Regulating Mercury with the Clear Skies Act:
The Resulting Impacts on Innovation, Human Health, and the Global Community

by

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Abstract

The 1990 Clean Air Act Amendments require the U.S. EPA to control mercury emission outputs from coal-burning power plants through implementation of MACT, Maximum Achievable Control Technology, standards. However, in 2003 the Bush Administration revealed an alternative and controversial regulatory strategy for mercury, developing a cap and trade emissions credit trading program under the Clear Skies Initiative. Although emissions trading was proven to be a successful regulatory strategy for sulfur dioxide through the 1992 Acid Rain Program, the uniquely dangerous properties of mercury make this market-based regulation risky for certain vulnerable segments of the population. Since its unveiling, the Clear Skies cap and trade approach has been criticized for being too industry-friendly and inadequately setting limits on mercury emissions. Current challenges to the Clear Skies approach to the regulation of mercury claim that not only is it illegal under the Clear Air Act, but that it inhibits innovation and undermines an international strategy to reduce anthropogenic mercury emissions.

This thesis evaluates the critiques of Clear Skies and the reasoning given by the EPA in defense of the regulation. Recent academic studies and a comparison case study with the Acid Rain Program are used to discuss the probable effects of Clear Skies on mercury reduction. The main questions addressed in the thesis are: 1) what is the motivation for Clear Skies? 2) what is the legal basis for the Initiative? 3) what are the potential failures of Clear Skies in protecting against mercury exposure? 4) what will be the resulting impact of Clear Skies on technological innovation? and 5) how does Clear Skies compare with international mercury reduction strategies?

Thesis Supervisor: Nicholas A. Ashford
Professor of Technology and Policy

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Section 1: Introduction / Motivation

Each year electric power plants in the United States emit almost 50 tons of mercury, a hazardous air pollutant responsible for a number of health effects and resulting in fish advisories for bodies of water in 45 states. The potential risks of methylmercury exposure, the organic form mercury takes when deposited in water sources, range from neurological to physical disabilities caused mainly from *in utero* exposure though a pregnant woman's ingestion of fish containing traces of methylmercury. Although classified as a hazardous air pollutant under the Clean Air Act, mercury emissions have gone unregulated in the US and are still outside of effective regulatory control of the EPA.

When President Bush announced the Clear Skies Initiative in 2003 as his Administration's proposed mercury reduction regulatory program, debate over market-based and traditional command-and-control standards for environmental regulation was renewed. The Clear Skies Initiative for mercury, sulfur dioxide, and nitrogen oxides seeks to reduce emissions through a national emissions credit trading program. The three years following the unveiling of Clear Skies produced a flurry of activity from academics and non-profits arguing the serious flaws of market-based regulation for control of a substance as hazardous as methylmercury. The literature and research work during this time covered important topics such as the reevaluation of cost-benefit analysis as a tool to critique environmental policy, the potential emergence of mercury "hot-spots" in localized areas, the *in utero* and neonatal effects of mercury that challenge the traditional dose-response curve for "safe" levels of exposure, and a challenge of extending the legal framework for cap and trade policy to mercury under the Clean Air Act. The totality of this work demonstrates the serious risks of mercury exposure that would continue under the Clear Skies Initiative and makes a compelling case for more stringent and traditional regulation of mercury emissions.

This thesis evaluates mercury regulation under Clear Skies in light of recent studies questioning the efficiency, legality, and safety of market-based regulation for mercury. It will expand the ongoing discussion to suggest the likely effects of Clear Skies on industry behavior, measured by new technology development and incentives to innovate. Additionally, this work addresses the place of Clear Skies regulation in a global regulatory framework to reduce mercury emissions, as well as looks at the role of state governments in the regulatory efforts. Given the breadth of research challenging the Administration's expected success of Clear Skies and the potential economic, political, and health consequences, the question of "why cap and trade?" remains especially important. I will address several historical and political reasons for the shift from traditional command-and-control environmental policy to market-based policy. Along with an evaluation of the political factors leading to the proposal of Clear Skies, I will compare the theoretical arguments for both market-based regulation and command-and-control environmental regulation. Perhaps most importantly, this thesis will address alternatives to the federal Clear Skies program for mercury reduction, evaluating state programs, alternative market-based approaches, and a possible return to more stringent command-and-control regulation.

Section 2: Background on Mercury

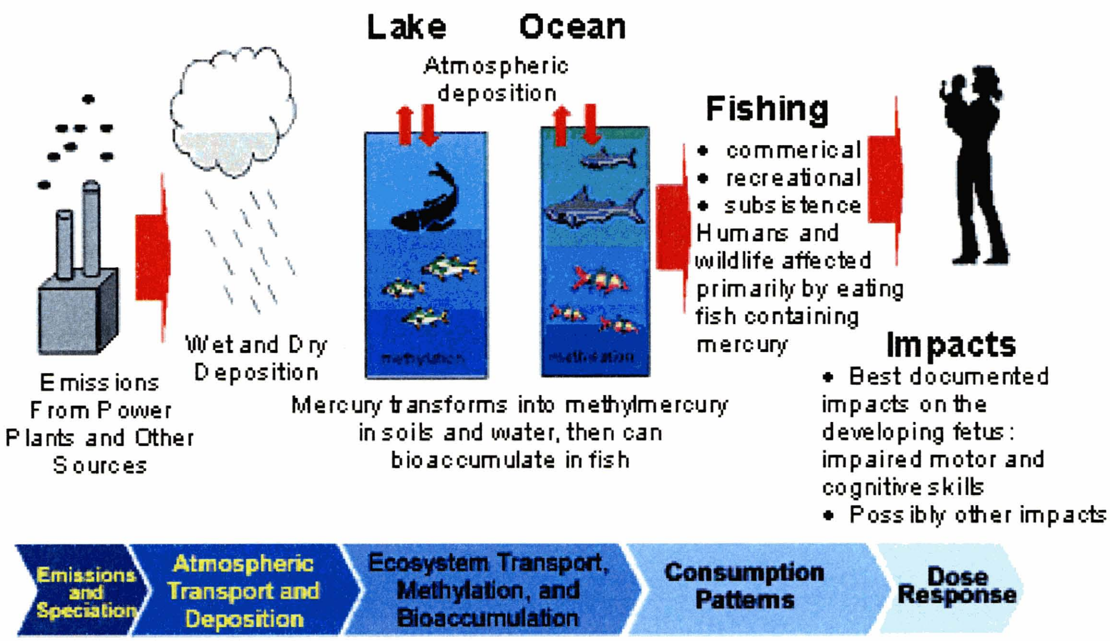
Mercury Overview

There are two main types of mercury that exist in the environment: inorganic mercury and organic mercury. Inorganic mercury includes mercury in its basic elemental states, as well as mercury oxides and mercury salts. Organic mercury refers to alkylated compounds, such as methylmercury[1]. While all forms are harmful at certain doses, methylmercury is the largest threat to human health, as it is the byproduct of inorganic mercury reacting with bacteria in water, and the form of mercury that is consumed at dangerous levels by humans. Methylmercury would not be a threat if not for the release of inorganic forms of mercury into the environment. While inorganic mercury can be released from natural sources such as water and volcanic activity, its existence in the atmosphere is mostly due to industrial emissions from incinerators and coal-burning electric power plants.

Before depositing into soil and water sources, which initiates the conversion to methylmercury, inorganic mercury can travel in the atmosphere. Mercury emissions from anthropogenic sources are typically categorized into three types: elemental mercury (Hg^0), reactive gaseous mercury (Hg^{II}), and particulate-bound divalent mercury (Hg_p). EPA modeling of mercury deposition suggests that when released as emission gas, Hg^{II} and Hg_p will deposit locally or regionally, within 50Km of a coal-burning plant. This accounts for approximately 50% of mercury emissions from such a plant. The other 50% of mercury is emitted in the Hg^0 form, which is much less soluble and has a half-life of 18 months[2]. This form of mercury is able to travel globally before converting to Hg^{II}, falling to the ground, and then undergoing the conversion to methylmercury. These chemical properties of mercury make it both a local and global problem. It also suggests the possibility for the emergence of "hot-spots" or geographic areas of increased mercury depositions localized around mercury-emitting power plants.

Once mercury is deposited on the earth's surface, it either directly settles in a water source or finds its way there through runoff or absorption into soil and the groundwater supply. When in water, inorganic mercury will react with the sulfate-reducing organisms present to undergo a chemical reaction, producing methylmercury. Fish can absorb methylmercury directly from the water contact with their gills or they can consume it when eating small organisms. Methylmercury binds to amino acids and is retained at high rates in muscle tissue[3]. Bioaccumulation occurs as larger fish feed on smaller fish, each time increasing the levels of mercury retained and stored in their system. Humans and other animals that eat fish will ingest methylmercury this way. The pathway from inorganic mercury emission from a coal-burning power plant to the human consumption of methylmercury is shown in Figure 1 below, taken from the US Environmental Protection Agency.

Figure 1: The Mercury Deposition Cycle



Source: US Environmental Protection Agency, http://www.epa.gov/mercury/exposure.htm

Health Effects of Mercury Exposure

Methylmercury is especially hazardous because almost 95% of the compound ingested is absorbed in the body. It can easily enter the blood stream and affect organs such as the kidney and liver. Most dangerous is the ability for mercury to pass the blood-brain barrier in adults and the placenta tissue in pregnant women. This activity can lead to adult neurotoxicity and a number of neurological effects in unborn babies, leading to a wide range of disabilities. Infants are especially susceptible to methylmercury exposure from the environment since the blood brain barrier is not fully formed until approximately 1 year of age. Methylmercury will stay in the body for a period of 2-3 months before it is demethylated and returned to an inorganic mercury form that can be excreted[4].

The earliest study on the harms of methylmercury exposure from fish consumption was conducted in 1956 in Minamata, Japan. In this region, pregnant women who ingested large amounts of fish resulted in over 30 cases of newborns with disability, including cerebral palsy, mental delay, blindness, deafness, and speech disorders. The dose of methylmercury ingested by women in Minamata was exceptionally high and a very rare occurrence of mercury poisoning. However, the study of the disabled children has helped establish scientifically the following basic facts about methylmercury[5]:

1. Environmental pollution can redeposit in the food chain and more specifically methylmercury can and will settle in fish.
2. Methylmercury can be ingested through fish in quantities large enough to harm the fetus.

In Iraq in 1972, thousands of citizens were ill and later found to be poisoned after a methylmercury fungicide was used. Most of the sick were children or newborns. Dr. M.R. Greenberg examined death registries from cities around the fungicide exposure and found that more deaths occurred in 1972 than years directly before or after. Most alarming was that "deaths for the 1-10 and 11-20 year age groups during the year 1971-72 were four-fold higher than the mean of the two preceding and two following years[6]." This yielded conclusive evidence that methylmercury was indeed a fatal toxin, especially to young children and newborns. The Iraqi and Japanese cases of methylmercury exposure and related health effects are cited as the standard evidence that methylmercury can have severe health impacts on unborn or newborn children, even when adult populations go seemingly unaffected.

In addition to the two historical cases of mass methylmercury poisoning that suggest the relationship between methylmercury exposure and disability, there are three additional recent large-scale epidemiology studies that are the basis for almost all subsequent methylmercury research and policy decisions. These epidemiological studies are known for their place of testing as the Faroe Island, the Seychelles, and the New Zealand studies. Each of the studies looks at mother-infant pairs from areas with a high rate of fish consumption. While all three found some links between methylmercury and neurological damage, only the Faroes and the New Zealand studies concluded a relationship between *in utero* methylmercury exposure and health effects, which the Seychelles Study did not have enough evidence to reach the same conclusion[7]. Unfortunately, there has been no conclusive reason given to explain the variation in the studies. Most alarming were the New Zealand study results, which suggested that *in utero* mercury exposure results in a 3-point decrease in IQ. The Faroes study concluded that *in utero* mercury exposure caused memory, language development, and attention problems[8]. The results from these studies were used by the National Research Council in 2000 when it set a reference dose (tolerable limit) for mercury consumption, which was later adopted as the official reference does by the EPA.

The harmfulness of methylmercury has been established by the above mentioned studies, the National Research Council, and the EPA. However, the risks of methylmercury exposure have until now been limited to a discussion of physical disabilities such as cerebral palsy, neurological damage, and cardiac problems. More recent and controversial studies have examined the link between mercury exposure and Autism or behavioral disorders such as ADHD. Autism affects 1 in 166 children born today, a rate that has increased 10-fold since the 1980's[9]. The classic symptoms of autism, loss of communication and social skills, are also interestingly symptoms of mercury poisoning. While the exact causes of autism are unknown, there are two hypotheses linking autism to mercury. The first, backed by the Public Health Service and American Academy of Pediatrics, claims a causal link between autism and exposure to ethylmercury in Thimerosal, a vaccine preservative. Thimerosal was injected with many childhood immunizations from 1988 until 2002, when it was taken off the market out of safety concerns. The second newly hypothesized link between mercury and autism is the effect of methylmercury on infants and the unborn. In a 2004 study, researchers found a ''biomarker' in autistic children that strongly suggests that these children would be susceptible to the harmful effects of mercury and other toxic chemicals[10]." The research showed that autistic children have less active glutathione, the chemical required for excretion of heavy metals, than average children. If a child with low levels of active glutathione was exposed to methylmercury *in utero* or during infancy, it would have little capability to excrete the mercury, leading to neurological damage and potentially symptoms consistent with autism[11].

Exposure Levels

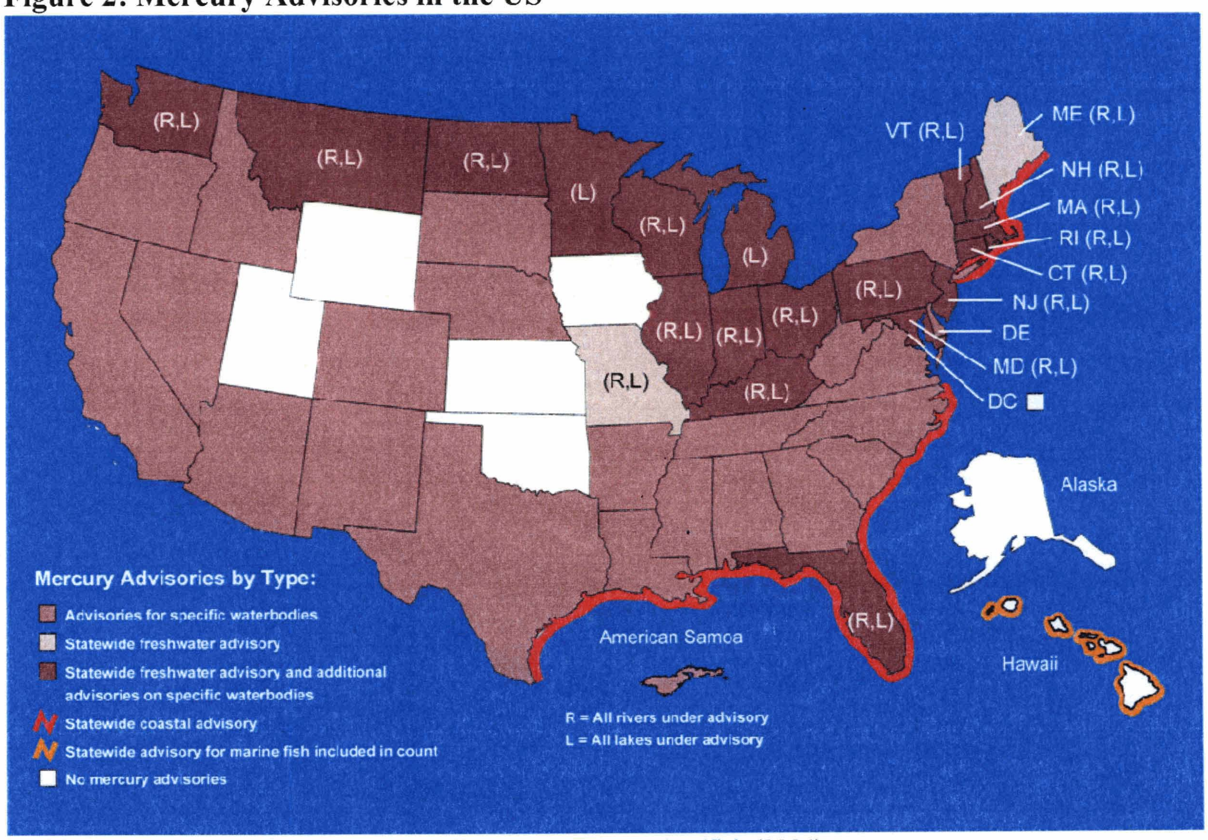
To protect consumers from methylmercury health risks, the EPA has set a reference dose (RfD) for consumption of methylmercury, which is the amount that can be consumed each day over a lifetime without posing a risk to health. Based on data from the 1972 mercury poisoning in Iraq, the EPA set the US RfD at 0.1 micrograms per kilogram of body weight per day. The accuracy of his reference dose was confirmed by the National Research Council in a 2002 review of methylmercury health effects. Yet despite setting an appropriate threshold for mercury exposure, the EPA and FDA can do little to ensure that adults and children do not exceed this dose. Approximately 8% of pregnant women in the US have levels of methylmercury in her blood greater than the 0.1 μg/kg day, resulting in 630,000 babies born annually with increased risk of health problems from methylmercury exposure[12].

