The Clear Skies Act

Technical Support Package

September 2002

EPA United States Environmental Protection Agency

Introduction

- On February 14, 2002, President Bush proposed the Clear Skies Initiative, a mandatory program for the control of sulfur dioxide (SO_2), nitrogen oxides (NOx) and mercury (Hg) from the electricity generation sector.
- On July 26, 2002, Chairman Billy Tauzin and Chairman Joe Barton introduced the Clear Skies Act in the U.S. House of Representatives (H.R.5266), and on July 29, 2002 Senator Bob Smith introduced the legislation in the Senate (S.2815) by request of the Administration.
- Extensive information on Clear Skies is currently available on EPA's website at www.epa.gov/clearskies. This package is designed to provide additional technical support to accompany the newly introduced legislation.

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Notes on this Analysis

- **EPA used a number of different analytical tools to prepare this analysis. The projections are EPA's estimates; modeling by other Agencies, such as DOE's Energy Information Administration (EIA), would likely show different impacts.**
  - The economic impacts, as well as the impacts on generation and emissions, were developed using the Integrated Planning Model (IPM®).
  - Air quality impacts were projected using:
    - (1) Regional Modeling System for Aerosols and Deposition (REMSAD) and,
    - (2) Comprehensive Air Quality Model with Extensions (CAMx).
  - Several additional models were used for the economic and benefit analysis, as described in section G.

- **Many of the results presented in this analysis are compared to a Base Case:**
  - The EPA 2000 Base Case in IPM includes Title IV, the NOx SIP Call, and state-specific caps in Connecticut, Missouri and Texas, all finalized before March 2001. The Base Case does not include any actions finalized after this date.
  - The REMSAD Base Case includes the rulemakings in the EPA 2000 Base Case, as well as the Tier II and Heavy Duty Diesel rules.

Section A:

Program Elements in the Clear Skies Act

Caps and Timing for the Electric Power Sector under the Clear Skies Act

2004: The NOx SIP call (summertime NOx cap in 19 Eastern States + D.C.)

2004

2008: Clear Skies NOx Phase I (2.1 million ton annual cap assigned to two Zones with trading programs)

2008

2010: Clear Skies Hg Phase I (26 ton annual cap with a national trading program)

2010: SO_2 Phase I (4.5 million ton annual cap with a national trading program)

2012

2018: Clear Skies NOx Phase II (1.7 million ton annual cap assigned to two Zones with trading programs)

2016

2018: Clear Skies Hg Phase II (15 ton annual cap with a national trading program)

2018: Clear Skies SO_2 Phase II (3.0 million ton annual cap with a national trading program)

2020

Affected Sources

Definition of Affected Units:

- For SO_2 and NOx, the program will cover all fossil fuel-fired boilers and turbines serving an electric generator unit with a nameplate capacity greater than 25 MW and producing electricity for sale, except cogeneration units that produce for sale less than 1/3 of the potential electrical output of the generator that they serve.
- For mercury, the program will cover all *coal-fired* units serving an electric generator with a nameplate capacity greater than 25 MW; the same exclusion for cogenerators applies as for NOx and SO_2 .
- For new units, there would not be a generator size cut-off, except for new gas-fired units under 25 MW. New units would have the same cogeneration exception as existing units.

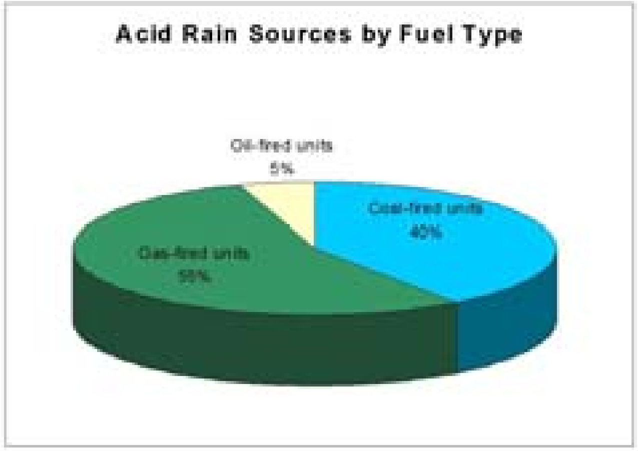
Factors Considered in Defining Coverage:

