed flexibility to comply with the proposed Clean Air Transport Rule and the upcoming utility MACT. For example direct sorbent injection (DSI) and dry scrubbing technology installation times are approximately 12 and 24 months, respectively.
- The design and construction of NOx, SO_2 and HAPs control technologies require engineers, skilled craft labor such as boilermakers and creates upstream and downstream employment and economic benefits.
- We estimate that over the past seven years, the implementation of CAIR Phase 1 resulted in 200,000 jobs in the APC industry.

Is labor availability likely to constrain the industry as it seeks to comply with the interstate transport and utility MACT rule?

The simple answer is that labor availability has never jeopardized overall industry compliance requirements, nor is there any reason to assume that it would prevent the power generation industry from effectively complying in a timely way with requirements. As an industry, we respond to whatever demand for products and services is placed upon us by affected industries complying with requirements. The corollary to this response is that the APC industry has proven, particularly in recent years, the dynamic nature of ours and related industries in meeting demand from the electric power generating industry. This has been demonstrated by repeatedly satisfying rapid and substantial increases in demand for services and products, working effectively with end-users to efficiently deploy resources to meet compliance deadlines, innovating then bringing those innovations quickly to market, and relying on inherent competitiveness within the industry to bring an ever broader range of economically reasonable solutions to our customers. The variable nature of our industry, including supporting and related industries, now finds us at a point where demand for products and services is low, so we are well-positioned to meet any new demand.

We are extremely confident in the ability of our industry to deliver and satisfy, as we have so successfully in the past, the labor, materials and resources needed to meet the demand. Labor availability did not constrain the electric power industry's ability to comply with CAIR and the NOx SIP Call. We based this observation on (1) recent and past decade of industry installation experience, and (2) the extent of controls already installed at existing coal-fired power plants. In addition, there are less capital intensive control technology options available to the industry that can be implemented in a shorter period of time. In these current market conditions the APC industry is in a period of underutilization as compared to the NOx SIP Call and CAIR Phase I years.

Figure 1. Cumulative SCR and FGD Installations by Year



Source: US EPA NEEDs database 4.10 v

Many of the technologies that will be needed to be installed to comply with the requirements of the proposed interstate Transport Rule and the as yet-to-be-proposed utility MACT rule are likely to be the same technologies installed in recent years for other successful and more labor-intensive programs. In fact, over the past decade (as illustrated in Figure 1) our industry has already successfully met the challenge of installing what were substantially new technologies on a significant portion of the electric power industry. These technologies have been refined and are readily available, as are the resources needed to complete their installation. Today more than one-half of the coal-fired electric generation fleet currently operates reliably on some combination of these technologies.

The trend in recent years has been to install the largest and most effective control systems such as FGD and SCR systems, which are also some of the most labor-intensive and time-consuming technologies available. The design and construction of a large 'wet' scrubber system may take 36 months to complete. Wet scrubbers reduce SO_2 emissions by more than 98 percent, and their construction and installation employ several hundred workers. Currently, more than one-half of the coal-fired electric generation capacity of the U.S. operates with FGD systems, with most having been installed over the past decade. We anticipate that FGD control installations from implementing the proposed Transport Rule will be radically less than our recent installation experience under CAIR Phase I. EPA projects that about 14 gigawatts (GW) of coal-fired generating capacity will be retrofitted with scrubbers and less than 1 GW with SCR controls by 2014 to comply with the recently proposed interstate Transport Rule. This is substantially less than what was accomplished under CAIR.

Going forward, ICAC expects a wide range of technologies will be available to provide flexibility for utility compliance strategies. In particular, we expect greater use of both DSI and dry scrubbing technologies, such as circulating dry scrubbers (CDS) and spray dryer absorber (SDA) technology, due to future backend water and disposal requirements. The added advantages of using these technologies are fewer resources required and shorter installation times – 12 months for DSI and 24 months for a dry scrubber. Moreover, the next round of EGU control installations will likely be on smaller coal-fired units, and DSI and dry scrubbing are well-suited to smaller footprints and high-sulfur bituminous coal applications. However, exact technology controls are chosen by electric power generating companies based on final requirements and in a context of multiple market variables.

Recent Industry Experience

The electric power sector has a demonstrated ability to install a large number of complex pollution control systems in a relatively short period of time, while coordinating outage schedules to maintain electric system reliability. Specifically, the industry's recent experience with the CAIR and the NOx SIP Call clearly demonstrates that the industry has more than sufficient capacity to comply with the proposed interstate Transport Rule and upcoming utility MACT rules.

The majority of coal plants have already installed NOx and SO_2 controls. Of the 310 GW of coal capacity in the United States, 170 GW have installed FGD systems and another 55 GW have FGD controls planned. As a result, roughly two-thirds of the existing coal fleet will soon be retrofit with FGD controls. Additionally, about one-half of U.S. coal capacity has installed or soon will be retrofit with advanced NOx controls. Many companies have also installed or optimized existing control systems for mercury reductions in response to state regulations, giving them a jump start on a future utility MACT rule. In the absence of a federal standard, almost 20 states have adopted mercury regulations for coal-fired power plants over the past several years.

Clean Air Interstate Rule. The Clean Air Interstate Rule (CAIR), limiting NOx and SO_2 emissions in the Eastern U.S., created substantial demand for SCR and FGD systems. Between 2008 and 2010, coal-fired power plants added approximately 60 GW of FGD controls and almost 20 GW of SCR controls with a total of 80 GW of FGD controls installed under CAIR Phase 1. CAIR created unprecedented high demand for scrubber components and, lead times on key components, including large recycle pumps, motors, fans, chimney components and construction. Utilities managing large, multiple-scrubber programs, also used the compliance flexibility in the rule to stage and optimize use of personnel and other resources over longer periods than would have been needed were there just one scrubber. It is notable to point out that in a recently presented paper (*Implementation Strategies for Southern Company FGD Projects*; Wall, Healy & Huggins; Power Plant Pollutant Control "Mega" Symposium, September 2010), the Southern Company authors noted that company-wide planning for FGD installations started in 2003, while the CAIR rule was not final until 2005.

Labor limitations are normally cited by the utility industry as the chief limiting factor in undertaking clean air retrofits, and boilermakers, in particular, are cited as the major source of concern because of their specialized skills. Other craft labor, such as iron and steel workers and carpenters, can be drawn from the broader construction industry.

Prior to the implementation of CAIR, EPA and industry stakeholders, such as the Utility Air Regulatory Group, assumed that skilled labor would limit the industry's ability to install air pollution control equipment. However, based on a retrospective review of actual experience by James Staudt, Ph.D., CFA, it was determined that EPA and industry dramatically underestimated the ability of the air pollution control industry to support the utility industry in responding to CAIR[1]. According to Staudt:

> "The assumptions regarding the availability of labor were demonstrated in this White Paper to be too limiting and, by imposing a "hard cap" on labor availability, did not take into account the dynamic nature of U.S. labor markets, which US EPA had acknowledged in the past. Also, assumptions by US EPA and the representatives of the utility industry regarding the timing of orders relative to the finalization of the CAIR proved to be incorrect. As a result, both US EPA and representatives of the utility industry underestimated the ability of the [air pollution control] industry to support the utility industry in its response to the CAIR."

Staudt offers several reasons for why EPA and industry underestimated the capabilities of the labor market: (1) boilermakers will work overtime during periods of high demand; (2)

[1] "Availability of Resources for Clean Air Projects", James Staudt PH.D., CFA, Andover Technology Partners, October 2010

boilermakers frequently travel to different locations for work, supplementing local available labor; (3) boilermakers work in fields other than power, such as refining/petrochemical, shipbuilding, metals industries and other construction trades, and workers can shift industry sectors with appropriate training; and (4) new workers will enter the field between 1999 and 2001 - for example, in advance of the NOx SIP Call, boilermakers increased their ranks by 35 percent mostly by adding new members.

NOx SIP Call. Between 2001 and 2005, the electric industry successfully installed more than 96 GW of SCR systems in response to the NOx SIP call thus adding NOx controls to roughly one-third of the U.S. coal fleet. During this same time period, the industry was simultaneously adding a record amount of new generating capacity. Between 2001 and 2004, the electric industry built more than 180 GW of new generating capacity, including natural gas combined cycle power plants, coal-fired power plants, and renewable energy facilities.

Alternative Control Options

Much of our discussion has focused on scrubbers and SCR systems that may be used for compliance with the proposed interstate Transport Rule and upcoming utility MACT rule. These technologies may require longer installation times, however, there are other less resource and labor-intensive alternatives that will also be used for compliance. For example, DSI is a technology that reduces SO_2 through injection of trona, sodium bicarbonate or hydrated lime upstream of a particulate control device. DSI does not generally provide the high rates of SO_2 control achieved with a scrubber, but the technology can achieve significant levels of control and can be implemented very quickly—typically within one year. DSI and other dry scrubbing systems also are effective in reducing some hazardous air pollutants that would be controlled under MACT, such as hydrochloric acid (HCl). These systems are likely to preferentially reduce HCl in the flue gas. With regard to NOx control, selective non-catalytic reduction (SNCR) is a widely used technology that can also be implemented in under a year. The levels of NOx control are less than what can be achieved with SCR, but the technology can be installed quickly with fewer labor resources. Again, industry choices prevail in complying with requirements, and there are now approximately 18 GW of generation with SNCR NOx controls.

Even if the upcoming utility MACT were to require the level of control achieved by wet scrubbers, it is unlikely that this technology would then be applied to all of the remaining unscrubbed fleet. We can see that the already installed pollution control systems, along with potential coal plant retirements, will change the future demand for equipment orders. When anticipating outcomes of the yet to be proposed utility MACT, it is important to recognize that wet scrubbers are placed into service to substantially eliminate SO_2 emissions, while the hazardous air pollutants may rely on a different set of less labor intensive technologies. One observation, is that the demand for large equipment orders on the scale of wet scrubbers, may diminish significantly for the near future when driven by the transport rule and utility MACT; and be largely supplanted by alternative technologies that demand less labor and shorter installation time. Historically, affected industry will comply with requirements by utilizing a suite of reasonably economic technology solutions.

It may also be possible to improve the scrubber performance of many older scrubbers that were installed in the 1970's and 1980's. For example, limestone forced oxidation wet scrubber system upgrades at the Vectren Culley Station Units 2 & 3, E.On's Trimble County Unit 1, and Michigan South Central Power's Endicott Station resulted in increased removal efficiencies in the range of 98 percent. Upgrades such as these can also be implemented quickly and at lower cost versus the installation of a new scrubber.

Preserving these compliance alternatives will require that EPA allow a degree of compliance flexibility in its regulatory design. For example, EPA has proposed a hybrid cap-and-trade approach under the proposed interstate Transport Rule that would allow companies to take advantage of these alternative control strategies. In addition, the Clean Air Act MACT program allows a state-granted one year compliance extension, if needed, to complete installation of controls.

What types of engineering and construction skills are required to design and construct NOx, SO2, and HAPs controls?