There are two critical problems with setting an effective reference dose for consumption: 1) informing and educating those consumers who are at risk and 2) monitoring levels of methylmercury in fish products so that consumers can be assured they are not exceeding the reference dose. Concerned with these potential problems, the Mercury Policy Project surveyed fish sold in major grocery stores during the summer of 2005. The objective was to test fish products in order to determine whether they fell below the FDA's allowable mercury level of 1 ppm in fish, and if consumption of such fish would remain below EPA's reference dose of 0.1 micrograms of mercury per kilogram of body weight per day. The results, taken from 22 grocery stores nationwide, were disturbing. The study found that over half of the stores sold swordfish with a mercury concentration over 1 ppm, including some fish samples over 2 ppm, double the allowable level. Tuna testing results concluded that "a 44 pound child consuming 6 ounces of tuna a week at this mercury concentration would be exposed to 4 times the EPA reference dose for mercury. A 120 pound woman consuming 6 ounces of tuna a week at this mercury concentration would be exposed to one and a half times the EPA reference dose[13]." Therefore, a person consuming more than one serving of tuna a week would be at a significantly higher risk of mercury exposure than determined safe by the EPA.

Mercury Advisories in the US

To protect citizens from consuming methylmercury at levels above the reference dose, the EPA issues a number of fish advisory warnings each year, which warn against consumption from any fish caught in the specified bodies of water. There are currently advisories for mercury in 43 states, some of which are under a state-wide advisory for every body of water. In total, 35% of the nation's lake acres (14,285,062 acres) and 24% of the nation's total river miles (839,441 miles) are under fish advisories. In addition, the EPA warns against fish caught in 65% of the coastal waters, mostly on the East Coast. Due to their geographic location due north of the nation's major mercury emitters in the Ohio River Valley, 100% of the Great Lakes are under an advisory for mercury[14]. Figure 2 shows the most current EPA advisories for mercury in bodies of water, set in 2004.

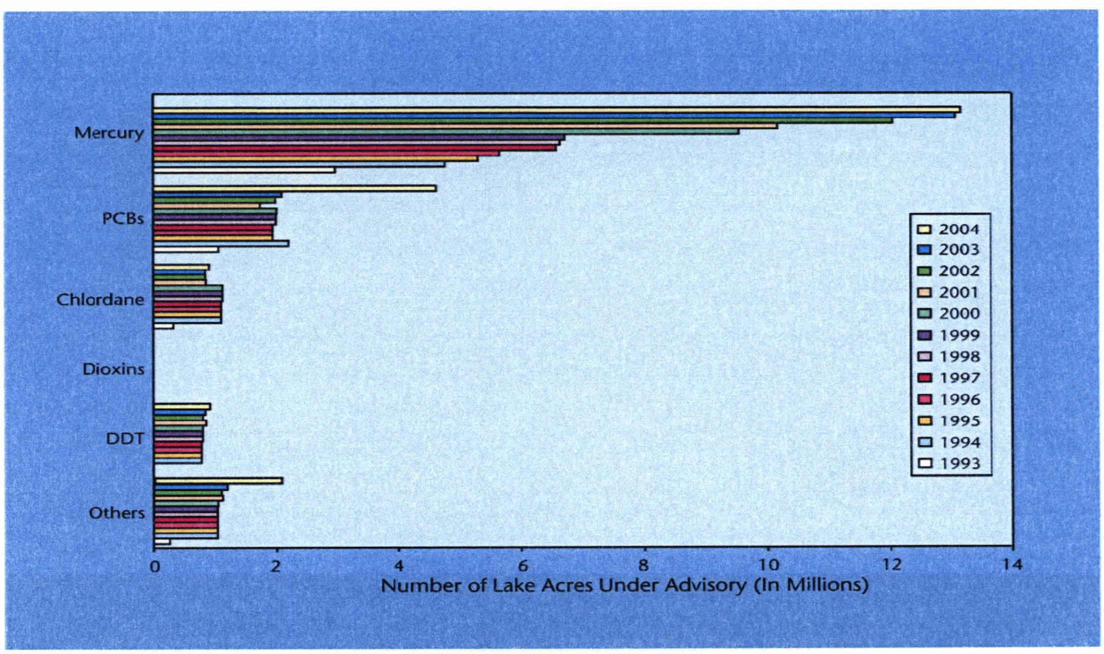
Figure 2: Mercury Advisories in the US



Source: US Environmental Protection Agency, www.epa.gov/ost/fish (2004)

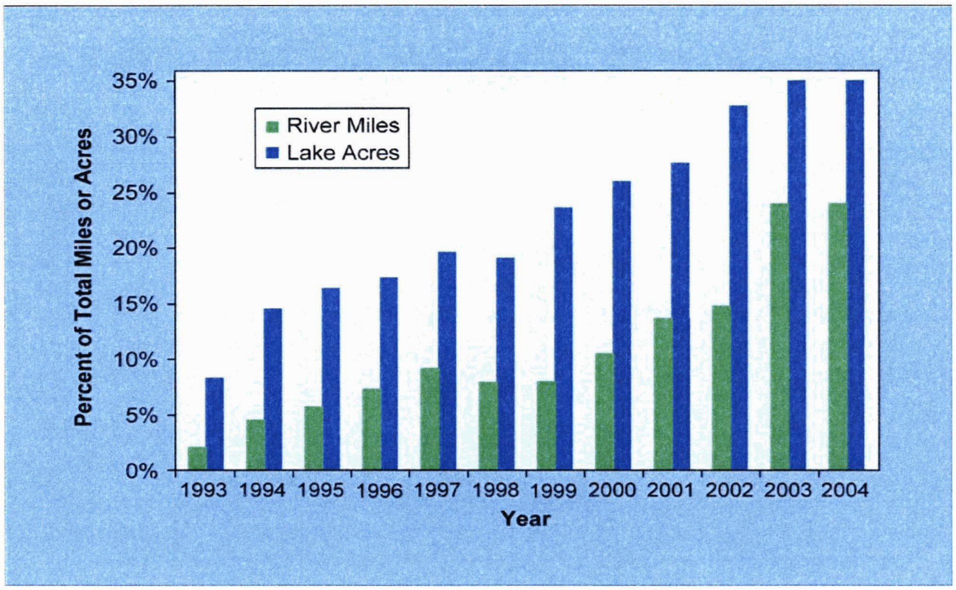
While there are a number of pollutants in the US that make their way into the nation's water supply, mercury is one of the largest threats. Despite runoffs and direct output of chemical pollution from plants, mercury's ability to convert to methylmercury and accumulate in fish makes it one of the most dangerous chemicals released into the environment. Additionally, mercury's ability to travel in the atmosphere greatly increases the area at risk from mercury deposition. There are currently three times as many mercury advisories for lakes than the next most hazardous pollutant in water bodies, PCBs. Figure 3 compares the number of EPA advisories for lake acres at risk from mercury, PCBs, Chlorodane, Dioxins, and DDT. In addition to mercury advisories far outnumbering other lake advisories, mercury is the only pollutant that has warranted a dramatic increase in the number of advisories. In the past ten years, mercury advisories more than tripled, while fish consumption and lake advisories for other chemicals have remained constant. Figure 4 shows the increase in percentage of lake acres and river miles at risk from mercury contamination over the past decade.

Figure 3: Mercury Compared with Other Toxins Found in US Lakes



Source: US Environmental Protection Agency, www.epa/gov/ost/fish (2004)

Figure 4: Increase in Mercury Advisories from 1993-2004



Source: US Environmental Protection Agency, www.epa/gov/ost/fish (2004)

Sources of Mercury

Although some mercury emission occurs naturally from land and oceans, the majority of global mercury emission is from anthropogenic sources. Of the 4,850 total tons of mercury particles that are released into the atmosphere each year, 2,750 tons of that (57%) comes from man-made sources[15]. In the US, coal-fired utility plants are the major emitters of mercury, responsible for 48 tons annually or 36% of total US mercury emissions. Oil and natural gas utilities emit a fraction of that, with approximately 0.5 tons per year attributed to each industry. Other sources of mercury emissions in the US are ore mining, chlorine production, incineration of municipal and hazardous waste, and industrial boilers. The breakdown of tons of mercury emitted by each industry annually is displayed in Figure 5. There are approximately 500 coal-burning power plants in the US[16]. Since coal-fired plants are the largest source polluters of mercury, they are the source of greatest potential for federal regulations to have an effect in reducing mercury output, which is why that industry is the focus of this thesis and the recent Clear Skies Initiative. A discussion of how anthropogenic mercury emissions in the US compares to those in other developed nations will be discussed in Section 10.

Figure 5: Sources of Mercury

Table 1. Mercury Emissions Sources

Sources to Atmosphere	Annual Emission Rate (tons yr^{-1})	Reference
Natural Emissions Land	1000 1100	Mason et al., 2002; Lamborg et al., 2002
Oceanic Evasion	2850[a] 900	Mason et al., 2002; Lamborg et al., 2002
Anthropogenic Northern Hemisphere[a]	2450	Lamborg et al., 2002
Anthropogenic Southern Hemisphere	450	Lamborg et al., 2002
Total Global Anthropogenic	2650 2850	Mason et al., 2002; Lamborg et al., 2002
Total Global Emissions	4850	U.S. EPA, 2003a
U.S. Utility Boilers Coal Oil Natural gas	48.9 (36%)[b] 48.0 0.5 0.4	U.S. EPA, 2003a
U.S. Ore Gold Ore Iron Ore Silver Ore Ferroalloy Ores, Except Vanadium	11.7 (9%) 11.5 0.2 4.0E-3 5.5E-4	U.S. EPA, 2003a
U.S. Chlorine Production	6.5 (5%)	U.S. EPA, 2003a
U.S. Municipal Waste Combustors	5.1 (4%)	U.S. EPA, 2003a
U.S. Hazardous Waste Combustion Commercial Hazardous Waste Incinerators On-Site Hazardous Waste Incinerators Hazardous Waste Incineration	5.0 (4%) 2.48 2.38 0.98	U.S. EPA, 2003a
U.S. Industrial Boilers Industrial/Commercial/Institutional Boilers & Process Heaters Stationary Combustion Turbines	3.8 (3%) 3.28 0.51	U.S. EPA, 2003a
U.S. Medical Waste Incinerators	2.8 (2%)	U.S. EPA, 2003a
Subtotal (U.S. Sources)	83.8 (61%)	U.S. EPA, 2003a
Total Point and Non-point U.S. Emissions	136.3	
Natural Emissions from U.S. [c]	64	

[a] In the Mason and Scheu (2002) model much of the mercury released to the atmosphere from the ocean re deposits into ocean.
[b] The percentage of total U.S. anthropogenic emissions as simulated in U.S. EPA (2003a) is based on 1999 emission estimates. U.S. anthropogenic emission estimates have been updated (www.epa.gov/ttn/chief).
[c] We developed this estimate based on natural global mercury emissions estimates of Lamborg et al. (2002). Using Lamborg's approach, the U.S. estimate is based on the ratio of U.S. landmass to total landmass of northern hemisphere

Source: Hammitt, James K. and Rice, Glenn. *Economic Valuation of Human Health Benefits of Controlling Mercury Emissions from US Coal-Fired Power Plants.* Harvard Center for Risk Analysis. NESCAUM, Northeast States for Coordinated Air Use Management. February 2005.

Section 3: US Legal Structure for Mercury Emissions

The legal framework for regulating anthropogenic sources of mercury in the US is found in the Clean Air Act and subsequent Clean Air Act Amendments of 1990. Under Section 112, mercury is classified as a Hazardous Air Pollutant, or HAP, the classification of which mandates that the EPA develop standards for mercury emissions from new and existing sources. In addition to requiring the regulation of mercury, Section 112 mandates the regulatory methodology that is to be used by the EPA for regulation of all 189 hazardous air pollutants listed. Known as the Maximum Achievable Control Technology standard, or MACT, this policy sets limits for emissions of HAPs based on current feasible technology. MACT is a command-and-control policy that mandates compliance from industry by setting acceptable levels of emissions at the same level as those currently being admitted from the best 12% of performers in the industry. While MACT accounts for available technology and therefore considers technology costs, it is only based on current performance of plants, not maximizing the potential for regulation to encourage innovation and a feasible technology that would emit less mercury. Alternatively, Section 112 allows for the Administrator to set a standard higher than MACT if human health effects warrant such a regulation to protect health "within an adequate margin of safety." The language of the statute does not discuss the ambiguity over setting such a margin of safety and whether it can realistically be set at a certain acceptable threshold from a health perspective.

Clean Air Act Section 112

Section 112 of the Clean Air Act defines the term "Hazardous Air Pollutant (HAP)," lists 189 known HAPs, and outlines mandatory action that must be taken by the EPA to regulate the pollutants, which includes determining and setting appropriate emission levels for each pollutant. Under Section 112 (b), all mercury compounds are listed as Hazardous Air Pollutants, which includes the organic form, methylmercury. Section 112 (d) 2 defines appropriate standards and methods that may be taken by the EPA to regulate emissions of hazardous air pollutants. Those standards and methods:

(A) reduce the volume of, or eliminate emissions of, such pollutants through process changes, substitution of materials or other modifications,

(B) enclose systems or processes to eliminate emissions,

(C) collect, capture or treat such pollutants when released from a process, stack, storage or fugitive emissions point,

(D) are design, equipment, work practice, or operational standards (including requirements for operator training or certification) as provided in subsection (h), or

(E) are a combination of the above.

In order to achieve the standards set by the EPA for emissions of hazardous air pollutants, the Clean Air Act Amendments mandate the use of Maximum Achievable Control Technology regulations. The text of Section 112 (d) 3, which outlines MACT, is presented below. It is important to note that the Section (d) charges the EPA with setting standards that are either equal or more stringent to the determined health threshold and Maximum Achievable Control Technology. Section 112 (d) 4 allows for the Administrator to establish a safe threshold for pollutant exposure and base regulations on this threshold. Since there is the ability for the EPA to consider the uniquely toxic properties of mercury when deciding on appropriate regulation, MACT does not serve as the strictest command-and-control policy for mercury regulation under Section 112. The public debate over the effectiveness of MACT in comparison to cap and trade emissions permit trading typically does not include an important alternative to mercury regulation allowed under Section 112, which would base regulation standards solely on human health effects.

Excerpt from Clean Air Act, Section 112 (d)

(3) New and existing sources.- The maximum degree of reduction in emissions that is deemed achievable for new sources in a category or subcategory shall not be less stringent than the emission control that is achieved in practice by the best controlled similar source, as determined by the Administrator. Emission standards promulgated under this subsection for existing sources in a category or subcategory may be less stringent than standards for new sources in the same category or subcategory but shall not be less stringent, and may be more stringent than -

(A) the average emission limitation achieved by the best performing 12 percent of the existing sources (for which the Administrator has emissions information), excluding those sources that have, within 18 months before the emission standard is proposed or within 30 months before such standard is promulgated, whichever is later, first achieved a level of emission rate or emission reduction which complies, or would comply if the source is not subject to such standard, with the lowest achievable emission rate (as defined by section 171) applicable to the source category and prevailing at the time, in the category or subcategory for categories and subcategories with 30 or more sources, or

(B) the average emission limitation achieved by the best performing 5 sources (for which the Administrator has or could reasonably obtain emissions information) in the category or subcategory for categories or subcategories with fewer than 30 sources.

(4) Health threshold.- With respect to pollutants for which a health threshold has been established, the Administrator may consider such threshold level, with an ample margin of safety, when establishing emission standards under this subsection.

(5) Alternative standard for area sources.- With respect only to categories and subcategories of area sources listed pursuant to subsection (c), the Administrator may, in lieu of the authorities provided in paragraph (2) and subsection (f), elect to promulgate standards or requirements applicable to sources in such categories or subcategories which provide for the use of generally available control technologies or management practices by such sources to reduce emissions of hazardous air pollutants.

(6) Review and revision.- The Administrator shall review, and revise as necessary (taking into account developments in practices, processes, and control technologies), emission standards promulgated under this section no less often than every 8 years.

(7) Other requirements preserved.- No emission standard or other requirement promulgated under this section shall be interpreted, construed or applied to diminish or replace the requirements of a more stringent emission limitation or other applicable requirement established pursuant to section 111, part C or D, or other authority of this Act or a standard issued under State authority.

A Timeline of US Mercury Regulation

Although classified by Congress and the EPA as a Hazardous Air Pollutant and subject to regulation under the Clean Air Act Amendments, mercury emissions have gone unregulated in the US to this day. In 1994, the EPA announced to Congress that it would complete a "Utility Air Toxics Study" in order to determine if it is "appropriate and necessary" to regulate power plants under the Clean Air Act. In 1997, an EPA study of the health impacts of mercury was presented to Congress, which was one of the first comprehensive studies on the health effects of mercury[17]. An additional report on power plant emissions was presented to Congress in 1998, who determined in 2000 that it was indeed "appropriate and necessary" to regulate power plants under Section 112 of the Clean Air Act, focusing on their dangerous emission of mercury. This Congressional decision was known as the "Utility Air Toxins Determination" and was followed by a Congressional commitment to regulate mercury by March 2003. Regulating under Section 112 would require the Maximum Achievable Control Technology standard to be set in consideration of the best performing 12% of mercury emitters, which in 2003 would result in a more stringent regulation, with a mandatory 90% reduction in mercury emissions in all power plants.

When Congress decided in 2000 that mercury emissions from power plants was indeed mandated by Section 112 of the Clean Air Act, almost a decade had passed since mercury was listed in Section 112 as a hazardous air pollutant. The appropriate threshold for the pollutant was studied under the Clinton Administration's EPA up until the final hours of the Administration, when the outgoing Clinton EPA recommended a regulatory plan based on MACT in December 2000, with hopes that the new Administration would favor this MACT and command-and-control policy over a more industry-friendly approach. However, one of the first acts of the Bush Administration EPA was to overturn Clinton's suggested policy and advocate for an alternative market-based approach to regulation. Although less stringent that the proposed Clinton MACT program in 2000, the Bush EPA used the fact that the Clinton EPA sat on the mercury regulations for the entire duration of the Administration without regulating, which helped them gain political support for their revised mercury policy. In March 2003, the EPA unveiled its new regulatory plan for reducing mercury emissions under the Clear Skies Initiative. Under Clear Skies, an emission credit and trading program (known as cap and trade) is proposed for mercury, which would mirror the successful Acid Rain emission credit program of the early 1990's. The legal basis for Clear Skies and cap and trade is discussed more in depth in the following section.