- Since 1990, there have been dramatic changes in the electric power industry associated with the emergence of competitive markets for electricity generation.
  - Most new generation comes from non-utility generators.
  - Many existing “utility” plants are being purchased by Independent Power Producers (IPPs) and operate as non-utility wholesale power suppliers.
  - Applicability of the program should recognize the emergence of competitive markets.
- The need for emissions reductions from the electricity generating sector was balanced with the desire to not discourage combined heat and power (CHP).
- The program includes units generating significant amounts of electricity that compete in the electricity generation market.

Affected Sources

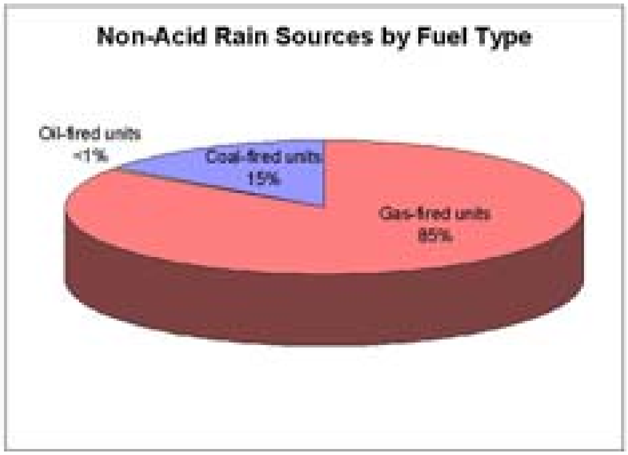
- Sources covered under the Clear Skies Act would include the 2,792 Acid Rain Program electric generating units.
- As many as 400 additional electric generating units, currently not in the Acid Rain Program, may be covered by the Clear Skies Act.
  - This number is based on units in the IPM analysis, which includes all electric generating units with firm sales contracts to the electric grid
  - This number likely over-estimates the number of units, since cogeneration units that sell less than one-third of their generation are excluded.

Gas-fired sources represent the largest percentage of Acid Rain units. In 2000, Acid Rain sources emitted about 11.2 million tons of SO_2 and 5.11 million tons of NOx.



Source: EPA 2000 Scorecard

The majority of non-Acid Rain units are gas-fired. In 2000, these non-Acid Rain sources emitted about 90,000 tons of SO_2 and 160,000 tons of NOx.



Source: NEEDS 2000 database

The Clear Skies Sulfur Dioxide (SO_2) Program

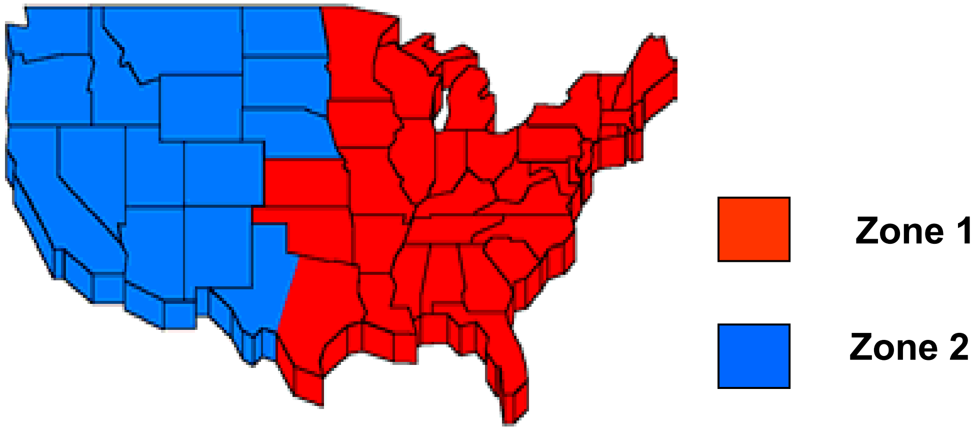
- **Under Title IV of the CAA, SO_2 emissions from the electric power sector are reduced about 50% from a 1980 emissions level of 17.5 million tons to 8.95 million tons in 2010.**
- **The Clear Skies Act establishes a new 4.5 million ton SO_2 cap in 2010 and then lowers the cap to 3.0 million tons in 2018.**
  - Clear Skies maintains the annual, national trading program established under Title IV.
  - Existing SO_2 allowances dated 2010 and later removed from accounts and replaced with a proportionately smaller amount of Clear Skies allowances.
  - SO_2 allowance allocations gradually replaced by auction over 52 years.
  - The Western Regional Air Partnership's (WRAP) 2018 SO_2 emissions milestone for power generators in 9 States would be honored through a backstop cap-and-trade program.