This is an extremely relevant question, such that dollars spent on air pollution control not only result in avoided health costs including avoided premature mortality, but these same dollars are plowed back into the U.S. economy as good and green jobs. Adding pollution control equipment to existing power plants requires engineers to design the systems and specialized construction labor, particularly boilermakers, to build and install the equipment. When operational, these control systems rely on a continuous supply of manufactured and processed reagents resulting in jobs in related industries. FGD and SCR systems require: (1) construction materials, such as steel plate, alloy steel, fabricated steel components, structural steel, and concrete; (2) engineered equipment and specialty materials, such as slurry pumps, fans, motors and catalyst; and (3) reagents, especially limestone and ammonia. These requirements are examples of direct and indirect employment opportunities resulting from the environmental drives for new and retrofitted air pollution control systems.

Looking back over the past seven years as industry installed SCR and FGD controls in readiness for the CAIR Phase I requirements, we estimate that this work required approximately 200,000 person-year jobs in direct and indirect labor. Specifically, a typical turnkey installation of a 500 MW scrubber is estimated to employ approximately 200 people, with about 80 percent dedicated to construction and 20 percent for engineering and project management[2]. The installation of SCR controls creates a similar number of jobs over a shorter time period and employs a greater number of boilermakers. As we near the end of installing this latest phase of beneficial control projects, these workers are readily available and trained to continue this level of activity.

Boilermakers are an important trade in terms of the installation of pollution control equipment. It is a specialized trade, serving the electric power, refining/petrochemical, shipbuilding, and metals industries, and boilermaker supply, represented by both union and non-union labor, is

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[2]*Engineering and Economic Factors Affecting Installation of Control Technologies for Multipollutant Strategies*; U.S. EPA; October 2002

dynamic in responding to demand. Other crafts can be and have been drawn from the broader construction labor market.

We are not aware that engineering labor has ever been raised as an issue that might limit the industry's ability to install air pollution control equipment. There are numerous suppliers of air pollution control equipment. If one supplier becomes busy, there are several other options. Also, companies that are building multiple scrubbers will often adopt standardized equipment designs, reducing the need for engineering support, as supported by Southern Company's experience referenced above.

In addition to the amplified employment demands of major clean air initiatives such as CAIR and the NOx SIP Call, our industry provides a continuous and enduring stream of good and green jobs related to the manufacturing, installation and servicing of air pollution control and measurement technologies.

If labor is in short supply among any of these trades are there actions that we should be taking today in order to ensure that we have the skilled labor needed to comply with the Clean Air Act?

We are extremely confident in the ability of the industry to deliver and satisfy, as we have so successfully in the past, the labor, materials and resources needed to meet the demand. While we do not believe that skilled labor will be in short supply, proactive steps to provide more clarity sooner to industry on the full suite of requirements for air, water, and waste regulations that they are facing, will in turn provide the needed investments and assist our industry in meeting demand. EPA's efforts to move forward expeditiously with the proposed interstate Transport Rule and the upcoming utility MACT rules will be helpful in this regard. We believe early and continuous installations are needed to promote job security in ours and other industries, as well as ensure more efficient application of resources to meet longer term challenges. As discussed throughout our response, labor availability has not and is not an impediment to industry compliance, and we are already at a high level of industry readiness. In closing, ICAC shares your enthusiasm that now is the time "to put American workers back on the job of modernizing our electric generating fleet" and give America the clean healthy air they deserve.

Sincerely Yours,

David C. Foerter, ICAC Executive Director

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December 10, 2008

Mr. Stephen L. Johnson, Administrator
United States Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, N.W
Mail Code: 1101A
Washington, DC 20460

Dear Administrator Johnson:

In June 2007 Delaware submitted to the Environmental Protection Agency (EPA) a state implementation plan (SIP) revision that demonstrates attainment of the 0.08 ppm 8-hour ozone National Ambient Air Quality Standard (NAAQS) in 2009 (Reference 1). In April 2008, Delaware submitted a SIP that demonstrates attainment of the 1997 fine particulate matter ($PM_{2.5}$) NAAQS in 2010 (Reference 2). For achieving attainment of these NAAQSs, Delaware has adopted numerous emission control measures that affect all emission source sectors. Among these controls, we have adopted stringent "multi-pollutant" regulations that require the control of nitrogen oxides (NO_x) and sulfur dioxide (SO_2) emissions from Delaware's coal and residual oil fired electric generating units (EGUs). By promulgating those SIPs and the associated regulations, Delaware has continued an extraordinary level of effort within its boundary to clean up air quality in order to attain and maintain the NAAQSs. However, Delaware's actual ability to attain and maintain the NAAQSs is severely impacted, and negatively interfered with, by sources outside of Delaware's boundaries.

Clean Air Act (CAA) 110(a)(2)(D)(i) prohibits any source or other type of emissions activity within a State,

> "from emitting any air pollutant in amounts which will contribute significantly to nonattainment in, or interfere with maintenance by, any other State with respect to any such national primary or secondary ambient air quality standard."

In adopting the above mentioned SIPs and associated regulations Delaware has complied with the requirements of CAA Section 110(a)(2)(D)(i) by controlling effectively emission sources within its boundary so that those sources do not contribute significantly to downwind states' non-attainment or interfere with downwind states' maintenance of NAAQSs. However, Delaware's ability to improve its own air quality to attain and maintain the NAAQSs is significantly impacted by emissions from EGUs in upwind states that have not undertaken adequate measures to control their emissions of air pollutants as required by CAA Section 110(a)(2)(D)(i) [1].

In light of this significant impact from upwind states on Delaware's air quality, and the failure of upwind states to address adequately these impacts as required by CAA Section 110(a)(2)(D)(i), we hereby seek relief. Section 126(b) of the CAA provides that,

> "[a]ny State or political subdivision may petition the Administrator for a finding that any major source or group of stationary sources emits or would emit any air pollutant in violation of the prohibition of Section 110(a)(2)(D)(ii) or this section."

By this letter, Delaware is hereby petitioning the Administrator of EPA under Section 126(b) of the CAA to find that EGUs in Maryland, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia are emitting air pollutants in violation of the provisions of Section 110(a)(2)(D)(i) of the CAA.

Delaware believes, that as a first step, a substantial portion of this impact can be mitigated by regulating NO_x and SO_2 emissions from EGUs in the upwind states that are now substantially contributing air pollution sufficient to impair Delaware's ability to attain and maintain the NAAQS, and are violating CAA 110(a)(2)(D)(i). For Delaware, reductions of NO_x and SO_2 emissions from upwind EGUs are crucial to the attainment and maintenance of the current ozone and $PM_{2.5}$ NAAQSs, and to the attainment of the new ozone and new 24-hour $PM_{2.5}$ NAAQSs. Mitigation of impacts under CAA Sections 126 and 110(a)(2)(D) must be obtained as soon as practicable, but not later than 2013. This is necessary for Delaware to take advantage of these CAA mandated upwind source reductions in the development of future required ozone and $PM_{2.5}$ maintenance and attainment demonstration SIPs. In addition, at least a partial mitigation of the impact of NO_x emissions from upwind EGUs is needed by 2009 to ensure attainment of the current ozone and $PM_{2.5}$ NAAQSs.

Delaware has submitted to EPA SIP revisions that demonstrate that Delaware will attain compliance with the current ozone and $PM_{2.5}$ NAAQSs in 2009 and 2010, respectively. In addition to reliance on an extraordinary effort to control sources within Delaware, these SIPs rely in part on some mitigation of upwind NO_x emissions in 2009, and it is critical that EPA fulfill its nondiscretionary duty to require upwind states to at least partially comply with CAA 110(a)(2)(D)(i) in 2009. Delaware believes that EPA can accomplish this by requiring controls equivalent to the requirements specified in Phase I of the Clean Air Interstate Rule (CAIR) under the authority of Section 126(b) of CAA. The consequence of EPA's failure to require this partial mitigation to occur in 2009 will be that Delaware's air quality may not meet the health based ozone and annual $PM_{2.5}$ NAAQS's by the 2009 and 2010 attainment dates, respectively, and,

[1] EPA promulgated the clean air interstate rule (CAIR), and indicated that compliance with CAIR satisfied states obligations under CAA 110(a)(2)(D)(i). The court vacated CAIR because it, alone, is not sufficient to satisfy CAA 110(a)(2)(D)(i). The vacatur of CAIR does not relieve the States who relied upon CAIR for compliance with CAA 110(a)(2)(D)(i) from their obligations to cease emissions that significantly impact the attainment or maintenance of any NAAQS in any other state.

therefore, the health of Delaware citizens may be compromised by unnecessary exposure to unhealthy air and air pollution in violation of CAA.

Additional background on Delaware's air quality, actions taken to date to address transport under CAA 110(a)(2)(D), and details on a proposed two-phase EPA action under this 126 petition are provided below.

1. Delaware's Air Quality

Delaware's air quality is designated by EPA as being in non-attainment for two health based NAAQSs: ground level ozone and $PM_{2.5}$.

1.1 Ozone

In 2004, EPA designated the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE a moderate non-attainment area with respect to the current 8-hour ozone NAAQS of 0.08 ppm (69 *FR* 23858). All three counties in Delaware were included in this non-attainment area. The designation indicates that people in this area often breathe air with unhealthy levels of ozone. Comprehensive studies, including those conducted by EPA (References 3 and 4), have demonstrated that unhealthy levels of ozone will cause:

- decreased lung function in children and seniors when outdoors
- increased respiratory symptoms (particularly in highly sensitive individuals)
- increased hospital admissions and emergency room visits for respiratory problems
- inflammation of the lung, and possible long term, life threatening damage to the lungs.

These health impacts on Delaware citizens cannot be tolerated.

Ozone is not emitted directly into the atmosphere but is formed by the reactions of two major precursor chemicals known as volatile organic compounds (VOCs) and oxides of nitrogen (NO_x). These precursor chemicals are released directly into the atmosphere from a wide variety of anthropogenic sources, including power plants, industrial facilities, motor vehicles, trains and planes, equipment with combustion engines, uses of solvents and paints with VOC contents, etc. Thus, in order to lower ambient ozone levels to meet the NAAQS, reductions of emissions of these precursor chemicals must be obtained. Further, peer-reviewed scientific studies supported by empirical evidence has shown that ozone and its precursors are transported over long distances, up to hundreds (or even thousands) of miles, along with winds (References 5 and 6). This long-range transport means that emission sources in one area can contribute to ozone problems in a downwind area hundreds or thousands of miles away. Therefore, for a downwind state to attain the ozone NAAQS, transport of ozone and its precursors from upwind areas must be attenuated so that it will not add significant loads of ozone and precursors to the ambient air of the downwind states. Because there is no way to attenuate natural winds, it becomes critical to control upwind sources to reduce their VOC and NO_x emissions. Located at the eastern edge of a continent where westerly winds prevail, Delaware is particularly vulnerable to the effects of upwind sources of air pollution.