Clean Air Act Section 111: Emission Trading

Although politically controversial, the current EPA argues that legally cap and trade is allowed under Section 111 of the Clean Air Act. Under the Cap and Trade system, the federal government lowers and caps the national total allowable emission level for mercury from power plants. The EPA then divides this set emissions level among the fifty states. Each state's regulatory agency then has the authority to further allocate emission levels to utility companies. Under cap and trade, power plants are given the decision to implement cleaner mercury-reduction technologies in order to sell or bank pollution credits, or they may continue or increase pollution of mercury through purchasing credits from other plants. Thus, the incentive to innovate and lower pollution under cap and trade for the industry is a financial one. There are a number of questions over the efficacy of cap and trade in predicting whether power plants will indeed be motivated to lower emissions. Additionally, the equity of cap and trade has also been challenged, as it allows for the potential creation of hot-spots, or areas of increased concentration around those plants that may choose not to lower emissions. Before evaluating the merits of arguments for and against cap and trade, especially in regards to Clear Skies and mercury, it is necessary to evaluate the legal basis for this regulatory decision.

To regulate mercury under CAA Section 111, the EPA first has to justify removing mercury from the jurisdiction of 112. The Agency has failed to do that under Section 112(c) 9, which only allows for delisting if:

(1) in the case of carcinogens, that emissions from any one source from the category will not pose a risk of greater than one in one million or more to the most exposed individual in the relevant population; OR

(2) in the case of other hazardous air pollutants, that the emissions level from any one source will be low enough adequately to protect the public health with an ample margin of safety and to avoid an adverse environmental effect

The EPA has not presented any evidence that methylmercury would fall under these exceptions and allow for delisting. The rationale given by the EPA for not regulating under Section 112 is that Section 111 can be applied and therefore overrules the mandate for MACT command-and-control regulation in Section 112[18]. EPA points to Section 112(n) which requires that the Agency "study alternate control strategies" to justify cap and trade. However, many legal scholars argue that the intention of Congress was not consideration of alternative forms of regulation, but instead the specifics of MACT command-and-control regulation.

There are two subsections of legislation under Clean Air Act Section 111 that are used by the EPA in justifying a cap and trade regulatory strategy for mercury. The first is Section 111 (a) 1, in which the law defines performance standards:

Sec. 111. (a) For purposes of this section:

(1) The term "standard of performance" means a standard for emissions of air pollutants which reflects the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction and any non air quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated.

Based on cost-benefit analyses, the EPA determined that cap and trade is the most cost effective regulatory strategy to reduction of mercury emissions. To support that decision legally, the EPA argues that the specific phrase "best system of emission reduction" allows the EPA to implement cap and trade regulations over MACT. Additionally, the EPA uses Section 111 (h) to argue that alternative regulations (that do not follow MACT) are allowed.

Excerpt from Section 111 (h):

(1) For purposes of this section, if in the judgment of the Administrator, it is *not feasible to prescribe or enforce* a standard of performance, he may instead promulgate a design, equipment, work practice, or operational standard, or combination thereof, which reflects the best technological system of continuous emission reduction which (taking into consideration the cost of achieving such emission reduction, and any non-air quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated. In the event the Administrator promulgates a design or equipment Standard under this subsection, he shall include as part of such standard such requirements as will assure the proper operation and maintenance of any such element of design or equipment [emphasis added].

Using this language without addressing feasibility or enforcement, EPA argues they have the right to "promulgate a design, equipment, work practice, or operational standard, or combination thereof, which reflects the best technological system of continuous emission reduction." Again, the language "best system" is used by the EPA to replace language requiring "maximum achievable controllable technology" under Section 112. However, in arguing that Section 111(h) allows for cap and trade, the EPA neglects the requirements of the "best technological system" standard. Section 111 (h) goes on to say:

(2) For the purpose of this subsection, the phrase "not feasible to prescribe or enforce a standard of performance" means any situation in which the Administrator determines that

> **(A) a pollutant or pollutants cannot be emitted through a conveyance designed and constructed to emit or capture such pollutant, or that any requirement for, or use of, such a conveyance would be inconsistent with any Federal, State, or local law, or**
>
> **(B) the application of measurement methodology to a particular class of sources is not practicable due to technological or economic limitations.**

This clearly indicates that Congress intended Section 111 to be used only when pollution capture technology was not available or so expensive that it was impractical. However, the long-proven effectiveness and use of scrubbers to reduce mercury emissions makes this clause null for the use of mercury regulation, since cost-effective technology does exist in practice. To address legal difficulties, Clear Skies would effectively amend Section 112 to exclude electric utilities from MACT regulation if they are subject to Section 111. Ironically, the EPA does stipulate that all non-mercury hazardous air pollutants should remain regulated under Section 112 and MACT.

Cap and Trade Regulatory Program

The concept of tradable emissions permits arose in the 1960s, and was deemed successful after implementation in the 1990s for sulfur dioxide reduction. The emission permits are a commodity that can be bought and sold in a market between power plants throughout the nation. Much like any market, with perfect information, the permit trading market would be efficient and equitable under perfect conditions. However, in the realistic market situation of less than perfect information and irrational decision making, this is not likely to occur. It is naïve of the Administration to hope for a perfect emissions trading market when such perfection has never been reached in the market. Unlike traditional command-and-control regulation, the outcome of a cap and trade system is largely speculative and based on market performance. Therefore, it is difficult to predict that results in 2018 will be both efficient and financially beneficial to firms. As MIT authors Nicholas Ashford and Charles Caldart describe, "where permit markets are characterized by bilateral, sequential trades under conditions of imperfect information – rather than by multilateral, simultaneous trades under conditions of perfect information, as assumed by economic theory – participants often make early sub-optimal trades that considerably reduce future cost-saving opportunities[19]." Additionally, the US market for electricity from coal-burning power plants is a factor in the success of the cap and trade system. Twenty years from now, the national dependence on coal may lessen or increase, creating market changes that were not accounted for in the 2003 drafting of Clear Skies.

Emission credit trading is an indirect control, as it is "an endeavor to induce the desired response through the creation of an economic incentive[20]."The benefits of emissions trading are internalization of the cost of polluting and lowered emissions at a minimal cost. The main financial disincentive to emissions trading is that once a firm can meet new emissions standards and start banking unused emissions credits, it has little future incentive to further reduce emissions.

As described by Ashford and Caldart in *Environmental Law, Policy and Economics*, there are three main types of permit systems. The first is an "ambient permit system," which is based on a series of pollution monitoring points. Each monitoring point is differentiated by pollution concentration and potential impact, and therefore receives a different number of permits for distribution. This system would create individual emission credit markets for each monitoring point. An "emissions permit system" assigns polluters to specific zones, who are allowed to trade with one another based on amount of emission. The main difference of this system is that it ignores different concentrations and characteristics of different pollutions within the zone. The "pollution offset system" is a combination of the two, which defines permits in terms of emissions but only allows for trading within a specific zone. In addition, there are air quality standards that must be met for each particular monitoring point. The mercury cap and trade program contains the additional feature of "non-degradation offset," which caps the national total of allowable emissions[21].

After selection of the permit trading system, the two most important system features are the initial allocation of permits and the ability of firms to bank unused permits for future use. There are a number of concerns over allocating permits equitably. The Clear Skies Initiative would allocate permits similar to the Acid Rain reduction trading program in 1990, which summed the total pollution from each state and distributed permits accordingly to the state governments. It was then left to the states to distribute permits to firms, based on firm size and emission output. A stock of permits was saved for new entrants to the industry, although required significant paperwork to be filed with the federal government before allocation.

The financial incentive to reduce emissions is based on the ability of firms to bank unused permits for future use or sale. From evaluation of the Acid Rain program, banking of permits is very popular behavior among the power plant industry. The desire to bank permits for financial resale in the future leads to quick implementation of the emissions reduction standards, often meeting goals before schedule. However, the banking of permits creates a long-term disincentive to continue innovation and leads to potential slowing of the emissions reduction timeline, as firms are allowed to continue polluting at high levels until their pollution credits are used. Under a cap and trade program, the level of allowable emissions decreases as the national cap is lowered, so banked emission credits should eventually be used up. However, with current EPA caps set at very feasible levels, it is likely that firms will be able to bank and store credits for many years without having to innovate or upgrade pollution control technology.

One of the main benefits of emission credit trading is the lowered cost burden on the Administration, since the system needs little oversight. However, for firms themselves, there may be high administrative costs in trying to identify a market for permits and negotiate the best price[22]. Competition between firms is also an important factor in the success of an emission credit trading market. Since over 25% of mercury emissions are from the three largest power companies in the US (American Electric Power, Southern Company, and Edison International), those firms have a competitive desire not to sell to each other and might potentially base their decisions on the predicted behavior of competitors[23]. The disinterest of firms to directly trade with one another has lead to the creation of third party mediators, who can buy and sell permits on the market for personal profit. This presents another criticism of cap and trade, as it allows third parties, rather than the federal government, to make a profit off pollution emissions.

Section 4: The Clear Skies Initiative

The Clear Skies Initiative was first announced by President Bush on February 14, 2002. It was introduced to both chambers of Congress in the summer or 2002, but did not gather momentum. A modified version of the Clear Skies Act was reintroduced to Congress in late February 2003. It is this version that is still undergoing intense scrutiny from Congress, lawsuits from states and environmental groups, and an ongoing comment period from the EPA. Although the EPA issued the specific cap and trade rule for mercury in spring of 2005, it was returned to notice and comment period after receiving strong opposition from state governments. As of May 2006, the EPA was still accepting comments on the mercury rule.

The Clear Skies Initiative mandates reductions of three air pollutants from electric utilities: mercury, sulfur dioxide, and nitrogen oxide compounds. Each is individually held to a separate cap and trade system of pollution credits or allowances; however implementation of one pollution prevention technology is usually sufficient for capture of all three pollutants. Therefore, it is practical for utilities to either purchase additional allowances for the emission of all three pollutants, or install technology that will reduce emission of all three pollutants.

Clear Skies anticipates two phases of reductions, one to start on January 1, 2010 and the other to start January 1, 2018. The reduction levels at full implementation will be 69% reduction in mercury, 73% reduction in sulfur dioxide, and 67% reduction in NOx from 2000 emission levels. Figure 6 shows the reduction caps for the three pollutants under each phase, which are less stringent than the 90% reduction that would have been required under Section 112 MACT regulation. While Clear Skies applies to a number of utility plants and boilers that emit SO_2 and NOx, the mercury caps are limited to "all coal-fired units serving an electric generator with a nameplate capacity greater than 25 MW[24]." For the purposes of this report, I will focus solely on mercury cap and trade, although the processes for SO_2 and NOx are almost identical.

Emission Allowances

During each phase, the EPA determines the cap on total allowable mercury emissions in the nation. The EPA has already set this level to 26 tons starting in 2010 (the second cap of 15 tons in 2018 is subject to adjustment by the EPA). Starting in 2010, the EPA will distribute, free of cost, 99% of mercury emission allowances. The remaining 1% of allowances will be available for purchase through an EPA auction. Each year for the next 20 year, the percentage of allowances available by auction will increase by another 1%. The percentage will then increase by 2.5% a year until finally all allowances are available by auction only and none are freely allocated to the utility industry[25]. The initial allowances will be allocated based on "proportionate share of their baseline heat input to total heal input," with adjustments made for varying coal types[26]. Once distributed, allowances are under control of the electric utility, who can then decide to use the allowance and emit mercury, sell the allowance to a fellow utility, or bank the allowance for future use. There is no penalty for banking allowances and using them in following years. Because early allowances are freely distributed, they have a high value and industry has an incentive to reduce emissions in early years so that the allowances can be saved for future use. The Clear Skies Act includes a "safety-valve" provision to protect against market volatility. Under this provision, the price of a 1-pound mercury allowance is capped at $35,000. If the demand for allowances is so high that auction prices rise above this price, the EPA will borrow allowances from the following year's auction. While this ensures control of the market for the current year, the ability to borrow from future allowances presents an interesting scenario, especially since the EPA acknowledges that unless superior technology is developed to reduce mercury more inexpensively, "Clear Skies modeling suggests that the mercury safety valve price will be reached[27]."

Figure 6: Clear Skies Air Pollutant Caps

Pollutant	Emissions in 2000	First Phase of Reductions (2010)	Second Phase of Reductions (2018)	Reduction at Full Implementation
Mercury	48 tons	26 tons	15 tons	69%
Sulfur Dioxide	11.2 million tons	4.5 million	3 million tons	73%
NOx	5.1 million tons	2.1 million tons	1.7 million tons	67%

Source: US Environmental Protection Agency Clear Skies Page, http://www.epa.gov/air/clearskies/basic.html

Pollution technology such as advanced scrubbers, are able to collect a portion of particulate matter for all three pollutants. The EPA estimates that the first phase for mercury reduction will not present a challenge to the industry because reduction caps will already be met by plants installing technology to control for SO_2 and NOx emissions. It is in the second phase of the mercury cap that firms may find it more cost-efficient to purchase allowances. An additional unknown in the Clear Skies program is the role of the states. Under the legislation, states cannot preempt Clear Skies but can require a specific facility to reduce emissions in response to local concerns. From existing legislation, it is clear that states do in fact wish to implement stricter controls of plants emitting mercury, and may use this provision as the loophole to forward their own regulatory programs.

Section 5: Challenges of Cap and Trade

The legality of regulating mercury under a cap and trade system and Section 111 is an important issue because if allowed, it will set a precedent for regulation of other hazardous air pollutants that might also gain exception from strict regulation. Aside from the legal debate, however, there is a larger policy question over the appropriateness of regulating mercury with emissions trading. Given the health risks associated with methylmercury exposure, there are a number of risks that might emerge under a cap and trade system that would not be present under MACT. Two of the central threats of cap and trade are the impacts on global strategies to regulate mercury and impacts on technology innovation within US industries. These potential challenges will be discussed more in depth in sections 8 and 10. However, it is important to note that discouraging innovation and challenging the global political community are not the only major risks associated with the decision to pursue cap and trade. This section will outline the other risks involved, which have been researched extensively and combine to make a strong argument against the new approach to regulation. Such risks divide into the broad categories of unequal risk of exposure and uncertainty over market and firm behavior.

Unequal Risk and Exposure

There are four ways to describe exposure to a toxic substance such as methylmercury: one-time, intermittent, periodic, and continuous[28]. Those who ingest methylmercury through consumption of fish are most likely subject to periodic exposure. This presents an increased risk to health, since the half-life of methylmercury can be up to 90 days when stored in body tissue, and periodic intake of a more frequent schedule would mean methylmercury accumulates in the body[29]. This pattern of exposure and effect leads methylmercury to be categorized as having "traditional chronic toxicity." This categorization, developed by Ashford et al, is defined as a "toxic process [that] typically proceeds to permanent damage over a time period from several days to several months, due to… reversible accumulation of a toxic agent[30]." This definition also assumes that methylmercury damage is reversible since it can be excreted from the body, and thus allows for a threshold to be set below which no damage from exposure will occur. The EPA and National Research Council have confirmed this existence of a threshold by setting the reference dose of mercury for a healthy adult at 0.1 micrograms per kilogram of body weight per day. This reference dose, based on a threshold, does not consider those subsets of the population more chemically-sensitive to methylmercury.

There are four meanings of the word exposure: initial exposure (amount in food), uptake (amount in the body), effective dose (amount at organs or places of concern), and molecular dose (amount likely to interact with a particular type of cell or gene on a molecular level)[31]. While the EPA reference dose for methylmercury exposure is an initial exposure amount, it is often more important to discuss exposure in terms of effective dose, which can do harm in the body. This is especially true when infants or those in chemically-sensitive groups are involved. The evidence that chemically-sensitive groups react differently to methylmercury comes from the study of active glutathione in autistic children, showing that certain children that do not have the metabolic system capabilities for ridding the body of mercury are more likely to experience ill health effects and have autistic traits. Such groups are not included on the distribution curve for effects of mercury exposure, and the EPA standard threshold and reference dose would not apply to them. Unfortunately, it is not known if these sensitive groups can safely ingest methylmercury at any dose, suggesting that a threshold and reference dose cannot be set, and that instead the EPA and industry should work to eliminate mercury emissions rather than capping them at a "safe" level.