The Clear Skies SO_2 Program

- **Why a national program?**
  - **The human health and environmental effects to which SO_2 emissions contribute are of national concern. Emissions of SO_2:**
    - Contribute to fine particulate ($PM_{2.5}$), which in aggregate is associated with premature mortality, chronic bronchitis, respiratory and cardiovascular related hospital admissions, and asthma attacks.
    - Cause $PM_{2.5}$ NAAQS non-attainment, regional haze, and acid rain.
  - **Atmospheric transport of emissions can pose problems in neighboring States.**
  - **Most of the plants that would be subject to the Clear Skies Act are currently participants in the national Acid Rain SO_2 Program.**
    - Building off the existing SO_2 trading program minimizes disruption of the existing allowance market and ensures lower costs for power companies and customers.
    - Current banked allowances would retain their value and sources would continue to have an incentive to reduce their emissions early.

The Clear Skies Nitrogen Oxides (NOx) Program

- **The Clear Skies Act has two trading zones for NOx.**



NOx Caps Under The Clear Skies Initiative									
	2000 Emissions			2008 Caps			2018 Caps		
	Total	Zone 1	Zone 2	Total	Zone 1	Zone 2	Total	Zone 1	Zone 2
Caps (effective emissions rate)	**5.1 million tons** **(0.40 lb/mmBtu)**	4.35 million tons (0.41 lb/mmbtu)	750,000 tons (0.33 lb/mmBtu)	**2.1 million tons** **(0.16 lb/mmBtu)**	1.582 million tons (0.15 lb/mmBtu)	538,000 tons (0.24 lb/mmBtu)	**1.7 million tons** **(0.13 lb/mmBtu)**	1.162 million tons (0.11 lb/mmBtu)	538,000 tons (0.24 lb/mmBtu)

Note: Values for 2000 represent actual emission levels, rather than the caps.

- Significant NOx reductions are required in the East to protect human health and address serious environmental issues. Less stringent reductions are required in the West, and are primarily aimed at maintaining good visibility. Therefore, the Clear Skies Act creates two trading zones. There would be no trading between the two zones to ensure that the different air quality goals can be met.

The Clear Skies NOx Program

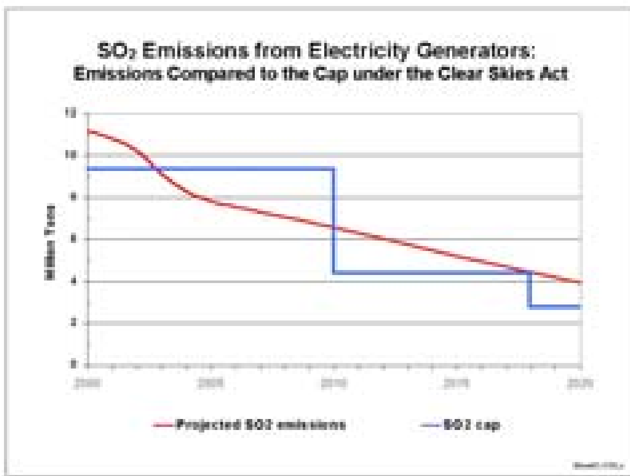
- **The Zone boundaries are established based on the nature, magnitude, and source of environmental concerns.**
- **All the States in Zone 1 either have ozone/$PM_{2.5}$ non-attainment concerns or contain sources that contribute to other States' ozone/ $PM_{2.5}$ nonattainment.**
- **Zone 2 includes:**
  - **States participating in the WRAP process:** Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming.
  - **Nebraska:** Nebraska does not appear to contribute to ozone or $PM_{2.5}$ non-attainment areas.
  - **The Western portion of Texas:** Texas was divided between Zone 1 and Zone 2 to reflect the State's Air Quality regulations and Electricity Industry Restructuring Legislation.
- **As with SO_2, during the first phase the EPA Administrator will review new scientific, technology, and cost information; if necessary, EPA can recommend that Congress adjust the Phase II NOx cap.**