1.2 Fine Particulate Matter ($PM_{2.5}$)

In April 2005, EPA designated the Philadelphia-Wilmington, PA-NJ-DE a non-attainment area with respect to the 1997 $PM_{2.5}$ NAAQS (62 *FR* 38652).[2] New Castle County, in Delaware, is included in this non-attainment area, along with five counties in southeastern Pennsylvania, and three counties in New Jersey. This designation indicates that people in this area are breathing air with unhealthy particulate matter levels. Particle pollution, especially fine particles, contains microscopic solids or liquid droplets that are so small that they can penetrate deeply into the lungs and cause serious health problems. Numerous scientific studies have linked particle pollution exposure to a variety of problems including:

- increased respiratory symptoms such as irritation of the airways, coughing or difficulty breathing
- decreased lung function
- aggravated asthma
- development of chronic bronchitis
- irregular heartbeat
- non-fatal heart attacks
- premature death in people with heart or lung disease.

There are two forms of particles: primary and secondary. Primary fine particles, or $PM_{2.5}$, include soot from diesel engines, a wide variety of organic compounds condensed from incomplete combustion, and compounds such as arsenic, selenium, and zinc that condense from vapor formed during combustion or smelting. The $PM_{2.5}$ that is formed by chemical reactions of gases in the atmosphere is referred to as "secondary" $PM_{2.5}$. These reactions form condensable vapors that either generate new particles or condense onto other particles in the air. Most of the sulfate, nitrate, and a portion of the organic compounds in the atmosphere, are formed by such chemical reactions. As such, these compounds are known as "$PM_{2.5}$ precursors." Like ozone, for a downwind state to attain the fine particulate matter NAAQS, transport of fine particulate and these precursors from upwind areas must be attenuated so that it will not add significant loads of fine particulate matter and precursors to the ambient air of the downwind state. Because there is no way to attenuate natural winds, it becomes critical to control upwind sources to reduce their NO_x and SO_2 emissions.

2. Federal and Regional Actions to Address Transport Have Been Helpful and Inadequate

2.1 Ozone Transport Assessment Group (OTAG)

In 1994, several states, including Delaware, requested that EPA take action pursuant to Section 110(a)(2)(D) of the Clean Air Act to address the overwhelming transport of ozone and ozone precursors across state boundaries. To respond to these requests EPA, in cooperation with the National Governors Association and the Environmental Council of States, created the Ozone Transport Assessment Group (OTAG), which conducted a two-year comprehensive study on ozone and precursor transport.

[2] In addition, EPA has announced its intention to designate New Castle County as non-attainment for the 2006 24-hr $PM_{2.5}$ NAAQS (71 *FR* 2710) in December 2008.

Delaware actively participated in the OTAG process. In July 1997, OTAG recommended to EPA that a number of specific controls be implemented in the eastern part of the country to reduce NO_x emissions and long-range transport (Reference 5). Through extensive modeling, OTAG concluded that regional NO_x emission reductions would be effective in producing ozone benefits to the downwind states.

2.2 OTC NOx Budget Program

In September 1994, the states of the Ozone Transport Commission (OTC) signed a Memorandum of Understanding, which initiated the first regional NO_x cap-and-trade control program in the northeast to address interstate transport and impacts of NO_x. The NO_x control program targeted EGUs that generated equal to or greater than 15 MWe, and industrial boilers and indirect heat exchangers with heat inputs equal to or greater than 250 mmBTU/hour. The OTC states developed and implemented a seasonal NO_x cap-and-trade program, which began in 1998, and was based on an emission rate of 0.15 lb/mmBTU. This program was replaced by the EPA NO_x SIP Call in 1999 (see Section 2.3 below).

2.3 NO_x SIP Call

In October 1998, EPA promulgated the NO_x SIP Call (63 *FR* 57356). This federal rule established seasonal NO_x emission caps in 23 jurisdictions in the eastern half of the country to address NO_x and ozone transport across boundaries of those jurisdictions. The NO_x SIP Call proved to be a good start of regional control strategy for attenuating NO_x and ozone transport, helping many counties in the northeastern states successfully attain the previous 1-hour ozone NAAQS (0.12 ppm) in 2005, and contributing significantly to the early efforts of many eastern states toward attaining the current ozone NAAQS (0.08 ppm) in 2009. This program was slated for replacement by EPA's Clean Air Interstate Rule (CAIR) beginning in 2009[3].

2.4 Clean Air Interstate Rule (CAIR).

In an attempt to further address regional transport of ozone, $PM_{2.5}$ and their precursors, EPA promulgated CAIR in May 2005 (70 *FR* 25162). This federal rule covered power-generating plants in 28 eastern states and the District of Columbia, and would reduce NO_x and SO_2 emissions that contributed to unhealthy levels of ozone and $PM_{2.5}$ in downwind states. The rule implemented a phased-in cap-and-trade approach, with Phase I caps effective in 2009 and 2010 for NOx and SO_2, respectively, and Phase II caps effective in 2015 for both NO_x and SO_2. The EPA projected that the phased-in approach would lead to an overall 61% NO_x emission reduction and 73% SO_2 emission reduction by 2020.

While CAIR did provide for emission reductions beyond the NO_x SIP Call, particularly in the non-ozone season months, undisputed evidence found in peer-reviewed scientific studies demonstrates that CAIR was not designed to mitigate fully the impacts of ozone and $PM_{2.5}$, and precursor emissions, relative to both the quantity and timing. In particular, CAIR is too little and too late to fully mitigate the impacts of upwind states on Delaware. As such, CAIR would not

[3] CAIR was vacated by the D.C. Circuit Court in July 2008, and at this time (December 2008) the status of the NO_x SIP Call is not clear. Also, see footnote 1.

fully mitigate transport, and would not satisfy the provisions of CAA Section 110(a)(2)(D). Delaware and a few other states realized this early on and developed state-specific rules that are more stringent than CAIR. Many states did not, however, including upwind states that emit air pollutants in amounts that contribute significantly to nonattainment in, and interfere with maintenance by, Delaware with respect to ozone and $PM_{2.5}$ NAAQSs. As such, sources in these upwind states continue to emit air pollutants in violation of CAA 110(a)(2)(D)(i)[4]. EPA is duty bound to cease these violations and mitigate these emissions.

3. Compliance of EGUs with CAA Section 110(a)(2)(D)

Among the largest sources of ozone and $PM_{2.5}$ precursors are dozens of Electric Generating Units, (EGUs) in Delaware and in upwind states. As mentioned above, Delaware has developed and submitted to EPA attainment demonstration SIPs which have included controls over all source sectors, and which have demonstrated that necessary NO_x and SO_2 emission reductions have been, and will be made, to attain these NAAQS's (Reference 1 and 2). These SIPs relied upon emission reductions from Delaware EGUs, and emission reductions from upwind EGUs that in part comply with CAA 110(a)(2)(D). Among the consequences of upwind EGUs not complying with CAA 110(a)(2)(D), aside from people in Delaware suffering the ill-health effects of upwind air pollution sources, is that Delaware residents and businesses, and those dependent on power from the EGU's, pay a higher financial cost to pay for these controls and are put at an economic disadvantage compared to upwind states who have failed to pay for controls.

3.1 Delaware Electric Generating Units (EGUs).

All of Delaware's EGUs are well controlled as summarized below:

- Control for generators powered by internal combustion engines is provided under Delaware Regulation 1144, "Control of Stationary Generator Emissions" (Reference 7). This regulation significantly reduces NO_x emissions from small EGUs that have low annual emissions, but high peak day emissions. The NO_x rate is limited to between 4.0 and 0.6 lb/MWh, depending on installation date.

- Control for oil and coal fired units is provided under Regulation 1146 "Electric Generating Unit (EGU) Multi-Pollutant Regulation" (Reference 8). This regulation significantly reduces NO_x, SO_2 and mercury emissions from Delaware's coal and residual oil fired EGUs. Emission rate of NO_x is limited to 0.125 lb/mmBTU, SO_2 to 0.26 lb/mmBTU, and mercury to 90% reduction or 0.6 lb/tBTU. Delaware Regulation 1146 sets up more stringent emission rate limits over those CAIR affected EGUs, plus an earlier effective schedule than that of CAIR Phase I and Phase II requirements.

[4] Also, see footnote 1.

- Control for peaking units is provided under Regulation 1148, "Control of Stationary Combustion Turbine Electric Generating Unit Emissions" (Reference 9). This regulation significantly reduces NO_X emissions from Delaware EGUs that have high peak day NO_X emissions, yet remained substantially uncontrolled after RACT (i.e., Delaware Regulation No. 1112) due to low annual emissions. Emission of NO_X from gas units is limited to 42 ppm and from oil units is limited to 88 ppm.

Delaware's EGU regulations are state regulations that are in effect before the ozone season of 2009. These regulations are among the control requirements adapted by Delaware as necessary to comply fully with CAA Section 110(a)(2)(D).

3.2 EGUs in Upwind States

As mentioned above, ozone and $PM_{2.5}$ air pollutant concentrations in Delaware and, thus, Delaware's ability to attain and maintain the NAAQS are significantly influenced by air pollution from upwind emission sources. More specific discussion on the impacts of upwind emissions on Delaware is included in Delaware's ozone and $PM_{2.5}$ SIPs (References 1 and 2, respectively) and below.

The EPA conducted comprehensive studies on upwind contributions to downwind ozone and $PM_{2.5}$ problems when promulgating CAIR in 2005. The EPA concluded, based on these studies, that emissions from the following states contribute significantly to Delaware's ozone and/or PM non-attainment problems (see in Tables VI-8 and VI-9 of 70 *FR* 25162):

Maryland (ozone and $PM_{2.5}$)
Michigan (ozone and $PM_{2.5}$)
New York ($PM_{2.5}$ only)
North Carolina (ozone only)
Ohio (ozone and $PM_{2.5}$)
Pennsylvania (ozone and $PM_{2.5}$)
Virginia (ozone and $PM_{2.5}$)
West Virginia (ozone and $PM_{2.5}$)

In addition, the CAIR analysis indicated that emissions from two states, New Jersey and New York, contribute significantly to ozone non-attainment problems of other counties, outside of Delaware, in the PA-NJ-MD-DE non-attainment area (see Tables VI-8 and VI-9 of 70 *FR* 25162). Because Delaware's attainment status for the current 8-hour ozone standard depends on attainment of the entire PA-NJ-MD-DE non-attainment area, these two states should be also regarded as emitting air pollutants at levels that significantly impact Delaware's ability to attain and maintain NAAQSs because they are contributing upwind states to the non-attainment area of which Delaware is a part.

Our confidence in these conclusions about upwind contributions is based on EPA analysis. Regional NO_x and SO_2 emissions were studied thoroughly by EPA through in-depth modeling analyses in its CAIR rulemaking process (Reference 6). For example, using the source apportionment total contribution metric, EPA estimated that the percent contribution of upwind states to the 2010 base case 8-hour ozone nonattainment in New Castle County, Delaware, was 37% (Table VI-2, Reference 6). Based on those analyses, EPA defined the above upwind states as significant linkages to ozone and/or $PM_{2.5}$ non-attainment problems in Delaware and the entire PA-NJ-MD-DE non-attainment area. Therefore, emissions of NO_x and SO_2 from EGUs as a group of significant sources in those upwind states must be controlled, under CAA Section 110(a)(2)(D)(i), to mitigate their contributions to downwind non-attainment problems.

Further, the EGU emissions of NO_x and SO_2 represent significant portions of upwind states' total emissions of air pollutants, as indicated in Table 1 below.