Hot-Spots

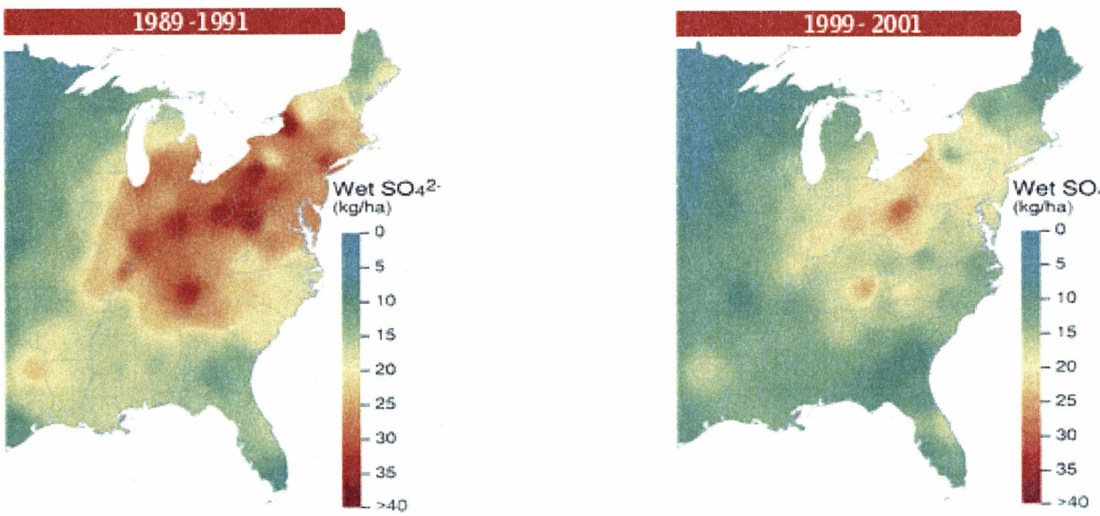
Perhaps most concerning of the risks of Clear Skies applied to mercury is the potential for the emergence of hot-spots. Hot-spots are localized areas of increased methylmercury deposition, usually located near emitting power plants or regions downwind of such plants. The EPA definition of "hot-spot" is a water source with "methylmercury fish tissue concentrations greater than 0.3 mg/kg, attributable solely to the utility[32]." Usually they are caused from the location of several power plants in one geographic area. In order to capitalize on utilization of the power grid, many firms have several adjacent facilities or are located near one another. Instead of an equal distribution of power plants throughout the nation, they are concentrated in certain vulnerable areas. The Midwest is especially populated with coal-burning plants, with 49 power plants located in the Ohio River Valley[33]. Areas with local plants are most at risk for concentrated mercury pollution, especially as plants are given the ability to maintain or increase pollution levels under cap and trade. Depending on individual firm behavior under cap and trade, mercury emissions could actually increase in some areas, creating a greater threat of hot-spots and more localized contamination than is already present.

When the Clear Skies mercury rule was formally announced by the EPA in 2005, a number of federal and state EPA personnel immediately spoke out with their concerns over potential hotspots. John Paul, an EPA advisory co-Chair and Ohio regulator came out to the day after the Clear Skies announcement to admit "hot-spots are a concern with me. I advise anyone who eats fish caught in a lake or stream near a power plant that they are at risk, and this rule will do nothing to protect them- and might make things worse[34]." Two days later, the Commissioner of the New Jersey Department of Environment Protection, Bradley Campbell, said "a cap and trade program for mercury further dilutes an already weak rule and create the risk of perpetuating dangerous mercury hot-spots that threaten the health of our communities and children[35]."

While cap and trade will lower the overall nation emission of mercury and provide diffuse benefits to the nation as a whole, the potential for hot-spots places an extremely high environmental and health cost on a small localized minority of the population. This is a classic demonstration of Mancur Olson's ideas on collective action, in which diffuse benefits have concentrated costs[36]. As summarized by the OMB watch group: "Those who live in hot-spot regions would share an unequal amount of the risk. Therefore, even if the cap and trade method does effectively reduce emissions overall, it is fundamentally unfair because it does not equally distribute the burden of the pollution or the benefit of reduced emissions[37]." Unfortunately for this small minority of Americans living in hot-spots, the owners of electric power generators have great political influence and lobbying power that is difficult to challenge.

The EPA points to the success of the 1990's Acid Rain cap and trade program to argue that hot-spots will not emerge under Clear Skies cap and trade for mercury. The Acid Rain program was successful in many respects and considerably reduced sulfur dioxide in the US. The figure below, from EPA modeling, shows hot-spots prior to the Acid Rain program and again 10 years after the program was implemented.

Figure 7: Hot-Spots under the Acid Rain Program

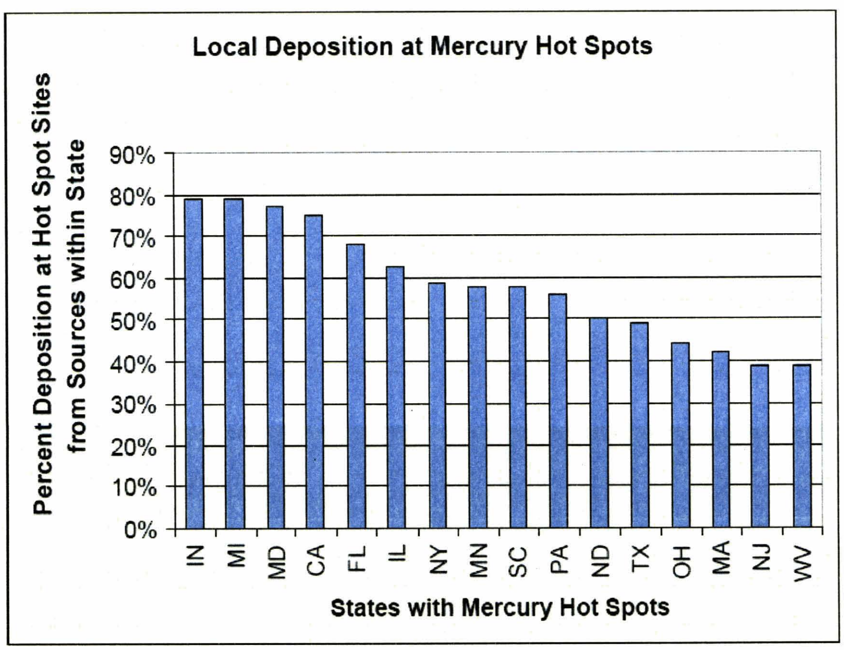


Source: US Environmental Agency, http://www.epa.gov/air/clearskies/captrade.html

However, using the Acid Rain program as the sole basis for prediction that no mercury hot-spots will emerge once Clear Skies is enacted is a weak argument. There are a number of important differences between the properties of mercury and sulfur dioxide that make them very different types of air pollutants. The first different is the weight of each pollutant. Mercury is almost three times heavier than sulfur dioxide, and thereby more likely to deposit regionally around the source of emission. Another distinction is the vast difference in the half-life for each of the pollutants. While the half-life of sulfur dioxide in the atmosphere is only a few days, the half-life of elemental mercury in the atmosphere is approximately one year[38]. Thus, mercury is more likely to accumulate in streams and soil once deposited, increasing the likeliness of the emergence of hot-spots. A final important distinction between the two is their means of exposure and resulting health effects once taken into the human body. Sulfur dioxide is largely inhaled, resulting in a number of potential lung diseases and respiratory problems. Methylmercury, however, is ingested through the consumption of food, and has the health impacts of neurological damage, especially on a developing fetus. While the health effects of sulfur dioxide can usually be linked to the pollutant, the health effects of mercury remain controversial and scientifically difficult to determine. As such, it is often easier to prevent against a known pollutant that is inhaled, either through improved home ventilation or filters. However, methylmercury is often consumed unknowingly from the food chain, and is much more difficult to prevent, except through the banning of eating fish, which even if politically feasible in the US, is unlikely to be enforced in poor communities that fish. Once methylmercury enters the body, its long half-life distinguished it once again as a particularly harmful toxin, as often has a half-life of up to 90 days when stored in tissue.

Modeling of local depositions of mercury near power plants emitting the pollutant shows the potential for localized hot-spots. Those states with multiple coal-fired plants are especially at risk. Figure 8 demonstrates those states whose hot-spots are largely created from in-state emissions of mercury. The data is consistent with plant location data, as well as predicted downwind effects, showing that the majority of East Coast states are at risk. The Director of the Natural Resources Defense Council, John Walke, has estimated that Clear Skies might result in increased mercury emissions by 841% in California, 176% in Colorado, 241% in New Hampshire, and 56% in New Jersey, based on internal studies of current mercury emissions in those states as well as the distribution of coal-fired power plants[39].

Figure 8: Local Mercury Hot-Spots



Source: Middleton, Paulette. "Mercury: A Local Concern/An International Issue." Presentation to RFF. June 2004. http://www.environmentaldefense.org/pdf.cfm?ContentID=3380&FileName=NationalMercuryAnalysis%2Epdf

Marginalization of Population Subgroups

The charge given to the EPA by Congress is to "protect human health and the environment." By awarding free emission credits to polluters, the EPA is instead protecting the best interests of industry and certain users of electricity. The beneficiaries of the cap and trade system are power plants themselves and citizens located far from plant facilities, who face no risk of exposure from hot-spots. The very people needing protection from mercury in the first place are those that become most at risk under the mercury cap and trade program that was devised to protect them.

Certainly most at risk for exposure to methylmercury are developing fetuses and infants, or the chemically-sensitive adult population. However, there is another group left susceptible to methylmercury exposure, not because of age or health, but socio-economic status. Communities in coastal or lake areas that rely on fish consumption as part of a daily diet are at high risk. In September 2001, Brookhaven National Laboratories released a study on the elevated methylmercury levels in geographic regions of the US. The study concluded that "there is a special concern pertaining to subsistence fishers or recreational anglers that consume large amounts of freshwater fish. These groups of people represent the high exposure cases that form the tail of the distribution of the general population[40]." Testing in the Southeastern US, with a large conglomerate of coal-fired plants, found that mercury levels in hair samples were 10 times higher than in the general population, corresponding to elevated risk. Increasing the danger of methylmercury exposure to those living in fishing communities is their dependence on fish consumption. Often such communities are lower-income and not able to purchase store-bought food products. Those living in fishing communities are also least likely to have the mobility to move and change careers, due to fewer resources. This is especially problematic in developing nations, where diets are more dependent on fish. Fish accounts for up to 25% of the protein in the diet of those living in Asia, as well as 17% of the protein for those living in Africa[41].

Similarly, the most at risk group to methylmercury exposure in the general population also lacks the ability for movement away from potential hot-spots. Pregnant women who live in areas surrounding power plants have a higher risk of hot-spot exposure to their unborn child. However, when pregnant and expecting a child, women do not have the mobility to change locations and leave their existing social networks and family that are needed for support. Therefore, the most at-risk groups left in at-risk areas are those from lower incomes, the elderly, children, and pregnant women. Each of these does not have a strong advocacy voice, so their concerns go unheard in Congress and at the EPA. This reinforces their marginalization and contributes to the even greater risk of not being able to represent themselves to challenge regulation. Also concerning is a recent CDC study that found white non-Hispanic children to have lower levels of mercury in their blood than Hispanic-American children and African-American children. Further research is still needed to determine if this is a result of regional living patterns and the increased probability for these groups to live near hot-spots, or if they are genetically more likely to accumulate and store methylmercury[42].

Market Uncertainty

Market-based regulation always carries some inherent risk due to the volatility of markets. In the formulation of Clear Skies, the EPA anticipated firm and market behavior for the next 20 years. Many of the predictions for firm behavior and market activity were drawn from the Acid Rain Program of the 1990s, expanding the extrapolation of market behavior over 30 years. The basis for EPA's decision to favor cap and trade regulations was based entirely on cost-benefit analyses that spanned the lifetime of the program. All predictions that cap and trade will lower emissions rely on the assumption that the price of emission allowances will make technological improvements in mercury a favorable economic decision. Local markets, inflation, and increasing strains on the US electric power supply will all affect the cost of emission permits. Since firms can only be expected to favor least-cost alternatives, there is no guarantee that the cost of permits will be higher than the cost of installing technology, thus creating a potential increase in mercury emissions in certain areas.

The uncertainty of predicting emissions markets was demonstrated in late April 2006 with the sudden crash of the International carbon market, which is used to trade pollution credits for CO_2 in the European Union. The crash occurred after several European nations reported better than expected reductions in carbon emissions. The resulting impact was an immediate 50% drop in the price of credits themselves, which is expected to fall even lower. As of early May 2006, the crash has resulted in a US $50 billion loss in value of the trading market[43].

As equally unpredictable as the market for emission permits is the uncertainty over firms' behavior under Clear Skies. As markets are never perfect, individual and firm behavior is not always rational. In a 2002 study of the federal Acid Rain Program effects in Florida and firms' strategic decisions to control SO_2 emissions, Academic John Swinton found that "power plants in Florida did not use the allowance market to its fullest potential: several plants are controlling emissions when purchasing allowances would be a more economic option[44]." Making rational decisions whether to use allowances or improve technology requires significant administrative overhead and costs on the part of electric utilities and individual plant managers.

Under George Stigler's definition of regulatory capture, institutional failure is a result of the regulated using the regulations to limit competition and create barriers to entry. Cap and trade is not only industry-friendly because it gives decision making power over whether or not to pollute to firms, but it also gives power to industry players over one another. Since competing firms are directly connected in trading emission credits, they have the ability to exert power over competitors in terms of how many credits they sell and to whom. Large firms have a greater ability to exert power over smaller firms, who probably do not have the financial choice to either innovate or use credits, but are more financially and organizationally inclined to one position.

The argument can be made that the first years of Clear Skies appear as a reward system, rather than a control strategy. There are a number of utility firms who already meet mercury emission standards and implement clean technologies for a variety of reasons, perhaps due to a state regulation or a conscious decision to be environmentally-friendly. Allocating these firms' unneeded emissions credits equates to a cash allowance. Including them in the cap and trade program allows them to enter the system with a competitive advantage, leading to a number of institutional failures. However, the irony is that to not award allowances to firms that already control mercury emissions would be to punish first-movers and those concerned about environmental impact.

This market uncertainty raises serious questions as to whether Clear Skies will accomplish its primary goal, which is to reduce mercury emissions by encouraging advancements in technology to aid in mercury capture and pollution prevention. Section 8 addresses this question, applying lessons learned from the Acid Rain cap and trade program to evaluate how firm behavior might deviate from technological innovation anticipated by its promoters under Clear Skies.

Section 6: The Move towards Market-based Regulation

If 1 in 8 women living in the US has dangerous level of mercury in her blood, if it is proven that mercury is linked to a number of fatal neurological diseases, and if cap and trade is not only less effective than previously thought but also more costly, why then does mercury regulation under Clear Skies receive as much support as it does from the Bush Administration? To answer this, there are a number of explanations for the current Administration's overall tendency to favor market-based regulatory instruments over the traditional command-and-control approach outlined in the statute of the Clean Air Act. While the use of market-based environmental policy is not unique to the George W. Bush Administration, his Administration is credited with favoring economic regulatory schemes almost exclusively and at the expense of potentially successful command-and-control standards for environmental protection. This section will explore two theories that attempt to explain the Administration's preference for cap and trade, especially in light of academic and epidemiological studies questioning the success of cap and trade under the Clear Skies Initiative.

First, we must ask whether the shift towards market-based regulations is historically based, building from Congressional and Executive decisions from the past two decades. Instead of viewing market-based regulation as a preference of this Administration, this theory credits past Congressional procedural mandates and executive orders, such as the mandated use of cost-benefit analysis and use of the Office or Management and Budget, as the originating basis for the pressure to use market-based environmental regulations. Alternatively, is there something unique about the culture of the Bush administration that favors electric utility industry interests and disregards respected academic studies suggesting that a strict environmental approach is necessary for adequate protection of human health? To explore the current Administrative culture, it is necessary to explore the relationship between the Administration and industry firms through records of political contributions. Coupled with financial donating power of the utility industry is the historical power of utility lobbyists in Washington and the US cultural of catering to certain industry interests. The final question that arises in evaluating the political cultural of the Bush Administration is whether there exists a conscious and intentional decision to disregard the environmental protocols of the international community. Can the US reluctance to regulate mercury in the same decisive manner as the international community be seen as simply another example of an Administrative culture determined to stand independently?

These questions must be asked in order to understand how the Bush Administration, Congress, EPA, and industry have interpreted crucial studies comparing cap and trade and MACT for controlling mercury. Understanding the Administrative culture and historical context of regulatory policy describes the lens through which mercury regulation is viewed by those with decision-making power.

Historical Shifts

When the Environmental Protection Agency was created in 1970, it marked the start of a decade in which the federal government was dedicated to strict regulation of industry in order to protect the environment and human health. Specific standards were written into the Clean Air Act of 1970 by Congress. What followed was a flurry of activity from the EPA and other agencies to reverse risk-prone industry practices through setting both specific technology requirements and emission output limitations. The Courts recognized agencies' abilities to regulate even in the event of scientific uncertainty, often favoring the Precautionary Principle in allowing a strict regulatory decision to prevent possible harm in the absence of concrete scientific evidence. In later decades however, ambitious social goals to protect human health and the environment were compromised by requiring the agencies to undertake regulatory impact analyses, forcing agencies to precisely quantify health benefits and justify regulation with a positive net cost-benefit analysis.

There were two major political decisions that caused the shift from social analysis to cost-benefit analysis of environmental regulation. Although Presidents of the late 20th century frequently used the power of executive orders to shape their executive regulatory oversight capacity, action taken by President Reagan stands as one of the more significant changes in major regulatory policymaking in the US. In the first month of President Reagan's term in 1981, he signed an executive order than has since changed the role of the Office of Management and Budget (OMB). Under Reagan the OMB grew from managing the federal budget to an Office charged with the responsibility of performing an analysis of all major federal regulatory proposals. President Clinton backed this expanded function of the OMB and introduced economic analysis with Executive Order 12866, which required the OMB the perform a cost-benefit analysis[45]. Based entirely on this financial analysis, OMB then makes recommendations on which programs should be included in the federal budget, without any review of the science behind each regulation.

A second major change in making regulatory policy occurred in the 1990's under Speaker Newt Gingrich's "Contract with America." Included in his concept of regulatory reform was expanded Congressional oversight of agencies and the requirement that agencies perform in-house cost-benefit analyses for all major regulatory programs. Additionally, the Regulatory Flexibility Act required agencies to examine cost-effectiveness of regulatory alternatives. These requirements further pressure agencies to select the lowest-cost regulation, often at the cost of impact and performance, for the sake of gaining Congressional budget approval.