Table 1. Relative Contribution of EGU Emissions to Total State Emissions in 2001*.

Significant Upwind State	**NOx**	**SO_2**
Maryland	24.2%	74.2%
Michigan	21.4%	71.8%
New Jersey	10.8%	42.9%
New York	12.6%	49.8%
North Carolina	25.7%	79.7%
Ohio	34.6%	84.0%
Pennsylvania	26.7%	80.4%
Virginia	17.7%	67.4%
West Virginia	54.0%	85.4%

*Note: Data compiled from EPA's CAIR emission file "Annual emissions of VOC, CO, SO_2, NOx, NH_3, PM_{10} and $PM_{2.5}$ model species for the 2001 Base Year, 2010 Base Case, and 2015 Base Case", at http://www.epa.gov/cair/pdfs/Emissions_summary_state_sector_speciation.xls.

Delaware's ozone SIP has demonstrated that its attainment of the current 8-hour ozone standard in 2009 depends partially on EGU NOx reductions from the upwind states (Reference 1). This partial dependence is also indicated by EPA's CAIR modeling analysis (e.g., Table VI-12, 70 *FR* 25162). For the current annual $PM_{2.5}$ standard, effects of EGU reductions under CAIR on Delaware's efforts for the 2010 attainment are also projected to be critical, as indicated in Table VI-10 of the final CAIR rule (70 *FR* 25162). Based on all this evidence Delaware believes that:

(1) NO_x reductions from EGUs in the nine states, (MD, MI, NJ, NY, NC, OH, PA, VA, and WV) at CAIR Phase I levels, at a minimum, are needed in 2009 for the 2009/2010 attainment in DE and Philadelphia ozone and $PM_{2.5}$ non-attainment area(s), and

(2) further NOx and SO_2 reductions from those EGUs are needed beyond 2009 for maintaining the current NAAQSs and attaining the new ozone and PM NAAQSs that were promulgated by EPA.

Therefore, emissions of NOx and SO_2 from those EGUs must be subject to timely control requirements pursuant to CAA Section 110(a)(2)(D)(i), so that they will cease emitting air pollutants in amounts that contribute significantly to nonattainment and interfere with maintenance in Delaware with respect to ozone and $PM_{2.5}$ NAAQSs.

4. Delaware Petition under CAA Section 126

As demonstrated above, air pollutant emissions from upwind states that are in excess of those allowed under CAA Section 110(a)(2)(D) are adversely impacting Delaware, and the entire PA-NJ-MD-DE non-attainment area. The EGUs in the states identified in 3.2 above are emitting air pollutants in violation of the prohibition of Section 110(a)(2)(D) of the CAA, and EPA must fulfill its nondiscretionary statutory obligation under CAA Section 126(b) to require this violation to cease. Ours is exactly the situation envisioned in the CAA for which Section 126 was intended. The extent of the upwind air pollution transport is significantly affecting Delaware's ability to comply with federal health based air quality standards, despite Delaware's best efforts. The air coming into Delaware and the PA-NJ-MD-DE non-attainment area does not meet the standard. Accordingly, timely EPA action is necessary to comply with the CAA. Failure to act would render meaningless this part of the CAA.

Full mitigation of upwind NO_x and SO_2 emissions is crucial to the attainment and maintenance of the ozone and new $PM_{2.5}$ NAAQSs. This full mitigation pursuant to CAA Section 110(a)(2)(D) must be obtained as soon as practicable, but no later than 2013. As discussed previously, Delaware has "clean hands" in that it has implemented all controls within its boundary to meet the requirements of CAA Section 110(a)(2)(D). The most recent control requirements include:

1. Architectural and Industrial Maintenance (AIM) Coatings: reduced VOC content of numerous coatings beyond federal requirements.
2. Mobile Equipment: established coating equipment standards to reduce VOC emissions.
3. Gas Cans: required that gas cans meet certain performance and permeability standards to reduce VOC emissions.
4. Degreasing: reduced degreaser vapor pressure and put in place equipment standards and work practices to reduce VOC emissions.
5. Control of NO_X Emissions from Large Boilers: reduced NO_X emissions from boilers larger than 100 mmbtu/hr that weren't well controlled through other programs.
6. Anti-Idling: reduced VOC, NO_X, SO_X, and DPM emissions from heavy duty vehicles by reducing allowable idling time.
7. Open Burning: put in place strict open burning ban during the ozone season.
8. Minor NSR: reduced criteria pollutant and air toxic emissions by subjecting new minor stationary sources to top-down BACT requirements.
9. OTC NO_X Budget Program: participated in a regional NOX Cap and Trade program to reduce NO_X emissions from power plants (program later replaced by the NO_X SIP Call).
10. Adopted several regulations to reinforce EPA-adopted heavy-duty diesel rules.

11. Peaking Units: reduced peak ozone day NO_X emissions from combustion turbines used as electrical peaking units.
12. Refinery Boilers: reduced NO_X emissions from large refinery boilers.
13. Non-Refinery Boilers: reduced NO_X emissions from large non-refinery boilers.
14. Utilities Multi-P: reduced NO_X, SO_X, and Hg emissions from Delaware's coal and residual oil fired electric utilities.
15. Lightering: reduced VOC emissions from crude oil lightering operations in the Delaware Bay.

Therefore, the adverse impact from upwind states on the health and welfare of Delaware citizens must be mitigated as soon as practicable. Further, mitigation by 2013 is necessary to ensure that Delaware can take advantage of these CAA mandated upwind reductions under CAA Section 110(a)(2)(D) as it develops future required maintenance and attainment demonstration SIPs.

Delaware's current ozone and $PM_{2.5}$ SIPs (Reference 1 and 2) rely upon the partial mitigation under 110(a)(2)(D) of upwind NOx emissions in 2009 (i.e., CAIR level reductions). CAIR was recently vacated by the courts, however, as, inter alia, not sufficient to satisfy CAA (110)(a)(2)(D). Among our concerns now is that some of the upwind states have relied upon CAIR to satisfy their obligations under CAA 110(a)(2)(D). The CAIR vacatur removed the CAIR-mandated obligations from upwind EGUs. Delaware is extremely concerned about the CAIR vacatur and its adverse impacts on Delaware's 2009 attainment for the current 8-hour ozone NAAQS and 2010 attainment for the 1997 annual $PM_{2.5}$ NAAQS, as well attaining the 24-hr NAAQS in the future.

With the above concerns, Delaware is hereby petitioning EPA under Section 126(b) of the CAA to find that EGUs in the identified upwind states are emitting air pollutants in violation of the prohibition of Section 110(a)(2)(D)(i) of the CAA.

Delaware believes, as a first step, much of this impact can be mitigated by regulating NO_x and SO_2 emissions from EGUs in the upwind states. After EPA makes the findings that EGUs in upwind states are emitting air pollutants in violation of the prohibition of Section 110(a)(2)(D)(i) of the CAA, Delaware recommend EPA to take the following actions:

- Make the required finding under section 110 of the CAA and then pursue additional courses of action to reduce air pollution, including:

- Phase One. Require partial mitigation of NO_x emissions from upwind EGUs by 2009. The need for timely EPA action on this petition is critical. Delaware has submitted to the EPA SIPs that demonstrate that Delaware will attain compliance with ozone and $PM_{2.5}$ NAAQSs in 2009 and 2010, respectively. However, these SIPs rely in part on some mitigation of upwind NOx emissions in 2009, and it is critical that the EPA take reasonable action to require upwind states to at least partially comply with CAA 110(a)(2)(D)(i) in 2009. This partial compliance can be done by requiring controls on those upwind EGUs equivalent to CAIR Phase I levels.

- Phase Two. Require full mitigation of NO_x and SO_2 emissions from upwind EGUs. This is crucial to the maintenance of the current ozone and $PM_{2.5}$ NAAQSs, and to the attainment of the new ozone and new 24-hour $PM_{2.5}$ NAAQS's. This full mitigation under CAA Sections 126 and 110(a)(2)(D) must be obtained as soon as practicable, but not later than 2013. The full mitigation of NO_x and SO_2 emissions from a subject upwind state is determined when emissions from its EGUs, together with emissions from other source sectors in the subject state, will no longer contribute significantly to Delaware's ozone and $PM_{2.5}$ non-attainment problems, or will not interfere with Delaware's maintenance of its attainment status, as shown by adequate modeling results.

Delaware believes that EPA can accomplish the Phase One recommendation of this petition by requiring controls equivalent to the first phase of its CAIR, or reinstating CAIR under the authority of Section 126(b) of the CAA. This would require those upwind EGUs to control their NO_x emissions to the levels equivalent to CAIR Phase I requirements under the authority of Section 126 of the CAA. The consequence of EPA's failure to require those reductions to occur in 2009 will be that Delaware's air quality may not meet the associated ozone and 1997 $PM_{2.5}$ NAAQS's by the 2009 and 2010 attainment dates, respectively, and Delaware citizens will be exposed to unhealthy air.

Given the failure of prior attempts to fully mitigate transport under the cap-and-trade approach (i.e., NOx SIP Call and CAIR), Delaware believes that sole reliance on a cap-and-trade program to mitigate transport is not an acceptable remedy. Prior experience has demonstrated that cap-and-trade schemes have proven to be ineffective as a sole remedy to the long-standing problem that Northeastern states, including Delaware, have suffered with because of the transport of air pollution from other states into their jurisdictions. Further, Delaware has demonstrated, through the promulgation its own multi-pollutant rule controlling EGUs (Regulation 1146), that even highly cost effective emission controls will not be installed on smaller EGUs under a cap-and-trade approach alone (Reference 8). Delaware believes that the EPA must set performance standards on each EGU in the states that impact Delaware in order to accomplish the Phase Two recommendation of this petition. The specific EGUs that would be subject to this performance standard are coal and residual-oil fired EGUs greater than 25 MWe.

Each unit coal or oil fired EGU that serves a generator of 25 MWe or greater must comply with a minimum level of control. Delaware believes the level should be equivalent to the level it has required its own in state coal and oil fired EGUs to meet under Delaware Regulation No. 1146 (Reference 8).

Delaware's Regulation 1146 includes rate-based NO_x and SO_2 emissions limits for Delaware's large coal-fired and residual oil-fired electric generating units (EGUs). All subject EGUs are required to have a NO_x emission rate no greater than 0.15 lb/MMBTU beginning in 2009, and a NO_x emission rate no greater than 0.125 lb/MMBTU beginning in 2012. Coal-fired EGUs are required to have a SO_2 emission rate no greater than 0.37 lb/MMBTU beginning in 2009, and a SO_2 emission rate no greater than 0.26 lb/MMBTU beginning in 2012. Residual oil-fired EGUs are required by the regulation to accept only fuel oil with a sulfur content maximum of 0.5% by weight beginning in 2009.

Delaware adopted Regulation 1146's NO_x and SO_2 emissions rate limits as a result of review and analysis of available EGU NO_x and SO_2 emission control information. Sources of this information included EPA publications, Clean Air Markets Division (CAMD) data, Energy Information Administration (EIA) data, industry reports, and control equipment vendor publications. The information was reviewed for the purpose of identifying NO_x and SO_2 emission rates that were technologically feasible for virtually any large (> 25 MWe) coal-fired EGU, were cost- effective for virtually any large coal-fired EGU, and were commercially available for retrofit to virtually any large coal-fired EGU. Delaware further determined that imposing emission rate limits in the regulation potentially provided a more cost-effective methodology than specifying a given control technology requirement by allowing subject sources the flexibility to choose a reduction technology or suite of technologies that best fit the needs of the particular source. The emission rate limits determined for Delaware's Regulation 1146 also closely correspond to regional average emission rates that can be estimated from the EPA's CAIR cap-and-trade program allowance allocations.

The NO_x emissions rate limits identified in Delaware's Regulation 1146 are similar in magnitude to the highly cost-effective region-wide average emission rates associated with the development of the EPA's CAIR cap-and-trade program budgets. The EPA's Technical Support Document for CAIR, Notice of Final Rulemaking, "Regional and State SO_2 and NO_x Emissions Budget", dated March 2005, discussed the development of the regional NO_x budgets associated with the CAIR program. EPA indicates in the document that region-wide NO_x emissions mass caps were determined by multiplying the base region-wide heat input by 0.15 lb/mmBTU and 0.125 lb/MMBTU for 2009 and 2015, respectively. Referring to this methodology, the document states "The EPA determined, through IPM analysis, that the resulting region-wide emissions caps (if all states choose to obtain reductions from EGUs) are highly cost-effective levels."

The aforementioned EPA CAIR technical support document also addressed the development of CAIR cap-and-trade program budget for SO_2 emissions. In the document, EPA discussed the designing of Acid Rain SO_2 allowance retirement ratios to achieve a 50% SO_2 reduction beginning in 2010 and achieving a 65% reduction beginning in 2015. These retirement ratios effectively established region-wide SO_2 mass emissions caps for 2010 and 2015. If these effective 2010 and 2015 SO_2 mass emissions caps are divided by the baseline heat input used by the EPA's technical support document in the determination of the NOx annual budget mass caps, the resulting region-wide average SO_2 emission rates are 0.37 lb/MMBTU in 2010 and 0.26 lb/MMBTU in 2015. Regarding the 50% SO_2 reduction in 2010 and 65% SO_2 reduction in 2015, EPA stated that "EPA determined, through IPM analysis, that the resulting region-wide emissions caps (if all states choose to obtain reductions from EGUs) are highly cost-effective levels." The SO_2 emissions rate limits identified in Delaware's Regulation 1146 are similar in magnitude to those highly cost-effective SO_2 region-wide emissions limitations associated with the EPA's CAIR technical support document. The EPA provided further discussion and justification of the above "highly cost-effective" NOx and SO_2 emissions budgets in the final CAIR rule (70 *FR* 25162).

Delaware believes that once all coal and oil fired units of 25 MWe or greater are controlled, that it would then be appropriate to overlay a cap-and-trade program to bring in gas and other units, with a cap significantly tighter than CAIR. Delaware believes that under this approach (i.e., performance standards plus cap-and-trade program) the emissions from the EGU sector would comport with CAA 110(a)(2)(D).

CAA Section 126(b) requires that within 60 days after receipt of any petition and after public hearing, the Administrator shall make such a finding or deny the petition. Once a finding is made, CAA Section 126(c) does not allow any major existing source to operate more than 3 months after such finding has been made with respect to it, except that the Administrator may permit the continued operation of a source beyond the expiration of such three-month period if such source complies with such emission limitations and compliance schedules (containing increments of progress) as may be provided by the Administrator to bring about compliance with the requirements contained in CAA Section 110(a)(2)(D)(ii) as expeditiously as practicable, but in no case later than three years after the date of such finding. As explained above, Delaware believes that compliance with the CAIR Phase I levels would satisfy the immediate timing for 2009, and that final mitigation must be achieved within 3 years thereafter.

We look forward to working with you and your staff during this critical period in which you make your finding relative to this petition, and take the required actions. If you have any questions or desire to meet and discuss this petition, please do not hesitate to contact me or Ali Mirzakhalili, Administrator, Air Quality Management Section.

Sincerely,

David S. Small acting for

John A. Hughes
Secretary

CC: Governor Ruth Ann Minner,
State of Delaware

Administrator Donald S. Welsh
US EPA Region III Office

Shari T. Wilson, Secretary
George Abum, Air Director
Maryland Department of the Environment

Steven E. Chester, Director
G. Vinson Hellwig, Air Division Chief
Michigan Department of Environmental Quality

Mark N. Mauriello, Commissioner
William O'Sullivan, Air Director
New Jersey Department of Environmental Protection

Pete Grannis, Commissioner
Jared Snyder, Assistant Commissioner for Air Resources
New York Department of Environmental Conservation

William G. Ross Jr., Secretary
Keith Overcash, Air Director
North Carolina Department of Environment and Natural Resources

Chris Korleski, Director
Robert Hodanbosi, Air Division Chief
Ohio Environmental Protection Agency

John Hanger, Acting Secretary
Joyce E. Epps, Air Director
Pennsylvania Department of Environmental Protection

David K. Paylor, Director
Mike Dowd, Air Director
Virginia Department of Environmental Quality

Randy C. Huffman, Secretary
John A. Benedict, Air Director
West Virginia Department of Environmental Protection

David Small, Deputy Secretary,
Department of Natural Resources and Environmental Control

James D. Werner, Director
Delaware Division of Air and Waste Management

Ali Mirzakhalili, Administrator
Delaware Air Quality Management Section

Judy Cherry, Director
Delaware Economic Development Office

References

1. Delaware State Implementation Plan for Attainment of the 8-Hour Ozone National Ambient Air Quality Standard: Reasonable Further Progress and Attainment Demonstration. Delaware Department of Natural Resources and Environmental Control, June 2007.
2. Delaware State Implementation Plan for Attainment of Fine Particulate Matter National Ambient Air Quality Standard. Delaware Department of Natural Resources and Environmental Control, April 2008.
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4. Review of the National Ambient Air Quality Standard for Ozone: Policy Assessment of Scientific and Technical Information. Staff paper, Office of Air Quality Planning and Standard, US Environmental Protection Agency, Research Triangle Park, NC, January 2007.
5. Final Reports, Vol. I-III, Air Quality Analysis Workgroup, Ozone Transport Assessment Group, May-June, 1997.
6. Technical Supporting Document of the Final Clean Air Interstate Rule, Air Quality Modeling, Office of Air Quality Planning and Standard, US Environmental Protection Agency, Research Triangle Park, NC, March 2005.
7. Regulation 1144, "Control of Stationary Generator Emissions", Delaware Department of Natural Resources and Environmental Control, January 2006 (EPA approved SIP regulation).
8. Regulation 1146, "Electric Generating Unit (EGU) Multi-Pollutant Regulation", Delaware Department of Natural Resources and Environmental Control, December 2006 (SIP Regulation pending EPA approval).
9. Regulation 1148, "Control of Stationary Combustion Turbine Electric Generating Unit Emissions", Delaware Department of Natural Resources and Environmental Control, July 2007 (SIP Regulation pending EPA approval).

STATE OF DELAWARE
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March 18, 2009

Mr. William T. Wisniewski (3RA00)
Acting Regional Administrator
Region III
U.S. Environmental Protection Agency
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Dear Administrator Wisniewski:

On March 12, 2008, the EPA revised the primary and secondary National Ambient Air Quality Standards (NAAQS) for ground-level ozone from the current 0.08 parts per million (ppm) to a new 0.075 ppm. Section 107(d) of the Clean Air Act (CAA) requires the Governor of each State to submit to the EPA a list of all areas (or portions thereof) in the State, designating each as nonattainment, attainment, or unclassifiable. This letter fulfills Delaware's obligations under Section 107(d) of the CAA. It also recommends the placement of Delaware's counties in non-attainment status under the new 0.075 ppm standard in a non-attainment area.

Area Description and Attainment/Nonattainment Status

Delaware is composed of three counties, namely New Castle, Kent and Sussex, laying from north to south. The northern portion of New Castle County lies above the Chesapeake and Delaware Canal, a waterway that connects the Chesapeake Bay with the Delaware Bay. This part of New Castle County is more metropolitan and industrialized than the remainder of Delaware. The remainder of Delaware lies south of the Chesapeake and Delaware Canal, and comprises the southern portion of New Castle County, and all of Kent and Sussex Counties. All three counties share similar air quality problems with respect to ozone, because the problem is predominantly caused by ozone and ozone precursor emissions from upwind states.

Delaware's ozone monitoring network includes ambient ozone monitors in each of its counties (three monitors in New Castle, one monitor in Kent, and one monitor in Sussex). Based on 2006 through 2008 ozone monitoring data (i.e., the most recent three years), the 8-hour ozone design values for New Castle, Kent and Sussex counties are 0.083 ppm, 0.081 ppm, and 0.081 ppm, respectively. Since these design values are all greater than the 0.075 ppm standard, all three counties in Delaware should be designated as non-attainment for both the primary and secondary 8-hour ozone NAAQS.

Placement of Delaware's Counties in a Large Nonattainment Area

Ground-level ozone and ozone precursor emissions are pervasive and readily transported. Numerous epidemiological studies conducted during the past decade have revealed that prolonged (i.e., 8-hour) exposure to ozone is associated with increased mortality and a range of serious morbidity health effects, including aggravation of a variety of respiratory symptoms and lung impairment, asthma attacks, respiratory hospital admissions and emergency department visits, and cardiovascular problems. This level of ozone concentration is also associated with adverse public welfare effects, which include impacts on vegetation, and forest ecosystems, and agricultural crop yields. The pervasive nature of ozone, and the serious adverse health and welfare effects associated with ozone non-attainment make non-attainment boundary determinations critical.

Under the 1997 8-hour ozone NAAQS, the EPA included Delaware's three counties in the Philadelphia-Wilmington-Trenton Nonattainment Area. In establishing this area the EPA relied on their policy presumption of using Consolidated Metropolitan Statistical Area (CMSA) boundaries and the prior 1-hour nonattainment area (NAA) boundaries as 8-hour nonattainment area boundaries, except they also considered the impact of upwind emissions and included Ocean County, NJ, despite Ocean County, NJ being part of the New York CMSA. Delaware believes that full consideration of upwind contribution when establishing non-attainment boundaries is necessary because ozone and ozone precursor emissions are pervasive and readily transported. It is important that the emissions that are causing Delaware's ozone problem be subject to the CAA non-attainment requirements.

In its guidance entitled "Area Designation for the 2008 Revised Ozone NAAQS (December 4, 2008)," EPA recommends using the Core Based Statistical Area (CBSA) or Combined Statistical Area (CSA), similar to the previous CMSA concept, to delineate nonattainment boundaries. In the guidance, EPA recognizes that upwind contribution is significant, and indicates that "In addition to nearby areas with sources contributing to nonattainment, ozone concentrations in a local area may be affected by long-range transport of ozone and its precursors (notably nitrogen oxides). In certain parts of the country, such as the eastern United States, ozone is a widespread problem." However, in this guidance document EPA also indicted that where this is the case, the CAA does not require that all contributing areas be designated nonattainment, but only the nearby areas; and that regional strategies, such as those employed in the Ozone Transport Region and EPA's NOx SIP Call are needed to address the long-range transport component of ozone nonattainment, while the local component must be addressed through local planning in and around the designated nonattainment area. The EPA's practice being guided by this interpretation has led to a separation between regional controls and local controls, which has been proved to be substantially ineffective in ozone NAAQS strategy planning and attainment. In particular, this interpretation has led ineffective, insufficient and delayed regional controls, and insufficient and even no local controls being installed in many areas due to exclusion of many contributing areas/counties in the nonattainment designation.