With an institutional pressure within agencies to overemphasize financial costs and select lowest-cost regulatory schemes, environmental market-based regulations materialize as the most rational decision. By looking at the gradual shift towards emphasis on costs of regulations, the Bush Administration's choice of cap and trade mercury regulation could be view not as a directed political decision, but instead the result of evolving trends in US environmental policy. However the extent of the use of cost-benefit analysis within the OMB and EPA is a function of political decisions of the Administration and raises serious questions over politics influencing crucial mercury reduction policy.

Political Influence

The manner in which the OMB and EPA carried out cost-benefit analyses for regulating mercury under Clear Skies is particularly interesting and telling of the channels for political influence. In an article for the Environmental Law Institute, academics Lisa Heinzerling and Rena Steinzor detail the relationship between the EPA and OMB in performing mercury cap and trade cost-benefit analyses and the political influences on each group[46]. According to Heinzerling and

Steinzor, both the EPA and OMB neglected to evaluate regulatory alternatives to cap and trade, although such practice is mandated by Congress. Additionally, neither organization attempted to quantify the benefits of reducing mercury emissions, resulting in a hugely erroneous cost-benefit analysis in favor of cap and trade. The specific oversights made in economic evaluation will be addresses in more detail in Section 7 of this report.

On the EPA side, Heinzerling and Steinzor found evidence in the public record that EPA career personnel were directed not to consider or evaluate alternative regulatory strategies for mercury outside of cap and trade[47]. When questioned publicly about this in 2003, the then EPA Administrator Mike Leavitt told the press he would direct his staff to evaluate alternative policies. But as the authors discovered, "within days, EPA Assistant Administrator Jeffrey Holmstead, the chief architect of the controversial scheme, reassured the utility industry that such reconsideration would be limited to details of the trading system's design, as opposed to a comprehensive reevaluation of the soundness of EPA's overall approach[48]."

As the Office within the OMB charged with implementing executive order 12866, the Office of Information and Regulatory Affairs (OIRA) should have caught the EPA's mistake of not performing alternative cost-benefit analyses for other regulatory strategies. Instead, "OIRA did not require EPA to look at more alternatives, nor did it even require EPA to prepare a formal regulatory impact analysis of the kind usually required for such a major rule[49]." After searching the massive public record on mercury regulation, Heinzerling and Steinzor could find no place where OIRA ever questioned the EPA's lacking cost-benefit analysis or mention of alternative more stringent regulatory policies. Another disturbing occurrence was the authors' finding that OIRA (despite having no scientific or medical expertise) recommended that the EPA use the word "possible" before describing health effects of mercury exposure[50].

The negligence of the OMB and EPA in their performing cost-benefit analyses of the proposed mercury regulation is now a key point in legislation calling for the District Courts to stop to the Clear Skies legislation. But it also raises and interesting point about the use of cost-benefit analysis and relationship between OMB and regulatory agencies. Additionally, the question remains: From which source did the political pressure to push through Clear Skies originate?

Political Contributions

The US political cycle is dependent on exuberate amounts of campaign contributions from industry corporations. In return, the US political cultural is one in which elected officials are beholden to industry interests and influence from lobbyists. This creates a slew of complicated relationships between industry leaders and elected officials from both political parties. While the political influence of industry is acknowledged and practically essential for a successful election campaign, it is simultaneously discouraged for replacing influential scientific and economic policy evidence with political influence. The sudden dismissal of the Clinton Administration MACT proposal for mercury raises a number of questions over such political influence and the tendency of the Bush Administration to favor industry interests. In a 2003 PBS NewsHour interview with then EPA Administrator Mike Leavitt, Margaret Warner quotes the New York Times in questioning this view, saying "The reversal came right out of the Karl Rove play book, a long promised payoff to President Bush's big contributors in the utility industry[51]."

Electric power utilities have the largest concentrated stake in federal mercury regulations, as the sole bearer of compliance costs to reduce mercury emissions. Interestingly, that industry also has a powerful and long-standing monetary relationship with Presidential candidates. In 1999, the thirty largest electric utility companies, whom all own power plants on the "50 Dirtiest" list, gave a combined $6.6 million to the Bush campaign and Republican National Committee. Edison Electric Institute, the professional association for electric utilities, had ten individual employees who rose over $1.5 million in contributions for the Bush campaign.

Political contributions are not a new concept in the US or an exclusively Republican activity. As mentioned, they are a necessary entity for funding a successful political campaign. The real question is exactly what is bought for industry interests through a political contribution as large as $6 million. In a 2004 Public Citizen Congress Watch report, a note from EEI President Thomas Kuhn to the Bush campaign is quoted, with Kuhn asking that the Bush campaign track incoming donations solicited by his company in order to "ENSURE THAT OUR INDUSTRY IS CREDITED" [emphasis in original][52]. The Public Citizen report recounts that EEI was then allowed to meet with Vice President Cheney's Energy Taskforce 17 times before legislation affecting them was written[53].

Regardless of the dollar amount contributed to the President's campaign, the electric utility industry is one of the oldest and most influential in DC. Given that the nation's lifestyle and industry is dependent on a constant source of uninterrupted electricity, this industry has inevitable influence over leaders. Beginning with the Industrial Revolution, the US has created a national identity built on productivity, which has awarded power plants unique political influence in the US. Electric utility lobbyists have the advantage of a long history of mutual relationships in Congress, in addition to the cultural influence they retain. As the main component of US livelihood and quality of life, the electric power industry has a seemingly justified place as one of the most important industry groups, one that Congress and the Presidency feels the necessity to appease.

Section 7: Economics of Cap and Trade

Cap and trade regulation was selected by the EPA for the sole reason that it has the potential to reduce mercury emissions for a fraction of the cost of command-and-control. This assumption was based on agency cost-benefit analyses, as well as looking at compliance data from the Acid Rain cap and trade program of the 1990's. Figure 9 shows the EPA's calculated economic impacts for MACT and cap and trade. As shown, the annual net benefits from MACT were assumed to be $13 billion, which those for cap and trade were over $55 billion. The costs for cap and trade also include control technology that might be installed for purposes of meeting the Clean Air Interstate Rule (a program for SO_2 and NOx), which would have a secondary benefit of capturing a certain percentage of mercury particulates as well. This figure however does not include health related costs or benefits. Also not shown in a simple cost-benefit analysis is that while cap and trade costs and health costs will continue each year, the costs for MACT is generally a one-time cost of installing mercury capture technology.

Figure 9: EPA Cost Benefit Analysis for Mercury Regulation

Table 1: Estimated Annual Economic Impacts of EPA's Proposed Mercury Policy Options in 2010

1999 dollars, in billions

Policy option	Annual costs	Annual benefits[a]	Annual net benefits
Technology-based option	2	15 or more	13 or more
Cap-and-trade option	Not estimated	Not estimated	Not estimated
Technology-based option and the interstate rule	Not estimated	Not estimated	Not estimated
Cap-and-trade option and the interstate rule	3 to 5 or more[b]	58 to 73 or more[b]	55 to 68 or more[b]

Source: EPA.

[a]As discussed further below. EPA's monetary benefits estimates do not include the human health benefits specifically related to reductions in mercury emissions. Instead, EPA monetized some of the health benefits that would occur as a secondary benefit of regulating mercury.

[b]According to EPA, the lower end of the range reflects a scenario involving no additional reductions beyond those achieved by the interstate rule, while the upper end of the range reflects mercury caps similar to those in the Clear Skies legislation. EPA estimated that the interstate rule alone would generate annual benefits of $58 billion or more while imposing annual costs of about $3 billion.

Source: US Environmental Protection Agency, http://www.gao.gov/new.items/d05252.pdf

In addition to the numerous health effects and other factors that challenge the validity of cap and trade mercury regulations, many argue that the cost-benefit analysis showing cap and trade to be more inexpensive was flawed. Lisa Heinzerling and Rena Steinzor on behalf of the Environmental Law Institute have examined all EPA and OMB public records looking at the actions leading up to the announcement of Clear Skies, and found that "neither EPA officials not the… economists at the Office of Management and budget asked whether we might get an even more wonderful cost-benefit profile if we regulated mercury more stringently." They claim that the EPA neglected to look at newer technologies that would make MACT more obtainable and achieve greater benefits in a short amount of time, cutting costs. Such concerns were brought to the EPA's attention by its own Office of Research and Development, who concluded that by 2010 technology could reduce up to 90% of mercury emissions[54]. In response to external pressure, then Administrator Mike Leavitt promised additional cost-benefit analyses be conducted. This action was never taken, however, as Assistant Administrator Jeffrey Holmstead kept his alleged promises to industry leaders and instead had additional analyses be "limited to details of the trading system's design, as opposed to a comprehensive reevaluation of the soundness of EPA's overall approach[55]." The reluctance of the EPA to closely perform a cost-benefit analysis for each mercury regulatory alternative should have been resolved by direction from the OMB to perform such analysis. Under Executive Order 12866, the EPA was mandated consider all alternative regulatory approaches. Strangely enough, and in contrast with their actions on almost all other major legislation, the OMB did not require this analysis from the EPA nor did it perform this analysis themselves.

In the limited cost benefit analysis that did take place for the cost-effectiveness of cap and trade, there is significant cause to believe that the EPA left out crucial data that may have changed the outcome. Before announcing the cap and trade strategy to regulate mercury, the EPA commissioned a cost-benefit analysis on methylmercury health effects to be conducted at Harvard University, which was then peer-reviewed and sent to the agency. The Harvard study found that instead of the $50 million reported by the EPA, the cost savings through health benefits associated with stringent command-and-control regulation would be approximately $5 billion each year. According to sources of the Washington Post, "top agency officials ordered the finding stripped from public documents[56]." In response to why the Harvard data was not included in EPA analysis, the agency said that it received the study too late to include it in findings. Records show however, that the study was delivered to the EPA before the EPA deadline. The co-author of the study, James Hammitt, the director of the Harvard Center for Risk Analysis, commented on the impact of his results, saying "if you have a larger effect of the benefits that would suggest more aggressive controls were justified[57]."

In an additional study evaluating the cost of methylmercury exposure through health impacts in the US, physicians Trasande, Landrigan, and Schechter calculated the annual cost to the US from lost worker productivity due to early-life methylmercury damage. The authors use EPA reference dose amounts and results from the Faroes Island Study to conclude that a doubling of exposure to methylmercury would result in an approximate loss of 1.5 IQ points. This reduction in IQ was related to lifetime productivity and a loss in total lifetime income. Overall, the authors estimate that the loss in IQ in American children from methylmercury to be worth $8.7 billion annually. However, the study accurately notes that not all methylmercury exposure is a direct result of mercury emissions from coal-fired power plants and uptake through fish consumption. The authors estimate that 33% of the US's 158 total tons of anthropogenic mercury are deposited in the US, along with an additional 35 tons of mercury from global sources. 41% of these total anthropogenic deposits can be attributed to emissions from coal-fired power plants. When taking this into account, $1.3 billion annually in lost productivity of Americans can be attributed directly to US coal-fired power plant mercury emissions[58]. This cost was completely overlooked in the EPA cost-benefit analysis of mercury regulations.

Section 8: Regulatory Effects on Innovation

One way to evaluate the success and effects of a regulation is to study its impact on industry behavior. Although cost effectiveness and protecting from environmental harms and health threats are the main criterion on which to judge environmental regulation, additional metrics exist to study the regulation's impact on industrial processes. An often overlooked side effect of any environmental regulation is its ability to change industrial operations, either through creation of new technology or new organizational procedures and processes. The environmental regulation serves as a catalyst for this change, which can affect productivity, workforce dynamics, and has an impact on industry compliance with future regulations. Since the announcement of the Clear Skies Initiative, academics have responded with harsh criticism and cite numerous evidence of the potential health hazards and costs of the market-based regulation. What is missing, however, is an expansion of this discuss to include the potential future impact of Clear Skies on the evolution of productivity, efficiency, and technology within electric power plants. To address the likely impact of cap and trade mercury regulation, it is useful to measure national efficiency by anticipating the nature of changes in technological innovation. This section will do just that, by exploring the concepts of innovation, using innovation under the Acid Rain Program as a case study, and examining theoretical arguments over the role of market-based vs. command-and-control regulation for encouraging innovation.

Innovation

Innovation can be defined as "the deployment of a new way to perform a function[59]." This differs from the concepts of invention, which is the first development or creation of a new process or product, and diffusion, which is the widespread commercialization of the new development. Innovation rests between these two actions and involves not only the discovery of a new technology, but its availability on the market[60]. Innovation is the appropriate measure of development of new technology, providing more insight than either changes in invention or diffusion. Since the majority of patented inventions never make it to market, the potential of their development is never realized and can not have any impact on firm behavior, industrial processes, or the market. Products already achieving widespread diffusion are not an accurate measure of the impacts of regulation on technological productivity because such products have already impacted industry behavior and the market, and cannot be considered solely as a direct result of regulation. In the case of mercury emission reductions, it is commercially available new products that promise reductions in mercury in a new manner that constitute innovation.

There is another distinction between types of innovation that must be made. It is easiest to think of innovation in the reduction of mercury as having three potential forms: technological, process, and cultural/social. The first is the development of advanced end-of-pipe technology for mercury emission capture, such as advanced scrubbers or injection of a solvent. Alternatively, innovation can occur within the process, with a complete overhaul of the technology used in coal-fired plants so that the mercury by-product is a nonexistent problem. This might involve changing significant components of the plant so that the flue gas stream does not contain mercury. A third type of innovation could occur at the cultural level. Changes in societal views on power production or industry decisions to lessen dependence on coal would result in more alternative energy generating sources, alleviating the problem of mercury emission from coal-fired plants. Ultimately such cultural change will be necessary to completely reduce the levels of mercury and other hazardous air pollutants routinely emitted in the generation of energy. While one could argue that this ambitious goal should be the objective of the Clear Skies Initiative and Clean Air Act, it unfortunately is not a legislative charge given to the EPA and such legislation is primarily concerned with end-of-pipe technology improvements to reduce emissions. Certainly source polluters could opt to make process changes to reduce mercury pollution, but there is little incentive for this kind of radical innovation in the Clear Skies Initiative. Only the option for innovation waivers under Clean Air Act Section 111J would encourage this dramatic change, although they have been used "sparingly by the EPA, both because industry has been unsure of their application and because the agency has not encouraged their use," according to authors Ashford and Caldart[61]. The historically limited use of innovation waivers means that electric utility owners are unlikely to utilize the existing system or press for expansion of the innovation waiver program. As such, this thesis will focus on innovation as it relates to development of advanced mercury control technology, working within the assumption that emitters have little interest in utilizing incentives to innovate through other means.

Innovation is a means to evaluate efficiency of both a firm and a regulation. Efficiency can be viewed as either static or dynamic. Because most decisions and evaluations are made considering current existing and available technology, static efficiency is most often discussed, which does not account for continual innovative changes in technology. In contrast, dynamic efficiency is the ability of technology to change over time. It often occurs in response to environmental regulation since firms are given an incentive to reduce production costs through compliance to the regulation through a more cost effective technology. A basic definition of static efficiency and dynamic efficiency are provided by Ashford and Caldart as "whether a particular policy instrument can achieve environmental objectives using existing technology at minimum cost" and "the extent to which a particular policy instrument has the potential to induce technological change to reduce environmental and human risk," respectively[62]. As explained by academic Dallas Burtraw, "dynamic efficiency is achieved by providing firms with an incentive to innovate, because firms can expect to keep some or all of the gains from innovation through reduced abatement costs plus reduced payments for taxes or permits[63]." One of the major flaws of cost-benefit analysis is that it can only consider projected improvements in efficiency of current technology, and not those that might actually be realized over time and greatly improve both efficiency and cost savings. It is important to note that while incentives for innovation will typically result in dynamic efficiency, regulations with the sole objective to reach better [static] efficiency will not necessarily do so by innovation[64]. This leads us to the central question posed in this section: Does Clear Skies encourage innovation and how does that compare to the potential innovation that would occur under a more stringent command-and-control regulatory program?

To address whether Clear Skies will enhance innovation within industry, I examine innovation under the Acid Rain Program as a close case study. While sulfur dioxide and mercury are incompatible comparisons when discussing health risks and environmental threats, it is an appropriate case study when looking at firm behavior and also when evaluating the theoretical arguments about innovation under market-based regulations. Before delving into this case study, it is interesting to examine the most recent innovations for mercury capture, which suggest that technological innovation is both technologically and economically feasible, and likely to expand if given the incentive under the appropriate regulation.

Emerging Technologies

Anticipating the impacts on innovation of either command-and-control or cap and trade regulatory strategies is a difficult task, since regulation typically precedes technological innovation. Additionally, costs of implementing technologies tend to decrease after regulations are mandated, since the regulations provide motivation for innovation and incentives for development of more efficient technologies. Thus, the most successful environmental regulations in encouraging innovation will set strict levels on emissions, allowing industries to meet the standards through any technological means necessary.

As described by Northeast States for Coordinated Air Use Management (NESCAUM), there are two types of mercury end-of-pipe control technologies, those that specifically target capture of mercury pollutants, and those that target capture other pollutants but are successful in the unintentional reduction of mercury particulates as well. Aiding in the widespread reduction of mercury emissions is the potential for co-benefits or incidental benefits from technology designed to reduce emission of NOx and SO_2. Both prior legislation and the provisions in the Clear Skies Initiative for NOx and SO_2 will require that coal-fired plants install technology to collect and prevent release of those pollutants. The preferred methods of capture, including wet and dry scrubbers, baghouses, electrostatic precipitators, and selective catalytic reduction, will have the additional benefit of collecting a percentage of mercury emissions[65]. Coal-fired power plants already in operation with dry scrubbers and baghouses collect approximately 95% of mercury from bituminous coal and 74-86% of subbituminous coal unintentionally[66]. Therefore, the required cost of technology to specifically reduce mercury particles will be substantially less than accounted for by the EPA and OMB in their cost benefit analysis of MACT. Small additions to already successful technologies that reduce mercury emissions would be enough to satisfy a command-and-control regulation requiring 90% reduction in mercury emission.