Section 107(d)(1) of the CAA defines a nonattainment area as "any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant." In the context of a regional problem like ozone nonattainment, the term "nearby" must be interpreted consistent with the scale of the problem and the nature of the pollutant. For the purposes of solving air quality problems associated with pollutants like sulfur dioxide and carbon monoxide, CMSA or CBSA/CSA scale boundaries have proven adequate. This is because concentrations of these pollutants above the standard are generally driven by emission sources that are very close, geographically and do not involve complex atmospheric chemistry. However, this is not the case with ozone. Over the past 35+ years, and in particular since 1990, Delaware's local sources of ozone precursor emissions have all been well controlled, yet Delaware's air quality remains non-attainment relative to ozone. High ozone concentrations in Delaware are not driven by emission sources that are geographically close, but rather emissions sources that are many miles away. Given this, Delaware believes that it is necessary to consider regional transport of ozone and ozone precursor emissions in establishing non-attainment area boundaries. More specific reasons for this belief include:

- The CBSA/CSA approach is based on census data rather than air-shed monitoring and/or analysis data. Census data, in comparison to air-shed data, represents a poor surrogate for determining ozone non-attainment boundaries. This is particularly true for areas like Delaware that are heavily affected by long-range transport of ozone and ozone precursors.
- Detailed regional air-shed studies have been completed in the past decade or so, such as the Regional Oxidant Modeling (ROM) project covering most of the Ozone Transport Region (OTR) states, the Ozone Transport Assessment Group (OTAG) project, the NOx SIP Call analysis covering most of the Eastern U.S., and the EPA Clean Air Interstate Rule (CAIR) analysis. These studies have demonstrated that the ozone problem is transport-driven and regional in scope, rather than localized or confined to the relatively small CBSA/CSA domains.
- The studies mentioned above have further demonstrated that individual CBSA/CSA based non-attainment areas do not have the ability to achieve attainment regardless of the levels of emission controls they implement within their own jurisdictional boundaries. Delaware believes that this conclusion should become the cornerstone of good air quality planning and policy, starting with the crucial boundary determinations.
- In many downwind nonattainment areas, including Delaware, the air coming into a county is often with ozone concentration greater than 0.075 ppm (i.e., greater than NAAQS). Therefore, it becomes impossible for such an area to solve its non-attainment problem under its own authority. The CBSA/CSA approach has led to situations where many downwind areas are struggling with non-cost-effective controls to reduce ambient ozone components that come from upwind areas that are not subject to the reasonable emission control requirements. As a result, protection of public health in those

downwind areas has been severely hindered and delayed because reasonable emission controls are not in place in the upwind areas.

- The CBSA/CSA approach has led to stringent controls being implemented within individual non-attainment areas. This approach has had success in the OTR toward achieving attainment of both 1-hour (0.12 ppm) and the current 8-hour (0.08 ppm) ozone NAAQS, however, the most success toward attainment of ozone NAAQS in the OTR to date is attributable to national measures taken by the EPA, and regional measures developed and adopted by the Ozone Transport Commission (OTC) member states. The area is also facing with having to implement measures that will provide diminishing returns. We are revisiting standards for a second or third time for sectors that go uncontrolled in the contributing upwind states.

In its December 4, 2008 guidance, EPA recommends nine factors for states to use to justify their boundary recommendations. The EPA states its rationale for recommending these factors as being that they are similar to the ones used to establish CBSAs and CSAs. Delaware believes, however, using these factors to justify ozone non-attainment boundaries because they are similar to the ones used to establish CBSAs and CSAs is not appropriate. Instead, boundary recommendations must be evaluated with consideration given to the pervasive nature of the pollutant ozone, and the ozone/precursor transport issue discussed above.

Based on the above discussion Delaware recommends that EPA include Delaware's three counties in a single multi-state regional large nonattainment area (NAA) that includes all counties in the states of Maryland, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. This area encompasses the emissions that are causing Delaware's ozone non-attainment problems, and rationale for it is more fully described in the CAA Section 126 petition that Delaware submitted to the EPA on December 15, 2008. A map that details Delaware's recommended nonattainment area boundaries is attached to this letter. Delaware believes that this approach would:

- Reinforce the science-based and wide-accepted fact that ozone non-attainment is a "regional problem" and not only a "local problem";
- Include all or most of the counties necessary to solve this regional problem, give them a vested interest in solving this regional problem, and foster cooperative development and implementation of control strategies that are most effective to solving the wide-spread ozone nonattainment problem;
- Remove political barriers and level the playing field by setting the consistent baseline of control requirements of Subpart 2 of Title I, Part D of the CAA within the region, which include New Source Review (NSR), vehicle Inspection and Maintenance, and highly cost effective Reasonably Available Control Technology (RACT) requirements;
- Effectively compliment national and regional rules that address regional transport;
- Greatly simplify and provide equity to the process of implementing the new 8-hour NAAQS.

implementation of control strategies that are most effective to solving the wide-spread ozone nonattainment problem;

- Remove political barriers and level the playing field by setting the consistent baseline of control requirements of Subpart 2 of Title I, Part D of the CAA within the region, which include New Source Review (NSR), vehicle Inspection and Maintenance, and highly cost effective Reasonably Available Control Technology (RACT) requirements;
- Effectively compliment national and regional rules that address regional transport;
- Greatly simplify and provide equity to the process of implementing the new 8-hour NAAQS.

Delaware believes that the above large-NAA recommendation represents the most effective and economical way to address the pervasive ozone nonattainment problem in the northeast region. If, however, the EPA chooses not to embrace the above recommendation (i.e., not to fully consider upwind contribution in setting nonattainment boundaries, and not to establish a large regional ozone non-attainment area), despite our confidence that is a better course of action, then Delaware proposes that the EPA establish Delaware as a stand-alone ozone nonattainment area (i.e., the geographical boundaries of Delaware constitute Delaware's ozone nonattainment boundaries). Delaware suggests this stand-alone alternative not because it is the best approach to clean the air, but rather because it is more rationale than a CBSA/CSA supported designation under the muse that emissions within the CBSA/CSA area are causing the nonattainment problem. Note that Delaware's ozone nonattainment problems are mainly caused by long-range ozone/precursor transport from upwind sources, and under this approach the EPA would need to commit to develop and implement effective regional controls to completely mitigate ozone/precursor transport in the timeframe of Delaware (and other downwind states) attainment schedule according to the CAA.

Thank you for your consideration of the above recommendations. If you feel you cannot support the large non-attainment boundary approach discussed above Delaware would like to have an opportunity to continue this discussion before you propose any modification. If you have any questions concerning this submittal or would like to discuss it further, please contact Mr. Ali Mirzakhalili, the administrator of our air quality management section, at (302)739-9402.

Sincerely,

Jack A. Markell
Governor

pc: Dave Small
Jim Werner
Ali Mirzakhalili
Judith Katz

Mr. William T. Wisniewski
March 18, 2009
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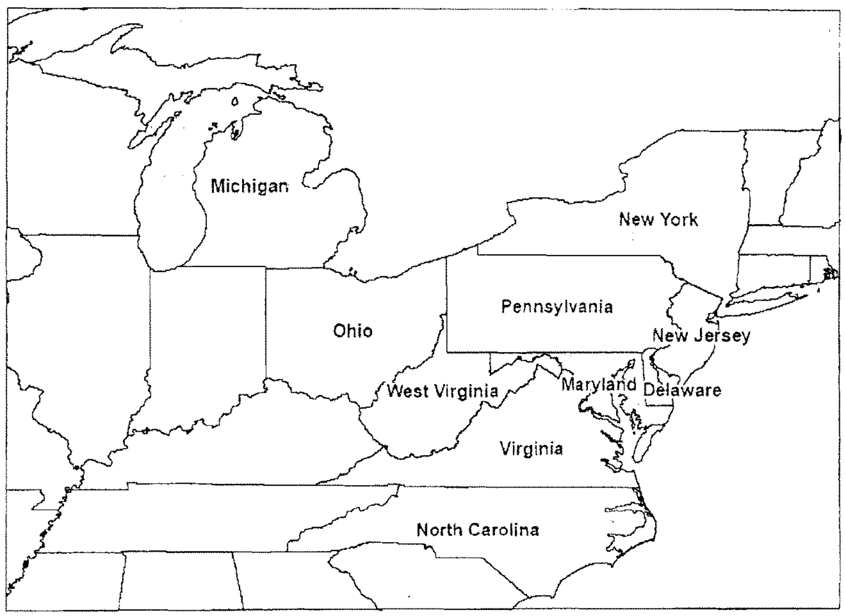
Attachment 1

Delaware Recommendation of Large
Nonattainment Area Boundaries for the 2008 Revised Ozone NAAQS

Delaware Recommended 8-hour Ozone Non-attainment Boundaries



STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
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October 1, 2010

EPA Docket Center, EPA West (Air Docket)
U.S. Environmental Protection Agency,
Mail Code: 2822T
1200 Pennsylvania Avenue, NW.,
Washington, DC 20460.

Attention: Docket ID No. EPA–HQ–OAR–2009–0491

In the August 2, 2010, Federal Register (Vol. 75, No. 147) the Environmental Protection Agency (EPA) proposed revisions to 40 CFR Parts 51, 52, 72, 78, and 97, Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone. The State of Delaware welcomes the opportunity to provide comments regarding this proposed rule.

Delaware has complied with the requirements of Clean Air Act (CAA) Section 110(a)(2)(D)(i) by effectively controlling emissions sources within Delaware so that those sources do not contribute significantly to downwind states' non-attainment or interference with downwind states' maintenance of National Ambient Air Quality Standards (NAAQSs). However, Delaware's ability to attain and maintain the NAAQSs is significantly hampered by emissions from sources in upwind states that have not taken measures to control their air pollutant emissions. This is discussed in detail in Delaware's December 15, 2008 CAA 126 petition to the EPA.

Delaware provides the following eleven (11) comments on the proposed transport rule.

1. *Delaware believes that it has been inappropriately named as a State that needs to be covered by the proposed transport rule.* According to the proposed rule the EPA modeled their 2012 Base Case emission projections to determine whether States met a threshold for "linkage" and thus "significant contribution to, and/or interference with maintenance" to downwind areas. The results of EPA's 2012 Base Case modeling show that Delaware's downwind contribution exceeds one or more of these thresholds for the ozone, annual and daily fine particulate matter NAAQSs. Consequently, the EPA

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October 1, 2010
Page 2

concluded that Delaware needed to be included in the transport rule. Delaware does not agree with this conclusion for the following reasons:

- Delaware's sulfur dioxide (SO2) and nitrogen oxides (NOx) emissions are significantly overstated in the proposed transport rule analysis. Delaware compared its 2005 Periodic Emissions Inventory (PEI) with EPA's 2005 emissions used in the proposed transport rule. Delaware then projected its 2005 PEI emissions to 2012, and compared them to the proposed transport rules 2012 Base Case emissions. The results, which are summarized in Table 1 and Table 2 below, indicate that EPA's NOx and SO2 emissions are inflated for 2005 and both NOx and SO2 are significantly inflated in 2012. [1]

Table 1 2005 Emissions

2005 SO2	EGU	NonEGU	Nonpoint	Nonroad	Onroad	Total
Transport Rule	32,378	34,859	5,859	11,648	422	85,166
DE PEI Emissions	31,745	34,686	1,034	2,755	422	70,642
DE Emission Difference (tpy)	**-633**	**-173**	**-4,825**	**-8,893**	**0**	**-14,524**
% Difference	**2%**	**0%**	**82%**	**76%**	**0%**	**17%**
2005 NOX	**EGU**	**NonEGU**	**Nonpoint**	**Nonroad**	**Onroad**	**Total**
Transport Rule	11,917	5,567	3,259	15,567	22,569	58,879
DE PEI Emissions	11,397	5,999	2,317	11,728	22,569	54,010
DE Emission Difference	**-520**	**432**	**-942**	**-3,839**	**0**	**-4,869**
% Difference	**4%**	**-8%**	**29%**	**25%**	**0%**	**8%**

Table 2 2012 Projected Emissions

2012 SO2	EGU	NonEGU	Nonpoint	Nonroad	Onroad	Total
Transport Rule	7,841	10,974	5,858	14,193	98	38,964
DE Projections	7,356	5,941	1,034	2,201	98	16,630
DE Emission Difference	**-485**	**-5,033**	**-4,824**	**-11,992**	**0**	**-22,334**
% Difference	**6%**	**46%**	**82%**	**84%**	**0%**	**57%**
2012 NOX	**EGU**	**NonEGU**	**Nonpoint**	**Nonroad**	**Onroad**	**Total**
Transport Rule	4,639	5,567	3,248	15,511	10,700	39,665
DE Projections	2,418	4,504	2,315	10,370	10,700	30,307
DE Emission Difference	**-2,221**	**-1,063**	**-933**	**-5,141**	**0**	**-9,358**
% Difference	**48%**	**19%**	**29%**	**33%**	**0%**	**24%**

[1] Delaware's 2012 projections' assumptions and methods are discussed in Attachment 1 to this letter, "*Delaware Division of Air Quality (DAQ) Technical Support Document for Emission-related Comments on the Proposed Transport Rule.*"

Because EPA's 2005 and 2012 emissions inventories are inflated Delaware believes that EPA's modeling of 2012 base case emission over-states Delaware's contributions to downwind areas (i.e., over-estimated emissions inventories result in over-estimated contributions to downwind areas).

Much of the inventory differences are due to control measures Delaware has implemented that are not reflected in the EPA analysis. [2] Delaware believes that once the EPA inventories are corrected, modeling will show that it is not necessary to subject Delaware to the transport rule.

- Despite that EPA inventories for DE are inflated (see above and Attachment 1 to this letter), EPA's inventories themselves indicate that it is not necessary to include Delaware in the transport rule, i.e.:

  Without variability limits, EPA proposes at 40 CFR 97.410 a 2012 Delaware NOx budget of 6,206 TPY, and at 40 CFR 97.710 a 2012 Delaware SO2 budget of 7,784 TPY. EPA has indicted that a state's emissions budget *"...is the quantity of emissions that would remain in that state from covered sources after elimination of that portion of each state's significant contribution and interference with maintenance that EPA has identified in today's proposal, before accounting for the inherent variability in power system operations... The state emissions budget is a mechanism for converting the quantity of emissions that a state must reduce (i.e., the state's significant contribution and interference with maintenance) into enforceable control requirements. In other words, it provides a quantity of emissions to use in developing a remedy..."*

  However, EPA's 2012 base case emissions for Delaware EGU's are 4,639 TPY for NOx and 7,841 TPY for SO2, Since the EPA is establishing Delaware's EGU budgets at a level that is not less than its 2012 base case emissions [3], Delaware has already met its obligation to remedy downwind contributions for NOx and SO2.

Given the above, Delaware should not be included in the final Transport Rule, since our current control strategies have already mitigated our significant contributions to downwind areas.

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[2] See Attachment 1 to this letter for a detailed discussion of these control measures.

[3] The difference between the EPA 2012 base case SO2 inventory and the proposed budget for Delaware is 57 TPY. Once the EPA corrects the problems with the inventory 1) overall modeled contributions will be much less given that EPA's 2012 SO2 projections are inflated on the order of 57%, and 2) Delaware's 2012 EGU projection will be less than the proposed budget.

2. *The establishment of annual and/or seasonal EGU cap-and-trade programs and mass emissions budgets alone is insufficient.* In the proposed rule, EPA has proposed to establish a cap-and-trade program for annual SO2, annual NOx, and seasonal NOx for the purpose of mitigating the transport of fine particulate matter and ozone. A centerpiece of this proposal is the establishment of cap– and- trade programs: a SO2 cap-and-trade program with annual state-by-state SO2 mass emissions caps and provisions for unlimited intrastate trading and limited regional trading; a NOx cap-and-trade program with annual state-by-state NOx mass emissions caps and unlimited intrastate and regional trading; and a NOx cap-and-trade program with ozone season NOx mass emissions caps and unlimited intrastate and regional trading. In the preamble to the proposed rule the EPA also indicated that it was soliciting comments on two alternatives. The first alternative is the implementation of a program similar to proposed cap-and-trade program that excludes the regional trading aspects of the proposed program but still permits intrastate trading. The second alternative is a program based on establishing unit-specific emission rate limits based on historic emission rates and installation of controls, while maintaining state-specific mass emission caps similar to the proposed option. This second alternative also requests comment on including averaging for units owned by a common company in that state.

   It is Delaware's opinion that establishment of annual and/or seasonal EGU cap-and-trade programs and mass emissions budgets alone is insufficient to mitigate transport and assure the elimination of contribution of upwind states to downwind state non-compliance with short term NAAQS. Delaware believes that instead of allowing a cap-and-trade program's market forces to determine which EGUs are controlled, well controlled, or not controlled, all EGUs should be subject to compliance with both short term emission rate limits/performance standards (that are supportive of applicable short term NAAQS) and longer term annual and seasonal mass emissions caps . Short term emission rate limits/performance standards should be established on the basis of technical and economic feasibility, on a unit-by-unit basis, such that the limits/standards are supportive of the short term NAAQS. These short term emission rate limits/performance standards would also be expected to help alleviate episodic air quality excursions. Given this opinion, Delaware is generally supportive of the EPA further developing and implementing its second alternative, as discussed in the preamble to the proposed rule, (i.e., a program based on establishing unit-specific emission rate limits and installation of controls) as the focus of this rulemaking effort.

   Delaware generally agrees with the concept presented for EPA's second alternative to the proposed program that includes establishing unit-by-unit performance standards/emission rates along with an overlaying cap-and-trade program, but recommends EPA consider some revisions to the process presented by the EPA for that second alternative.

   - The first recommendation is that EPA reconsiders the use of the most recent quarterly data from the period 2007 through 2009 as the baseline. It is popularly viewed that calendar year 2007 is the last calendar year that has little effect from the current economic downturn. As such, it is assumed that the operation of EGUs in 2007 is more representative of expected normal operation for the units that operated during that period. For many of the units not incorporating post-combustion controls, unit hourly loading and average capacity factor can have a noticeable effect on emission rates (in terms of lb/MMBTU or lb/MW). Therefore, it is Delaware's opinion that utilizing 2007 operating data would provide a more accurate indication of both the units' uncontrolled emission rate and the emission rate resulting from the theoretical installation of emission controls. For units that did not operate in 2007, such as new units, emissions data from the earliest of 2008 or 2009, as applicable to the individual unit, could be utilized.

- The second recommendation is that EPA reconsiders the use of averaging the emission rate of all of a single company's EGUs in a given state as a compliance alternative. While Delaware agrees that this concept has merit in providing a company flexibility in control installation planning and compliance strategy, Delaware also believes that this flexibility could result in a number of smaller and/or low capacity factors to continue operation with little or no controls. The existence of such units contributes to transport issues and compliance with short term NAAQS. If EPA retains the concept of permitting same- company averaging for compliance, Delaware recommends that EPA consider doing so for only a small number of compliance periods to provide some initial flexibility for control installation planning until transitioning to a true unit-specific compliance requirement.

  In the TSD ***State Budgets, Unit Allocations, and Unit Emissions Rates***, Section 4, Direct Control Rate Limits, EPA indicates that, "The unit-level rates which sources must comply with under this approach are determined analogously to unit-level allocations – each unit's proposed allocation is divided by the reported or projected heat input associated with that tonnage." It is not clear that the modeling inputs are adequate to perform a proper evaluation. Further, it appears that the emission rate limits would still be determined primarily on an economic basis, thereby still allowing some units to operate with little or no emission controls. It is Delaware's opinion that this methodology does not adequately evaluate, on a unit- by-unit basis, the technical or economic feasibility of installation of cost-effective emission controls for these units. The methodology therefore may not adequately determine realistic emission rate limits for all of these units. It is Delaware's opinion that unit-by-unit technical evaluations are necessary to properly set such emission rate limits for every EGU in the program. Such evaluations must take into account the unit types, fuel(s) combusted, unit size, unit historic capacity factor, projected additional lifetime, existing emissions controls, commercially available controls for retrofit, etc.

- Delaware is also concerned with EPA's concept of providing 1-year and 3-year average variability mass emission provisions that could serve to allow upwind states to increase their emissions above the limit that EPA has calculated to be required to fully eliminate that state's significant contribution or interfere with maintenance in a downwind state. It is Delaware's understanding that EPA has considered the use of this variability concept in order to help address concerns regarding the variability in electric demand and to prevent impact on electric grid reliability. While Delaware understands the need to maintain grid reliability, it is Delaware's concern that under this scenario any given upwind state, or group of upwind states, could potentially emit on a routine basis at levels that exceed the values calculated by the EPA as needed to eliminate significant contribution and interference with maintenance in a downwind state. It is Delaware's opinion that the proposed variability concept be eliminated or revised such that any revision would preclude the potential for and upwind state or group of upwind states to significantly contribute to a downwind state's inability to comply with applicable NAAQS, or interfere with maintenance of that NAAQS.

3. _Co-generation Unit Exemption._ In the preamble to the proposed rule EPA requested comments regarding the length of the historic period that would be appropriate for a "look back" to determine if a unit met the efficiency and generation requirements to be eligible for the co-generation unit exemption provided for in the proposed rule. EPA is proposing the use of November 15, 1990 or the date on which the unit first produces electricity, whichever is later, as the date for which the unit must have started meeting the efficiency and generation requirements to be defined as a co-generation unit. In the preamble to the proposed rule EPA indicates that it may be difficult for some units to produce historic data of that age, and requests comments on utilization of a later date. Delaware agrees that the "look back" period for co-generation unit exemption determination should be shorter than the EPA has included in the proposed rule. Specifically, Delaware believes the "look back" period for determination of eligibility for the co-generation unit exemption should be the later of the calendar year prior to the effective date of the rule or the first full calendar year after the unit first produces electricity. Using this one year "look back" for determination of co-generation exemption eligibility would make this requirement more consistent with proposed rule's requirement for co-generation units to re-qualify for the exemption on an annual basis.