There are a number of newly developed techniques for mercury capture, currently tested through industry partnerships with the US Department of Energy (DOE) or academic institutions. The National Energy Technology Laboratory, within the DOE's Office of Fossil Energy, is the largest source of funding for mercury technology pilot programs. The goals of the program are to evaluate new technology that would reduce mercury emissions from coal-fired power plants by 50-70% at a price 25% lower than current cost estimates, as well as reduce mercury emissions by 90% in 2010. While a number of innovative technologies are funded for testing, the basis of the program includes full-scale testing of two emerging technologies: enhances wet scrubbing and sorbent injection[67]. The success of these projects suggests that mercury capture is more feasible than previously thought by the EPA, suggesting that the caps set under Clear Skies are too lenient and would probably be feasible without substantial technology upgrades or innovation.

There are a number of potentially successful technologies for capturing mercury pollution as it leaves the power plant as flue gas. A brief summary of the leading technologies, as determined by successful DOE pilot programs, is provided below.

Activated Carbon Injection (ACI)

This technology includes the injection of dry powdered activated carbon in the stream of flue gas between the pre-heater and electrostatic precipitator or baghouse, at extremely high temperatures. Since no specific hardware is required and a process change or the existing control technology is not necessary, this is a relatively inexpensively option[68]. The DOE has funded full-scale tests of this technology in four US power plants. Results indicate that across a range of coal fuel types and types of existing controls, the efficiency of ACI can range between 60 to 90% reduction in mercury emissions[69]. The highest capture rate was achieved with use of a baghouse in place of electrostatic precipitation. Although requiring a higher capital cost, the use of a baghouse instead of electrostatic precipitation for mercury reduction has an expected payback period of only 3-4 years.

The success of ACI has been proven commercially from its widespread adoption by the municipal waste combustion industry, which has been regulated for mercury emissions for the past several years. There are some differences between the municipal waste and coal-fired power plants, in that the volume of flue gas is higher at power plants and the percentage of mercury particles in the stream is lower. However, many researchers believe that ACI in coal-fired boilers is only a question of technology transfer and will require little in the way of new research. The challenges with the technology are the disposal of activated carbon and its potential to become emitted with the flue gas.

Enhanced Wet Scrubbing

This process seeks to improve performance of mercury removal by the existing scrubber by oxidizing elemental mercury in the flue gas before it reaches the scrubber. There are a number of methods to promote oxidation, including injection of a chemical reagent or catalyst. In the two ongoing DOE full-scale tests of enhanced wet scrubbing, mercury reductions ranged between 50-80% reduced emissions[70]. Additional programs will help refine the chemical reaction procedure.

Selective Catalytic Reduction, SCR

Selective Catalytic Reduction is a common technology used to eliminate or reduce NOx from a flue gas stream. It involves adding a reducing agent that can be absorbed onto a catalyst and reacted with the NOx, converting it to nitrogen and water in the presence of oxygen. Recent research has suggested that SCR can provide the co-benefit of aiding in reduction of mercury emission. Results from a large-scale study of SCR in the Netherlands suggest that when combined with electrostatic precipitation (ESP) and flue gas desulphurization (FGD), SCR can yield a 90% reduction in mercury emissions, as compared with a 75% mercury reduction from ESP and FGD alone[71].

Especially important to remember that these three promising technologies were mainly developed in response to standards set for SO_2 and NOx, with later research leading to the discovery of their effectiveness for mercury capture. Until required to find alternatives for mercury capture under stringent regulatory standards, the industry is unlikely to innovate to its full potential. True reduction in mercury will come years after mandatory compliance through a regulatory standard. If that standard is not in place, what is feasible and available today may still be the baseline efficiency when cap and trade reaches its final phase in 2018. While the DOE programs to test new technology are helpful in determining what is feasible, widespread innovation and diffusion comes only from regulatory and market forces.

Acid Rain Case Study

Program Overview and Success

The Acid Rain Program was developed as part Title IV of the Clean Air Act Amendments of 1990, which allowed for the regulation of sulfur dioxide emissions to take place under a cap and trade emission credits trading system. Much like Clear Skies, the program involved two phases for the targeted reduction of sulfur dioxide. Phase I began in 1995 and required compliance only from 110 existing power plants with a generating capacity greater than 100 megawatts, most of them located in the Midwest[72]. Phase II went into effect in 2000 and included all coal and oil-fired power plants in the US with an output higher than 25 megawatts[73]. Allowances are distributed to power plants for free until 2025, with a small percentage of allowances, 2.8%, available for auction each year[74]. As under Clear Skies, industry firms are allowed to bank or save allowances for future use, as well as sell or trade with other emitters. The program has been declared a success for meeting environmental goals and reducing sulfur dioxide. By the end of phase I in 2000, emissions had been reduced approximately 33% from 1990 levels and there was 100% compliance from industry polluters[75].

Cost Savings

The most triumphed success of the Acid Rain trading program is not the environmental benefits realized through a reduction of sulfur dioxide, which undoubtedly would have also occurred under command-and-control regulation, but the achievement in reduction goals at a low cost to both the EPA and industry polluters. In "Ex Post Evaluation of Tradable Permits," MIT Professor Denny Ellerman compares the costs of compliance under a SO_2 tradable permits system with the costs of command-and-control, which is displayed in Figure 10.

Figure 10: Cost Comparison of MACT and Emissions Trading for Sulfur Dioxide

Table 1: Total Cost of Compliance with Title IV in 2010 (billion 1995 dollars)		
Cost Assumptions	Command-and-Control	Efficient Trading
1989 Prices and Technology	$2.67	$1.90
1995 Prices and Technology	$2.23	$1.51
1995 Prices and 2010 Technology	$1.82	$1.04
Source: Carlson et al. (2000). Table 2. p. 1313		

Source: Ellerman, A. Denny. "Ex Post Evaluation of Tradable Permits: The US SO_2 Cap-and-Trade Program." Massachusetts Institute of Technology, 2002.

There are a number of challenges that can be made to the validity of comparing compliance costs of tradable permits with command-and-control regulation. First are the nature of innovation and the likeliness of innovative technology that could follow regulatory decisions. The cost of command-and-control technology today is a measure of static efficiency and does not account for inevitable increased in efficiency that would be developed if mandated under more stringent regulation. Second, the costs of compliance do not include the probable additional costs of slower regulation under cap and trade emissions trading. When health benefits are realized after a 10-year phase compliance period, rather than mandated immediately, there is a substantial cost in healthcare and lost productivity from those affected by the pollutant. Lastly, a basic comparison of compliance costs does not address the intention behind the regulation, which is to protect against an environmental hazard. A quantitative comparison through a cost-benefit analysis leaves no room for discussion of whether cap and trade is an appropriate regulation when the pollutant might pose a differential risk or exposure and harm for different subsets of the population.

Since the Acid Rain permit trading program is a market-based regulation, the costs of compliance are dependent on changes in the market and firm behavior. Without perfect market conditions and rational reaction from firms to market changes, the full benefits of permit trading as a less costly alternative to command–and-control may not be realized. There is considerable research that firms making decisions on whether to innovate and sell permits or use them on emissions do not have the resources to make decisions and such internal knowledge would require high administrative costs of more personnel. Additionally, state and local politics can play a role in compliance decision making. As noted by Ellerman, "public utility commissions have adopted policies that encourage sub-optimal choices by individual utilities, such as to scrub local high-sulfur coal in order to protect in-state jobs[76]."

Incentives to Innovate

In framing the SO_2 permit system, Congress acknowledged the need to provide industry incentives for innovation. Therefore, 300,00 extra allowances were set aside as part of the Conservation and Renewable Energy Reserve, CRER, which would grant the extra permits to firms who showed increased efficiency through development of new technologies, including renewable energy sources. To qualify for one allowance, a firm must prove to the EPA an efficiency savings of 500 megawatt-hours. The expectation of Congress and the EPA was for firms to innovate to meet reduction goals and gain extra allowances. However, through April 2003, only 16% of all available bonus allowances had been distributed[77]. Of those bonus allowances distributed, approximately 75% were awarded for improvements in efficiency, while the other 25% were awarded to utilities that generated energy through renewable sources. The application period for CRER allowances expired in 1999, which means the Acid Rain's Conservation and Renewable Energy Reserve will remain with 252,500 unused allowances, worth approximately $37.9 million total on the market. Title IV contained an additional innovation incentive program titled "reduced utilization," which allocated allowances for firms showing better efficiency. Interestingly, the EPA did not receive a single application showing "reduced utilization" from the power utilities[78]. This behavior from the electric power industry in compliance with cap and trade shows that even the incentive of pollution credits did not entice industry to innovate.

Innovation under Acid Rain

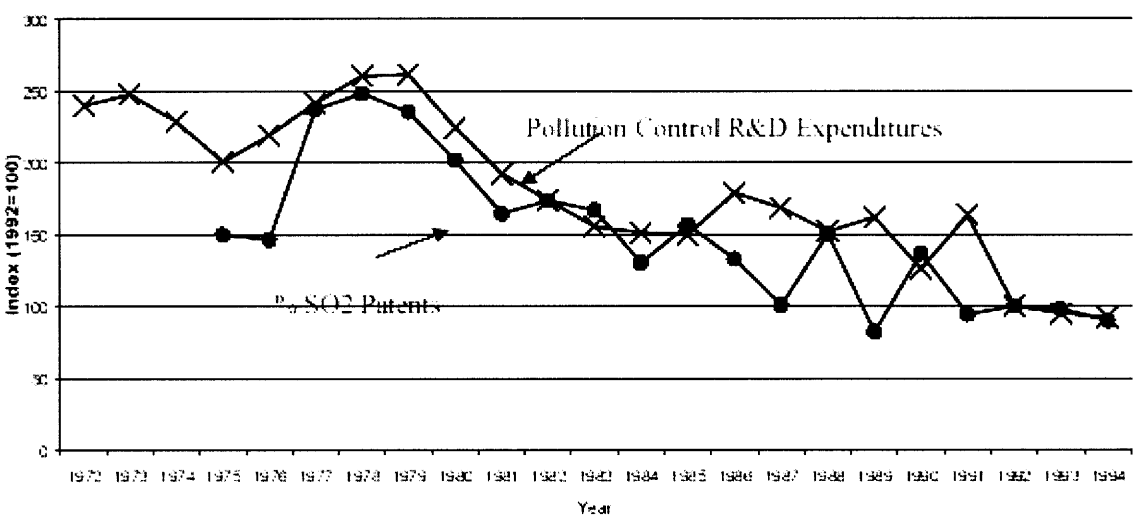
Congress and the EPA anticipated industry compliance with the cap on sulfur dioxide emissions from the advancement of scrubber technology. However, half as many scrubbers were used to meet emission reductions than anticipated by the EPA in phase I[79]. In reality, only about 28% of reductions in SO_2 emissions can be attributed to use of scrubbers or innovations in advanced scrubber technology. Instead, the majority of reduction goals, approximately 58%, were met by switching to coal with a lower concentration of sulfur[80]. Instead of creating incentives for pollution control innovation, the Acid Rain Program changed the operation of a number of coal supported industries in the US. This is demonstrated by evaluating the simultaneous decrease in patents for scrubbers and increase in availability of inexpensive low-sulfur coal.

Prior to the 1990 Clean Air Act Amendments, coal-fired power plants purchased coal from local suppliers to avoid the high cost of coal transport. Since most of the nation's plants are located in the Midwest, the high-sulfur coal found in the Appalachian Mountain region and Midwest mines was most frequently used. After the creation of the Acid Rain Program, which "unleashed competitive pressure" within the coal supply industry, transport and delivery costs dropped significantly[81]. Innovations with the rail industry allowed for cheaper delivery from western coal, with a lower sulfur concentration and lower rate of SO_2 emissions. Through the period from 1990 to 1994, the price of low-sulfur coal dropped by 9%, which resulted to a 28% increase in the sale of low-sulfur coal. During this same time, sales of high-sulfur coal dropped by 18%, despite a 6% reduction in price[82]. The tendency of industry to switch coal types instead on innovating through pollution capture technology is likely to repeat under a mercury emissions trading program, as low-sulfur coal contains approximately 30% less mercury than high-sulfur coal[83].

One of the explanations for the low rate of innovation under Acid Rain is the finding that "among incentive-based instruments, the incentives for innovation are greatest under auctioned emission permits, less with an emission tax, and least under free emission permits[84]." Since the Acid Rain program is still under the free allowance of emission permits, this could explain the reluctance to innovate. Burtraw also found that rather than development of specific pollution capture technologies, most of the innovation that took place under the first phase of Acid Rain involved organizational innovation. Figure 12 shows the number of patents filed for SO_2 control technology over the past thirty years. Although not always an indicator of innovation, patent data is representative of inventive activity and a metric used for measuring probably innovation. As displayed in the graph, patent activity is greatest around the years of government regulation, but decreased after legislation goes into effect. In the years immediately following passage of the

Clean Air Act Amendments and the start of cap and trade for SO_2, the number of patents filled for sulfur dioxide control technologies decreases significantly. In their assessment of patent trends, Taylor et al assert that "the flexibility provided by the 1990 Acid Rain regulations discouraged inventive activity in technologies[85]." Even though patent data suggests an increase in applications coinciding with the passage of the Clean Air Act Amendments, "there is little evidence that the new patents created before 1990 improved the ability of scrubber to more effectively control pollution[86]." One theory for the decrease in innovation was the ability of firms to meet lower emission standards without investing in new technologies. When caps are set at a feasible level that is already being met by industry leaders, there is little incentive for firms to design scrubbers that exceed emission standards.

Figure 11: Thirty-Year Trends in Patents and R&D for SO_2 Technology



Source: Popp, David. "Pollution Control Innovation and the Clean Air Act of 1990." Nov. 2001 http://www.nber.org/papers/w8593.pdf

There are several additional interesting findings from evaluating the Acid Rain trading program. One unpredicted result was a geographic shift in the emission of pollutants. In evaluating the SO_2 program, Burtraw et al discovered a "sizable geographical and temporal shift in emissions, in some states over 20% of emissions, due to trading and banking[87]."

Market-based vs. Command-and-Control Regulations and Innovation

The lack of success in the Acid Rain emissions trading program to encourage innovation suggests that a larger discussion is needed over the theoretical drivers of innovation. This leads to a question of whether either command-and-control or market-based environmental regulation can effectively encourage technological innovation and industry behavior. Historically, federal environmental legislation has had mixed results in creating incentives for technology innovation within firms. Only through the Supplementary Environmental Programs, where penalties were significant enough to encourage action, was industry willing to undertake plant and process modernization[88]. As innovation academic Daniel Cole states, "federal air pollution control efforts ignored three important variables, any one of which can determine the efficacy and efficiency of pollution control efforts: institutional knowledge and learning; technological constraints and innovations; and the changing costs and benefits of pollution control over time[89]." To understand the likely impacts of Clear Skies on innovation of mercury control technology, one must also compare the objectives and incentives within theoretical market-based and command-and-control regulation.

Proponents of market-based environmental regulation are quick to point out the lowered cost of regulatory compliance for both industry and the government in oversight[90]. However, these lower costs are largely dependent on 100% compliance from industry and efficient monitoring techniques from the oversight agency. If done inefficiently and with outdated technology, costs of measuring point-source emissions could possible exceed the costs of research and development for potential new technology that would reduce emissions and eliminate the need for monitoring in the first place.

With industrial innovation usually comes a first-mover advantage over competition that lags in innovation. Broadly speaking, with technological innovation firms are able to either differentiate their products to a new market or achieve a competitive advantage in a current market. Electric power plants, however, are somewhat immune from this first-mover advantage driver of innovation. Due to the nature of the commodity produced from power plants, the energy generation product itself can not be improved by technological innovation. From a consumer standpoint, environmental controls and the reduction of mercury will have no effect on the actual utility of electricity, but would perhaps only increase the costs of electricity to the consumer due to increased costs of production. Most electric utilities are under state contracts and while firms of other industries are in competition with each other, their output is unlikely change to despite variations in environmental controls that may result in different composition of their byproduct streams.

Acceptance of market-based regulation as an environmental regulatory strategy raises a number of potential questions over other environmental decisions. By allocating free allowances under Clear Skies, the EPA is essentially granting industry the right to pollute hazardous air pollutants. This leaves open the potential for future similar decisions, using Clear Skies as the precedent to justify giving industry the right to pollute the atmosphere. Additionally, treating pollution as a right suggests that both air and emissions are defined as property, to be controlled by the EPA, rather than a common good allowed to society as a whole. Alternatively, a strict adherence to command-and-control would suggest a different principle: the polluter pays principle. In this regulatory scenario, the air is treated as a common good and industry is punished for emitting pollutants. The polluter pays principle could be enacted for mandating industry compliance to lower levels of emissions, which would require technology investments, or through a pollution tax for emissions. This would set an equally strong yet greatly different precedent, holding industry responsible for future release of hazardous air pollutants.

Encouraging Innovation

The potential failure of the Clear Skies Initiative raises serious questions over the appropriateness of different regulatory strategies to efficiently regulate mercury emissions, while simultaneously encouraging technological innovation. A review of the Acid Rain Program as a case study suggests that market-based regulations will do little to encourage technological change. Additionally, strict adherence to command-and-control regulation also raises a number of questions over how industry will meet compliance to regulations and leaves questions of impacts on innovation unanswered.

MIT Professor John Deutch defines innovation as "the process by which technological change is accomplished." In outlining the measures government can take to encourage technological change, he defines the two steps of innovation as technology creation (i.e., invention) and technology deployment into society. Deutch believes deployment is by far the more difficult process, as it involves "(1) making an uncertain investment decision. (2) managing change in a production process, along with its work force, and (3) tailoring a new service or product to customer need." The uncertainty and risk involved with innovation adoption require government intervention in order to promote such innovation deployment through incentives. Deutch outlines the potential role of the government as a driving force for innovation through the following activities[91]:

- establishing patents
- setting and publishing standards
- creating tax incentives for R&D
- setting export controls on technology
- promoting education of scientists and engineers
- creating mechanisms for partnerships
- providing access to venture capital

In general, the federal government has become very skilled at invention and development of new technology. Through a number of national labs, research grants, and pilot programs, the government has developed a number of advanced air pollution control technologies. In 2006, the federal government will spend approximately $132 billion in total on R&D, with $8.5 billion allocated to the Department of Energy and $0.6 billion allocated to the Environmental Protection Agency[92]. Ensuring the strength of these budgetary allotments for research is the desire of Congressional members to please home constituencies. Government pilot projects and academic grants are popular political dollars within Congressional home districts. However, one area which needs more attention is the transfer of technology between government research and deployment in private industry. Even if technology is created (i.e., invented) with federal resources, what is the incentive for industry to adopt (i.e. commercially) such technology in plant processes? This requires more advances incentives for industry adoption and technology transfer.

In evaluating the role of government in encouraging innovation, Deutch looks to the US Synthetic Fuels Program as a representative case study. As he notes, "the primary lesson of the

SFC story is that the government should be very cautious in establishing large programs based on the assumption that current estimates will come to pass[93]." Suffering from a similar potential uncertainty as market-based regulations, government programs have potential for failure when they relay top heavily on predictions of markets and technological development. His final take-away message is that while initial government support of technology development is strong, also needed are indirect incentives such as tax credits, which could help demonstrate to industry that adoption of innovative technology is feasible, efficient, and economically desirable.

In their work on the effects of regulation on technological change, Ashford and Caldart define the three decisions that must be made by policymakers prior to implementation of successful regulation. Those decision criteria are "a) what technological response is desirable; b) which industrial sector will most likely innovate; and c) what kind of regulation will most likely elicit the desired response[94]." In the case of reducing mercury emissions, the EPA has jumped to decision c, in formulating a policy without first addressing the objectives of such policy on technological response and without considering likely responsive behavior from the electric power industry. The current strategy to promote cap and trade has been to defend the policy decision by using numbers based on past success of Acid Rain Program. However, what alternative policy could be made if the EPA instead had a forward thinking approach and first began with the objective to promote technological change in the industry that would decrease the problem of mercury emissions?

One of the regulatory strategies the EPA can use to encourage innovation is the granting of innovation waivers, which are allowed under Section 111J of the Clean Air Act. Innovation waivers are time extensions granted to firms trying to reach compliance by implementing technological change. This allows for the necessary trial and error research and development period. Innovation waivers however, have not been widely used by industry to date, mostly due to lack of encouragement on the part of the EPA[95]. However, their legal basis in the Clean Air Act makes incorporation of these waivers into Clear Skies relatively easy and practical.

Challenges to Innovation

Aside from the weaknesses in Clear Skies and market-based regulatory strategies, innovation is often a challenge under any environmental regulation. As noted by Carol Sanchez, "managers of environmentally regulated firms believe that it is harder to innovate because regulations often change unexpectedly and because regulators are unpredictable[96]." To create incentives for innovation, environmental regulations must be long-term and allow for flexibility. Michael Porter suggests that the most effective regulations for technological change are those that focus on process changes, rather than a pollution standard that would encourage a quick-fix solution[97]. In the case of the Acid Rain Program and the likely scenario under Clear Skies for mercury reduction, firms pursued the short-term strategy of coal switching, which allowed for immediate reduction in mercury emissions. This quick-fix behavior was encouraged under cap and trade because firms had a financial incentive to bank emission credits from early years in the program. With the predicted allowance schedule of mercury permits, this behavior is even more likely to occur, as the cost of permits increases each year.

Section 9: State Mercury Legislation

Under Clear Skies, states retain the authority to set their own more stringent standards for reducing mercury emissions. However, states are prohibited from preventing the sale, purchase, or trading of emission allowances. Therefore, in reality state laws can do little to interfere with Clear Skies cap and trade[98].

State governments largely oppose the federal Clear Skies regulations. Immediately after the specific regulation was announced in March 2005, thirteen states filed law suits claiming that the regulation should be halted and replaced by a more strict command and control strategy. This challenge of the federal regulation in the US Court of Appeals is led by Minnesota, Wisconsin, Illinois, Pennsylvania, Vermont, New Jersey, New York, Maine, New Hampshire, Connecticut, California, New Mexico, and Massachusetts, states mostly located in the Northeastern US and most vulnerable to mercury emission deposits. The opinions of the states' administrations are summarized by a comment made by Connecticut Attorney General Richard Blumenthal, who said, "This rule defies common sense and the law, and deserves a quick judicial demise. We are suing immediately to stop it because mercury is a proven killer and crippler, and the new rule gives power plants a free pass to spew this deadly neurotoxin into our air and water. The Bush administration has once again demonstrated that it puts corporate profits over human health and the environment. My office will work with other states to fight a federal flight of policy that threatens to sicken our citizens and despoil our environment[99]." As of May 2006, the law suit remains pending. However, a number of health organizations have now joined the suit in support of the states' position. Coming to the states' defense are Physicians for Social Responsibility, American Public Health Association, American Nurses Association, American Academy of Pediatrics, Sierra Club, Environmental Defense, and the National Wildlife Foundation[100].

It is the states' current and previous regulation of mercury that most clearly demonstrates that 90% reduction of mercury under MACT is both technologically and economically feasible. The following figure, generated from NESCAUM information, is a list of state regulations for coal-fired power plant mercury emissions.

Figure 12: State Regulatory Programs for Mercury Emissions

State	Regulation	Compliance Date
Connecticut	90% removal of mercury or limit of 0.6 lbs/TBtu	July 1, 2008
Massachusetts	Phase 1: 85% removal of mercury or limit of 0.0075 lbs/GWh	October 1, 2006
	Phase 2: 95% removal of mercury or limit of 0.0025 lbs/GWh	October 1, 2012
Wisconsin	40% reduction in mercury emissions	January 1, 2010
	80% reduction in mercury emissions	January 1, 2015
Iowa	83% mercury emission reduction	Current

Source: Information taken from: Amar, Praveen, Project Director. *Mercury Emissions From Coal-Fired Power Plants: The Case for Regulatory Action.* NESCAUM, Northeast States for Coordinated Air Use Management. October 2003.

Approximately 20 states are considering adopting a mercury reduction plan designed by the State and Territorial Air Pollution Program Administrator and Association or Local Air Pollution Control Officials[101]. This strategy is expected to help states regulate in the short term while lawsuits challenging Clear Skies are still pending. The new proposal has two different options for staging mercury reduction. The first plan has two phases, one requiring 80% emission reduction by 2008 and the second requiring 90-95% emission reduction by 2012. The second plan option requires emission reduction by 95% by 2008, while allowing plants extensions if they agree to install technology that will also capture SO_2 and NOx emissions. The plan appeals to industry leaders because of its built in flexibility. Until 2012, the plan would allow utilities to average emissions across all emitting plants in a state. After 2012, utilities would still be allowed to average emissions, this time within a single plant for multiple units[102].

Federal Preemption of State Legislation

The resistance of many states to implement Clear Skies raises questions over federal preemption of environmental legislation. As written, the Clean Air Act and Clear Skies do not preempt state law. However, states are not allowed to interfere with the cap and trade emissions credit program, and are left with few regulatory strategies that could co-exist to reduce mercury emissions while still supporting the federal cap and trade program. There are four categories of federal preemption that would result in a federal policy overruling state law. The first is express preemption, which is explicitly directed by Congress in the language of the act. The second is implied preemption, which is inferred by looking closely at the Congressional record and language. A third type is preemption by conflict, which grants the federal regulation supremacy when a state and federal law directly conflict and cannot be implemented simultaneously. The fourth type of preemption is known as frustration on purpose, which is a combination of implied and conflict preemption and usually determined by the federal courts. The Clear Skies Initiative effectively preempts state power through conflict preemption, since technology-based command-and-control policy using MACT standards is not compatible with the market-based cap and trade scheme.

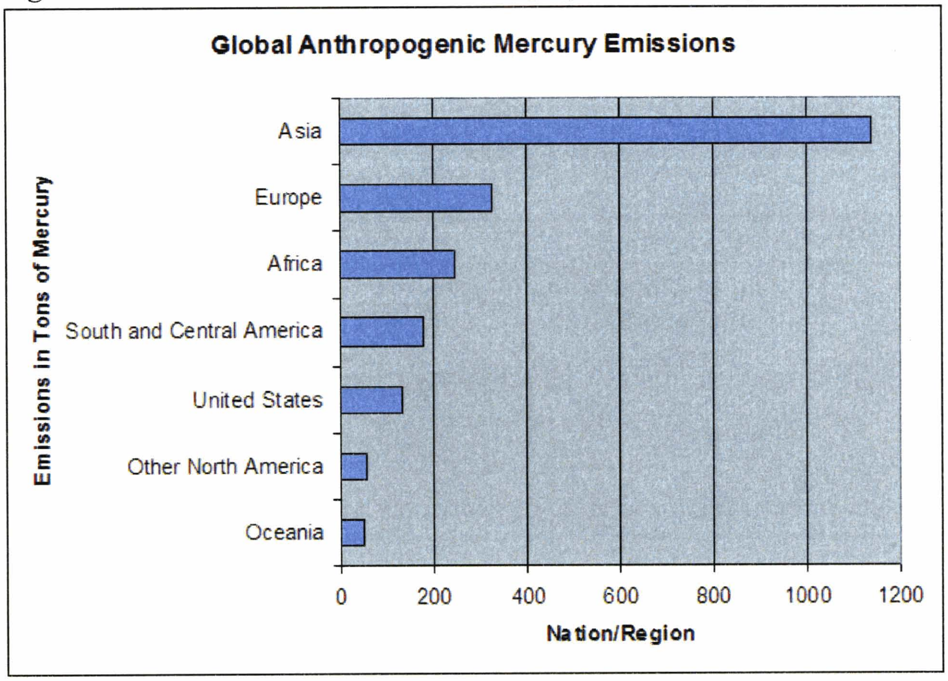
In recent years, states have seen a shift in the number of topic areas that are preempted by federal legislation. Since 1990, Congress has passed 117 laws that preempt and usurp power from the states[103]. This has led to conflicts between the federal government and the states. In addition to losing the power to legislate their own citizens, states are often left paying for implementation of federal legislation. It is estimated that unfunded federal mandates have cost states $75 billion in the past two years (2004-2006)[104]. It appears that the trend toward federal preemption is continuing. There has been recent discussion of a Congressional act that would declare federal preemption of state legislation for all environmental laws. The Supremacy Clause of the Constitution allows the federal government to preempt state laws in this manner. Therefore if the environmental preemption law is passed by Congress, states will be able to do little to challenge the Constitutionality of the move and will have no power to regulate around the Clear Skies Initiative.

Section 10: International Regulatory Strategies

Compounding the problem of controlling mercury pollution through regulations is that mercury can travel globally, and therefore requires global cooperation to decrease emissions. When mercury particles enter the air from flue gas, they can travel across the world before being deposited. This claim is supported scientifically by the increasing deposits of mercury found in Antarctica, which were discovered in 1998 and are frequently referred to as the "Mercury Sunrise" phenomenon. Mercury emissions from a range of global power plants enter the atmosphere and travel the globe as vapor. Each day the strong UV rays of the Antarctic sunrise spurs chemical reactions and results in the deposition of mercury in snow banks. Both Antarctica and the Artic Polar caps have seen an increase in mercury deposition in the past decade, even through they remain free of mercury pollution sources[105].

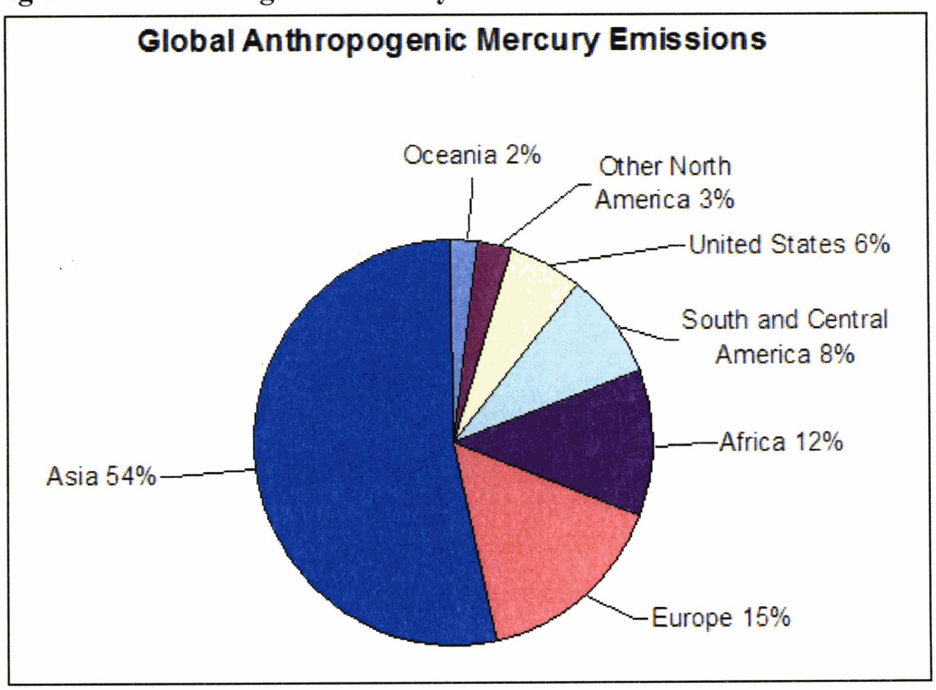
To examine the global context of current US attempts to regulate mercury emissions, it is important to consider the US as a mercury pollution emitter as well as receiver. The breakdown of global anthropogenic mercury emissions, attributed by nation and geographic region is show in Figures 13 and 14. These charts clearly show that the US emits a significant percentage of mercury, but is even more vulnerable by mercury pollution emitted in Asian countries. Global modeling has suggested that the US receives a considerable amount of mercury deposits originating in China and other Asian nations. Meanwhile, Canada and Europe bear the burden of US mercury deposits in their lakes and rivers. Thus the individual national regulatory strategies for reducing mercury emissions have a considerable effect on global neighbors and allies, adding to the political complexity of the mercury problem.

Figure 13: Global Emissions of Anthropogenic Mercury Emissions by Nation or Region



Source: Information used in graph from: Miller, Michael. "Mercury Resources Update." From the EPRI Conference on Addressing the Mercury Problem: Global Challenge, Local Impact. Washington, DC. June 15, 2004.

Figure 14: Percentage of Mercury Emissions Attributed to Nation or Region



Source: Information used in graph from: Miller, Michael. "Mercury Resources Update." From the EPRI Conference on Addressing the Mercury Problem: Global Challenge, Local Impact. Washington, DC. June 15, 2004.

International Strategies

Although mercury from anthropogenic sources has been recognized repeatedly as a global problem, there exists no legally binding international strategy for reduction of mercury emissions. With the increased awareness of heavy metals as a global environmental health problem during the 1990's, the dangerous health effects of mercury were brought into the spotlight. The 1990 International Conference on Mercury as a Global Pollutant was the first international conference held specifically to address international cooperation for reduction of mercury. The conference has since been held every two years and often serves to encourage further advancement of studies on mercury health and environmental impacts, as well as development of new regulatory strategies and advanced technologies to reduce mercury output.

A number of factors contribute to the delay of implementation of a legally binding international regulation for mercury. Most notable is the resistance from the United States. As argued by Noelle Selin before the Berlin Conference on the Human Dimensions of Global Environmental Change, resistance from the U.S. can be attributed to 1) the political philosophy of the Bush administration to resist involuntary international agreements and 2) the Administration's political and financial relationship with electric utilities, which make regulation of those industries political difficult[106].

National politics and principles are also to blame for the resistance of other nations to get behind a legally binding international regulation. Canada, for example, does not support an international binding regulation for mercury for fear that it might set a precedent for strict international regulation of other heavy metals. Since the Canadian economy is in part dependent on the mining of heavy metals such as cadmium and lead, future metals regulation would be a significant economic hindrance. Canada also highlights the financial overhead required of an international legally binding declaration, which would require a significant amount of funding dedicated to negotiation travel instead of directly funding a national-level plan to reduce mercury[107].

There are a number of global strategies to reduce mercury, most of which originate from the United Nations and European Union. The 2003 United Nations Heavy Metals Protocol targets mercury as one of three metal pollutants that must be returned to pre-1990 emission levels[108]. In 2002 the United Nations Environment Programme, UNEP, reported their global assessment of mercury. The UNEP Governing Council recommended several strategies aimed at reducing mercury pollution, including compliance to standards by all nations and technology transfer from developed nations to developing nations that need can not support in-house R&D for environmental innovation[109].

The Commission of European Communities was quick to respond, issuing a strategy to combat mercury. Their own study took a life-cycle approach to analyzing mercury and conducted an Extended Impact Assessment[110]. The EU pointed out that there is a "global pool" of mercury that continues to cause health effects as it "mobilized, deposited, and remobilized.[111]" In order to reduce mercury emissions, Europe recommends requiring emission controls for plants and grants an extension to new still developing member states. Mercury is treated as a "classical" air pollutant under Clean Air for Europe, CAFÉ, and is thus subject to traditional control strategies limiting emissions[112].