4. _State Contribution Thresholds._ In Section III. A. of the preamble to the proposed rule, EPA discusses that the proposed methodology of the rule uses air quality analysis to determine whether a state's contribution to downwind air quality problems is above specific thresholds. EPA states, "If a state's contribution exceeds those thresholds, EPA takes a second step that uses a multi-factor analysis that takes into account both air quality and cost considerations to identify the portion of a state's contribution that is significant or that interferes with maintenance." This statement is troubling to Delaware. It is Delaware's opinion that an upwind state's emissions contribution is significant or interferes with maintenance in a downwind state based on the emissions and their effect on air quality, and is independent of cost considerations. It is Delaware's opinion that

cost considerations are relevant when selecting the source category or population of sources that are to be targeted for control, not in determining if the emissions contribute to significant contribution or interference with maintenance in a downwind state.

5. _EGU Inventories._ During review of EPA's technical support documents for budgets and allocations for the proposed rule, Delaware has identified a number of problems with the inventory of EGU's included by EPA in the development of the budget and allocation levels for Delaware. [4] The problems noted during Delaware's review include the following:

- EPA's proposed rule unit inventory has included in Delaware's unit inventory a number of units that are co-generation units.

- By combining sources of data and information concerning units, as discussed in EPA's TSD ***State Budgets, Unit Allocations, and Unit Emissions Rates***, EPA "double counted" emissions among three Delaware units, by accounting for emissions for two header supplied steam turbine- generators from one data source, and then from another data source accounting for emissions from a boiler that supplies that steam header for the two header supplied steam turbine-generators.

  EPA's emissions data and allowance allocations have included header steam turbine generating units that are supplied by multiple non-fired heat recovery steam generating units. As the boilers are not fired, it is uncertain how they would produce emissions given that the emissions associated with related combustion turbines are attributed directly to those combustion turbines.

- EPA excluded two Delaware units from the proposed program, apparently due to the EPA's data assigning the units output ratings less than 25 MW. It appears that the EPA based this rating on data that indicates that these units have "summer" ratings of 22 MW on a net output basis. However, these particular units have "nameplate" ratings in excess of 25 MW, and also have "winter" ratings of 25 MW on a net basis. There are three apparent issues demonstrated within this problem.

  - The first apparent issue is the use of "summer" output ratings, which includes the effect of higher summer temperatures reducing the output of the unit, which is contrary to the definition of nameplate rating included in the EPA's proposed rule which states, "Nameplate capacity means, starting from the initial installation of a generator, the maximum electrical generating output (in MWe) that the generator is capable of producing on a steady state basis and during

[4] Because of the generic nature of some of these apparent problems, Delaware is of the opinion that similar issues may exist for some other states subject to this proposed rule. These problems that appear to have the potential to generic in nature should be investigated by EPA and corrected as necessary in establishing final emissions budgets, allocations, etc.

continuous operation (when not restricted by seasonal or other deratings) as of such installation as specified by the manufacturer of the generator…"

- The second apparent issue with the use of "summer " output ratings, is that the "summer" output ratings includes the effect of higher summer temperatures that tend to reduce the output of some units (combustion turbines and steam units). This appears to be contrary to EPA's definition in the proposed rule, as noted above, that indicates that the nameplate rating should not include any capacity restrictions due to "seasonal or other deratings".

- The third apparent issue is the use of these values that are "net" unit electrical outputs, or the electrical output available to the grid after subtracting any electrical energy that is utilized by the unit in the generation of the total electrical energy. The definition of nameplate capacity in EPA's proposed rule, as noted above, clearly indicates that EPA intends that nameplate capacity be the gross electrical output, or total electrical output from the generator.

6. *Allowance Distribution Methodology.* In the EPA's proposed rule and supporting technical support documents, EPA proposes an allowance distribution methodology for distributing allowances to individual units. The proposed unit-specific allowance allocations will be made on the basis of each unit receiving its proportional share of its state budget based on that unit's share of state emissions assumed in developing the budget. Using this methodology, the units that historically had the highest emissions (in percentage of the state's total) would be allocated that same percentage of the states allocation. It appears that such a methodology provides a negative benefit to those units that either had a lower emission rate by design or installed controls to achieve a lower emission rate in the past. It is Delaware's opinion that it would be more appropriate to allocate allowances on the basis of a specific unit's historic heat input, as a percentage of the entire heat input that resulted in the state's total allowance allocation. It is Delaware's opinion that this would establish a fuel-neutral allocation methodology that does not provide a negative benefit to those units that had previous reduced their emission rates.

7. *Non-EGU Emission Reductions.* EPA has requested comments on whether non-EGU emissions reductions should be required and on the specific control measures that would serve as the basis for those reductions. It is Delaware's opinion that EPA should consider requiring emissions reductions for some non-EGU categories. Included in this view are fossil-fuel fired electric generating units with a nameplate rating between 15 MW and 25 MW, fossil-fuel fired co-generation units serving a generator with a nameplate rating of 15 MW or greater, and fossil-fuel fired industrial and commercial (ICI) boilers with a heat input capacity rating of 250 MMBTU/hr or greater. It appears that these categories of units can contribute to air quality excursions and impact a downwind state's ability to attain NAAQS. It is Delaware's experience that the small EGUs (<25MW nameplate)

tend to operate most during periods of high electric demand which often coincide with ambient air quality excursions in downwind states. While co-generation units tend to operate with a more constant capacity, there is some data that indicates those units' loading may increase during periods of high electric demand to capitalize on opportunities for increased income from electric sales during high cost periods or to offset the purchase of additional electric at high relative cost. The large ICI boilers also tend to operate with a relatively constant capacity factor, which would also include operation during the periods of high electric demand that may coincide with air quality excursions in downwind states.

It is Delaware's opinion that cost-effective emissions reduction technologies are proven and commercially available for these types of units. For boilers serving EGUs with nameplate ratings of 15 MW or larger (including co-generation units) or ICI applications, commercially available cost effective controls for retrofit include fuel switching in some cases for SO2 and NOx reduction, low-NOx burners and SNCR and SCR for NOx control, and wet and dry scrubbers and sorbent injection for SO2 controls. For combustion turbines driving generators with nameplate ratings greater than 15 MW, including both EGU and co-generation application, commercially available cost effective controls for retrofit include fuel switching in some cases for SO2 and NOx control, and dry low-NOx burners, water injection, and SCR for NOx reduction. The March 2006 STAPPA/ALAPCO document "Controlling Fine Particulate Matter under the Clean Air Act: A Menu of Options" provides considerable discussion regarding the applicability of emissions controls for these units.

Delaware has also experienced some considerable success with its state rulemakings that resulted in control installations similar to those discussed above. One such rulemaking resulted in the addition of water injection for NOx control on all fossil-fired combustion turbines driving electric generators with a nameplate rating greater than 15 MW (but less than 25 MW) that had not been previously controlled. The affected units tend to operate as peaking units and operate primarily during periods of high electric demand. Post installation testing indicated significant NOx emission rate reductions were achieved by all of the affected units.

8. *Opt-in Provisions.* Somewhat related to the issue of including the smaller size units in a proposed program is the concept of opt-in provisions in the proposed rule. EPA has requested comments regarding the appropriateness of the proposed rule's opt-in provisions. While Delaware does not necessarily oppose the opt-in provisions, Delaware is skeptical that the opt-in provisions would provide sufficient incentive for a source to make the commitment to perform an emission reduction project that would not have occurred anyway without the opt-in provisions. In this event, additional allowances would have been created without any environmental benefit as a direct result of the rule. In any event, it is Delaware's opinion that if the proposed rule addresses the smaller units

(EGUs 15MW<>25 MW, co-generation units > 15MW, and ICI boilers > 250 MMBTU/hr) then the population of likely opt-in units will be greatly reduced.

9. *The EPA proposal is unnecessarily complex.* Delaware is supportive of EPA's efforts to propose a rule that effectively eliminates an upwind state's significant contribution or interference of maintenance with a NAAQS in downwind states. The EPA has provided much complex information and analysis in their proposal and technical support documents. Delaware has gleaned from the EPA documents that there are two main determinations being made: 1) a determination of whether a state significantly interferes with the attainment or maintenance of a NAAQS in a downwind state, and 2) a determination of the remedy for the states that do significantly interfere. Delaware has spent considerable time studying the EPA proposal, and participating on telephone calls and meetings with others discussing the proposal, and has concluded that both EPA's characterization of the problem and the proposed solution have been made unnecessarily complex and difficult to understand and evaluate. This is a very important proposal to downwind states like Delaware. The health and welfare of Delaware citizens has and continues to be negatively impacted by emissions from upwind states, and those emissions must be mitigated. This unnecessary complexity has required Delaware to expend significant resources to review and understand the proposal, but even after spending many man-hours reviewing it is not clear that the rule will result in emission reductions once it is fully implemented.

10. *An EGU Cap-and-Trade Program alone is not sufficient to mitigate a states impact on downwind states.* Delaware understands the bottom line of the EPA proposal is that the control of EGUs is all that is needed in order for a state to mitigate its significant impact on downwind states. This conclusion is inconsistent with much of the information Delaware has learned in its efforts to address the ozone problem over the past 40 years, and the more recent fine particulate matter problems. The installation of all reasonably available control technology (RACT) on all volatile organic, nitrogen oxide, and sulfur dioxide emitting sources is needed. In addition, advanced best available control technology (BACT) level controls on EGUs and other large sources stationary sources is needed. And, based on Delaware's experience the timing associated with the design, permitting and construction of advanced emission controls on EGUs is relatively short; on the order of 24-months. If upwind states were to implement these measures (i.e., RACT on all sources, and BACT on all large stationary sources), as Delaware already has, attainment of the current and upcoming ozone and PM2.5 NAAQSs would be in reach. Delaware believes these measures must be added as required elements of this proposal.

11. *The proposal does not offer necessary relief to downwind states.* Delaware understands that the EPA is in this proposal segregating transport related to the 0.08ppm ozone NAAQS from the lower 75ppb ozone NAAQS promulgated last year, and from the new lower ozone NAAQS anticipated to be finalized by the EPA later this month. This does

not seem reasonable to states like Delaware who, despite having already subjected its sources to advanced and costly emissions control requirements, continues to be impacted by unhealthy air from upwind states. And, Delaware will continue to be impacted by this unhealthy air long into the future. Given the low level of the new ozone NAAQSs relative to current air quality, and the overwhelming impact of transported emissions, further delay in installing and operating appropriate emission controls in upwind states is not warranted.

Thank you for providing this opportunity to comment. We look forward to the EPA promulgation of a rule that provides full mitigation of upwind emissions that continue to negatively impact public health and welfare in Delaware, and Delaware's ability to attain and maintain compliance with national ambient air quality standards.

Sincerely,

For Ali Mirzakhalili, P.E.
Director

Attachment