European Union

With a strong emphasis on environmental regulation, Europe is a global leader in anthropogenic mercury reduction. Although the global total of mercury emissions increased by 20% from 1990 to 2000, mercury emissions in the European Union fell by 60%[113]. Most of this progress was realized as the byproduct of regulatory controls of other air pollutants from coal-fired sources. Although the European Union has been active in regulating mercury products, there still exists no binding regulatory program for the reduction of mercury emissions from coal-fired power plants.

In 2005, the Commission of European Communities sent a proposal to the European Parliament addressing actions leading to the reduction of mercury emissions. Among the proposed actions was support of the United Nations Global Mercury Programme and Heavy Metals Protocol, as well as funding a pilot program to help reduce mercury emissions in developing nations such as China, India, and Russia. To assist in this global effort, the EU plans to be a leader in technology transfer, aiding developing nations in upgrading coal-burning technologies.

In March 2006, the European Parliament accepted the suggestions for mercury reduction made in the report from the Commission of European Communities. This acknowledgement of mercury emissions as a significant problem is an important step in regulating mercury in the EU. While the Parliament's affirmation of all recommended policies of the EC is not binding, it is likely to be respected and therefore passed. To accomplish the mercury emission goal, the European Parliament stressed their preference for BAT, best achievable technology, which is the EU counterpart to the MACT program in the US.

Canada

Although the nation is similar to the US in their reluctance to enter into an internationally legally binding agreement to reduce mercury, Canada has a strict national regulatory strategy to combat mercury from anthropogenic sources. As the recipient of much of the mercury emissions from the US mid-west, Canada has a significant stake in regional partnerships for the reduction of mercury in North America.

Canada is responsible for 8 tones of the 2,200 annual tones of global mercury emissions released into the air each year. This is significantly lower than the 106 annual tones released by sources in the US. Due to regional weather patterns and the ability of mercury to travel in the atmosphere for weeks of years before returning to earth, eastern Canada is the recipient for much of the mercury emission from the concentration of electric utility plants in the American mid-west. Overall an average of 10% of mercury deposits in Canada can be attributed to US sources, while that number increases to 38% in the Canadian Great Lakes region.

In June 2005, the Canadian Council of Ministries of the Environment proposed updated regulations for reducing anthropogenic mercury in the nation, while also criticizing the US cap and trade policy under Clear Skies for its relaxed approach to mercury regulation and therefore potentially detrimental effect on Canadian health and safety. The national Canadian strategy for reducing mercury emissions relies on command-and-control regulation as well as a national emissions cap. New coal-fired plants must meet mercury reduction under BACT, best available control technologies, effective immediately. This results in a 75%-85% reduction in mercury emissions, depending on the type of coal used at the plant. Existing plants will face a cap on mercury emissions in 2010, requiring 65% capture from coal, which is essentially a 52%-58% reduction in mercury emissions from 2004 levels. In 2018, the cap will increase to require an 80% capture of mercury from all burned coal[114]. An additional feature of the Canadian system is that while a national cap is in place, provinces are also capped at specific levels. This regionalization of regulations will ensure that each region sees a decrease in mercury emissions, preventing the potential for differential risk and the emergence of hot-spots that could occur under cap and trade in the United States.

Developing Nations

Given the potential for global transport of mercury emissions, coal-fired power plants that go unregulated in developing nations are a serious concern. China, with its 2,000 and growing number of coal-fired power plants, is the largest global mercury polluter. Its 600 tons of annual emissions makes up ¼ of the total anthropogenic mercury emissions in the world[115]. Unfortunately for China, like most developing nations, there is little regulatory structure protecting citizens from air pollution. Instead, national pressure is placed on increasing development and industrialization, often with serious health consequences. Water tests from Chinese rivers indicate that people consuming fish from such rivers at ingesting mercury at a level 18 times what is allowed in the US[116]. The current regulatory structure allowed Chinese plants to emit mercury or pay an essentially low fee of $500,000 to the government[117]. While this encourages the growth of power plants, it is troubling for other nations receiving deposits of China's mercury emissions. Studies from water sampling in the US have indicated that deposits in New England have a composition that matches emissions from Chinese plants[118].

In addition to the lax regulatory structure for air pollution and mercury in China, dramatic growth of coal-fired plants is anticipated in the region. By 2020, the electrical capacity of China is expected to double, with almost 75% of this power being produced from coal-fired plants. The coal demand is already rising, with a 12% increase in coal consumption over the past year[119].

Future Role of Global Regulation

Global environmental regulation is often hindered by a difference in national policy preference for means to control a pollutant. The US typically prefers a back-end approach to regulation, with policies focused on end-of-pipe control technology and a legal structure that allows for tort suits after harm is committed. The European perspective is much different, and often favors a front-end approach, with more policy influencing process design and requirements for pre-emission permits. While the US has recently favored market-based environmental regulations, Europe has remained true to their standard of Best Available Technology. The European system is much more welcoming of the Precautionary Principle, which advocates that the absence of evidence of harm does not indicate absence of harm, and some restrictions on potential harm are justified even before conclusive evidence is available. The major theoretical differences in approaching regulatory partnerships is made even more difficult by the presence of developing nations, many of which have no environmental regulation for air pollutants and are less likely to desire such controls.

As mercury is a global pollutant, it is important to reach international cooperation to reduce emissions from the main emitter, coal-fired power plants. US reluctance to enter into other international environmental partnerships, such as Kyoto, as well as diminishing relations with other nations due to unrelated international conflicts, has decreased the likelihood of a global initiative with US participation. More important is Canada's and the EU's rejection of the Clear Skies Initiative with cap and trade as the US basis for regulation of mercury. Unfortunately implementation of Clear Skies appears likely to worsen rather than strengthen US-International relations on the matter of environmental regulation.

Section 11: Alternative Mercury Regulatory Strategies

With the Clear Skies Initiative hotly contested in the press, challenged legally in the US court system, and still not implemented by industry, the timing is right for a second look at the regulatory policy to reduce mercury emissions. In addition to challenging the legality of the EPA's cap and trade approach to mercury regulation, states are aggressively fighting for the authority to regulate mercury emissions within their own borders. With so many critics and an increasing amount of evidence that raises serious questions about the safety of mercury cap and trade, the EPA should begin addressing alternative approaches to achieve a reduction in mercury emissions. This consideration of alternatives, although usually mandated by Congress and the OMB, was neglected when Clear Skies was first proposed. The exploration of alternatives should start with plans already developed by state and local governments. Additionally, the EPA should return to the language of Section 112 of the Clean Air Act and the mercury reduction proposals under Clinton's Administration to identify a technology-based MACT mercury policy. Lastly, if the EPA remains set on implementing a cap and trade policy for reduction of mercury emissions, the agency should consider implementation of previously omitted protective features of cap and trade, such as geographic or temporal restrictions on trading, or enhancement of the EPA's policy of granting innovation waivers for those firms wishing to upgrade to cleaner technology. With mercury emissions becoming an increasingly known health hazard, the EPA has the ability to gain public favor with implementation of strict technology-based standards, overlooking cost-benefit analysis and instead arguing for the protection of human health and safety.

MACT-based Regulation

The Clean Air Act Amendments clearly demonstrate the intentions of Congress in how the EPA should regulate Hazardous Air Pollutants. Section 112 not only lists mercury components as a risk and mandates their regulation, but very specifically details how mercury is to be regulated by holding all plants accountable to the same levels of output achieved by the top 12% of performers with the lowest mercury emissions. Had Congress desired the EPA to consider market-based alternatives, the Maximum Achievable Control Technology standard would not have been so clearly specified and defined. The EPA's decision to instead reduce mercury under a cap and trade approach came out of a cost-benefit analysis, one that was not directly required by Congress in the Clean Air Act. Instead of requiring such a cost-based evaluation of alternatives, Congress used the standard of setting regulations on par with the top 12% of performers to ensure that mercury reduction at this level was in fact economically and technologically feasible, as it was already being done by 12% of the industry. If some current power generators can not comply, new power entities can be built or existing efficient ones expanded to replace them.

As mentioned early, implementation of standards based on MACT would result in immediate reductions in mercury emissions up to 90%. This is a considerably greater reduction of mercury than would take place under Clear Skies, which reduces mercury by 69% by 2018. In favoring their cap and trade scheme, the EPA neglected health information suggesting the grave danger of methylmercury exposure, instead conducting the cost-benefit analysis that led to the cap and trade decision without any inclusion of medical costs or costs of lost productivity due to methylmercury caused disabilities. What was also not considered was advanced pollution control technology, with greater potential to further reduce mercury emissions and at a fraction of the current cost. Ironically, it is implementation of a strict technology-based standard that would initiate rapid diffusion of these new technologies, while also encouraging further innovation. Without a regulation forcing innovation of new technology, there is little promise for industry development or installation of mercury reduction controls.

State-based Regulation

States have a long history of regulating environmental pollution within their borders, usually with much success. However, this ability has been challenged by recent trends toward federal preemption of state laws. As discussed in Section 9, a number of states are challenging the Clear Skies Act and instead in favor of more strict command-and-control regulations.

Since one of the main dangers in allowing Clear Skies to pass is the creation of hot-spots and differing amounts of mercury exposure on regional populations, it makes sense to allow states the power to control mercury emissions within their borders. With the potential for national permit trading under Clear Skies, it would be possible for a state to only see an increase in mercury emissions, while the benefits are passed on to those in other states. Most states are calling for more stringent standards than those currently proposed under Clear Skies. A leader in mercury reduction, Massachusetts would call for an 85% reduction in mercury emissions starting in fall 2006. The economic and technological feasibility for this standard is based on the current performance of the top 12% of lowest mercury emitters in the industry, the same standard that would be applied federally under MACT. The benefit of state-based regulation is that states have more detailed information about their own pollution production from local industries. States can use such knowledge to create regulatory policy that would eliminate the potential for areas of high mercury deposition. In states with large concentrations of power plants, such as those in the Ohio River Valley, this might mean technology-forcing. However, for states in the Pacific Northwest with relatively little mercury emissions, a statewide cap and trade program might suffice.

One of the main ways states are fighting the federal preemption of mercury legislation and challenging Clear Skies is through a grassroots effort and the support of many newly formed mercury advocacy groups. In Massachusetts, the New England Zero Mercury campaign and Mercury Policy Project are major players in disseminating public information on the harms of methylmercury. Their cause has been supported by national citizen groups such as the National Resources Defense Council and Clean Water Action Group. The success of these groups in increasing the numbers of citizens concerned about methylmercury exposure is an encouraging sign for those fighting for state autonomy in regulating mercury emissions.

Limited Cap and Trade Regulation

With the Administration's insistence on regulating mercury through a market-based cap and trade approach, it is perhaps more realistic to discuss modifications to the cap and trade program, rather than calling for an overhaul of the system and implementation of MACT standards. One aspect of Clear Skies that might be changed is the permit allocation process. Rather than free allowances in the first year of the program, a fee-based credit system could better encourage firms to innovate rather than pay to pollute. Additionally, innovation waivers could be granted as before under the Acid Rain Program. Yet to increase the success of this option, further incentives perhaps in the form of funding or time extensions should be granted. Further, the EPA could evaluate the possibility of a pollution offset system of cap and trade, which would regionally define polluters and only allow for trading within a polluter's own zone.

A further modification to cap and trade has recently been studied and advocated by Woodrow Wilson School Professor Denise Mauzerall. Through modeling of NOx emissions and their movement in the atmosphere before depositing, Mauzerall has been able to conclude that it is possible to predict the originating source for air pollutants. This leads to the potential for implementation of a variable charging system, increasing the fee for those polluters creating the most damage and leading to the creation of hot-spots. This difference in damage caused by emissions might be due to weather patterns, presence of a downwind area of high population density, or existence of reacting organisms that make pollution effects more harmful. In the case of mercury, location near large bodies of water such as the Great Lakes increases the harmfulness of nearby mercury emissions. Based on such modeling data, Mauzerall suggests that permit prices be adjusted accordingly for different polluters based on the probable damage caused by their emissions. She argues that such a scheme would "attach externality-correcting prices to emissions… Charging emitters fees that are commensurate with the damage caused by their…emissions would create an incentive for emitters to reduce emissions at times and in locations where they cause the largest damage[120]."

The Precautionary Principle

Section 112 of the Clear Air Act mandates technology-based MACT standards be used to ensure for economic and technological feasibility. However, the language of Section 112 also allows for more stringent regulations if the hazard demands such protection. Section 112(d)4 allows the Administrator to consider the determined threshold for any air pollution when regulating emissions. Currently, the reference dose for methylmercury is set at 0.1 micrograms per kilogram of body weight per day. By EPA policy, this is set as $1/10^{th}$ of the approximated threshold. However, given recent data that 1 in 8 women in the US has elevated levels of mercury in her blood, resulting in 630,000 babies born each year with disabilities linked to methylmercury exposure, this reference dose should reexamined. It is becoming clearer that women in the US are exposed to mercury emissions beyond those values recommended by the EPA and FDA, suggesting that regulations are not adequately controlling exposure through emissions. Additionally, new epidemiological and toxicology studies have been released in recent years, suggesting new disabilities and disorders that might be caused by exposure. This would support a reevaluation of the methylmercury threshold, last evaluated in 2000 by the National Research Council. If such a threshold for methylmercury exposure was lowered, the EPA would be justified under Section 112 to greatly reduce mercury emissions, regardless of the current performance of the industry's top 12% of performers in reducing emissions.

The recent and increasing health studies linking methylmercury to a number of neurological and behavioral disorders is reason to argue for implementation of the precautionary principle. This principle, upheld by the Supreme Courts although not found in US law, says that one should regulate if a harm is suspected, even in the absence of conclusive evidence. It is based on the principle of "first do no harm," and protects against false-negatives, or harms that go unregulated simply because the science did not exist to conclusively prove their existence. The Precautionary Principle was adopted at the UN Conference on Environment and Development in 1992 as an appropriate means to regulate environmental harms. Although rarely used in the US, it is more popular in European law and is used to regulate against a number of hazards in the EU. While some critics of the precautionary principle warn about its costly implications to industry, such a stringent regulation would not only protect against mercury exposure, but force innovation within industry, resulting in advanced and inexpensive mercury control technology or process changes.

Section 12: Conclusions

The Bush Administration's proposed Clear Skies Initiative is troubling for a number of reasons. Foremost, the decision to regulate through a market-based regime such as cap and trade is a direct violation of the Clean Air Act Section 112, which requires a control based on technology that matches the current best 12% of industrial mercury emitters. If the Administration implemented this required approach, mercury reductions would reach 90% in the coming years. Instead, cap and trade will slowly reduce mercury emissions over a twenty year period, culminating in a 69% reduction in mercury emissions. Legal arguments aside, it is this difference in mercury emissions that might be allowable over the next twenty years that poses the greatest concern to critics of Clear Skies, which are the immense health effects linked to methylmercury exposure.

Neurological damage, cardiac damage, physical disabilities, autism, and behavioral disorders have all been linked to in utero exposure to methylmercury. Most troubling is the statistic that 1 in 8 women in the US already has elevated levels of mercury in her blood, with women consuming a high percentage fish-based diet having mercury levels exceeding the EPA reference does by ten times. As there are 45 US states currently under mercury fish advisories, avoiding a dietary intake of mercury can be difficult to achieve. These developing health effects make a strong case for standards that would satisfy MACT or provide stricter regulation.

The flaws of the Clear Skies Act regulation of mercury can be broken down into four categories: emergence of hot-spots, health effects that have gone unaccounted, stunting technological innovation, and attributing to the global mercury problem. The expected success of Clear Skies has been entirely based on the Acid Rain Program of the 1990's, which reduced sulfur dioxide emissions in the US. However, the properties of mercury and risks of methylmercury make the pollutant a unique threat. A simple overview of the properties of mercury demonstrates that regional hot-spots might indeed be possible under Clear Skies, with dangerous health consequences. Since the emergence of hot-spots has been overlooked by the EPA in drafting Clear Skies, the health impacts of the regulation were erroneously omitted, leading to a skewed cost-benefit analysis. Several academic studies have determined that when the health effects of increased mercury exposure under Clear Skies are included in a cost-benefit analysis, the costs of the regulation are immense and even exceed those of a technology-based control regulation.

Also overlooked in the discussion of Clear Skies is the potential impact of the regulation on technological innovation in the electric power industry. Data from the Acid Rain case study suggests that in the face of cap and trade, industrial firms are most likely to switch coal types or buy emission permits, rather than invest in innovation and control technology, as would be required under MACT. While this behavior may achieve some mercury reduction in the short-term, it inhibits innovation within industry for long-term changes in power plant technology, which will ultimately be needed to alleviate problems of air pollution.

Lastly, the Clear Skies Act raises significant questions over the intentions of the US to participate in an international partnership for the reduction of mercury emissions. Strongly opposed by both Canada and Europe, the US plan will likely hinder future environmental partnerships and make consensus on future mercury reduction programs more challenging. Unfortunately national partisan politics is resulting in an international consequence of lessen the global community's ability to control mercury emissions from coal-fired power plants.

This paper has worked through the arguments against Clear Skies, relying on legal challenges, medical studies, academic studies, comparisons with the Acid Rain Program, and global regulatory comparisons, in order to demonstrate the far-reaching implications of the Act. While global relations, impacts on innovation, and economics are all important factors, the most important factor in mercury regulation remains protection of human health and safety. It is in failing to achieve this goal that Clear Skies has the most potential for failure and irreversible harm. To protect the nation's citizens as written in the statutory mandate given to the EPA, a more stringent regulation based not on markets, but on technology, is necessary. Whether that legislation takes the form of enhanced cap and trade with innovation incentives, strict technology-forcing legislation, or more control handed over to the states, an alternative to the proposed Clear Skies Act will better address the threat of mercury emissions and exposure.

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