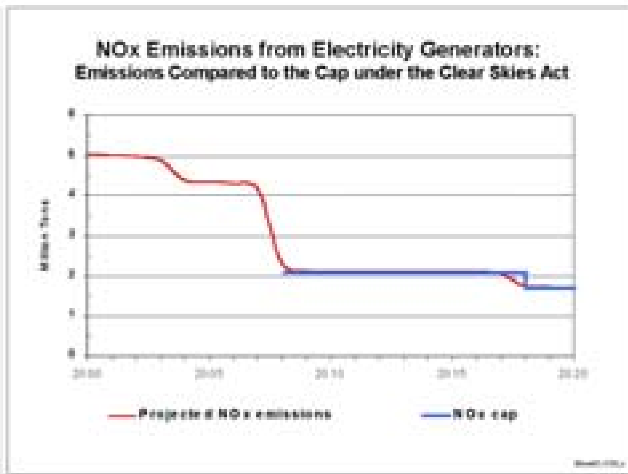
The Clear Skies Mercury Program

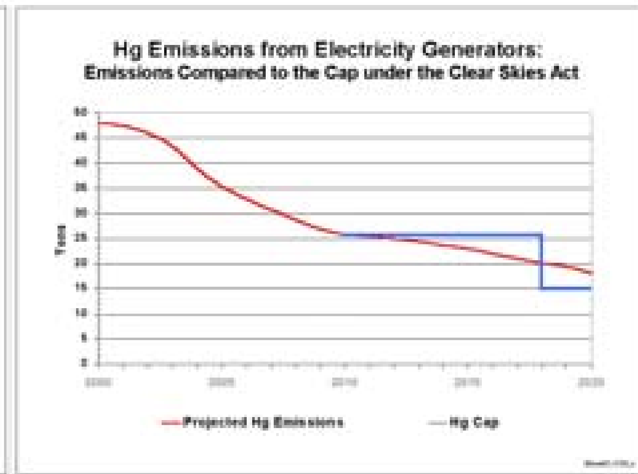
- **Mercury deposition is a nationwide issue:**
  - Currently 42 States have fish advisories.
  - The emissions reductions may allow States to redesignate local water bodies as safe.
- **Power generation is the largest remaining man-made source of mercury emissions in the U.S. (approximately 37% of total).**
  - In 1999, coal-fired power generators emitted 48 tons of mercury. The Clear Skies Act will cut mercury emissions from coal-fired power generators by 69% when fully implemented.
- **The Clear Skies Act establishes a national, annual cap of 26 tons in 2010, and then lowers the cap to 15 tons in 2018.**
  - Under Clear Skies, the primary reductions in mercury emissions will be in the ionic form, the form of mercury that is prone to deposit close to its source.
  - During the first phase, the EPA Administrator will review new scientific, technology, and cost information; if necessary, EPA can recommend that Congress adjust the Phase II mercury target.
  - As is the case currently, States can require facility-specific reductions to address local concerns.

Projected Emissions from Electric Generating Units

- The Clear Skies Act will result in significant over-compliance in the early years, particularly for SO_2, because sources are allowed to bank excess emissions reductions and use them later. The use of these banked allowances for compliance in the later years of the program (e.g., 2020) results in SO_2 and mercury emissions initially above the second phase cap, gradually declining to the cap level.

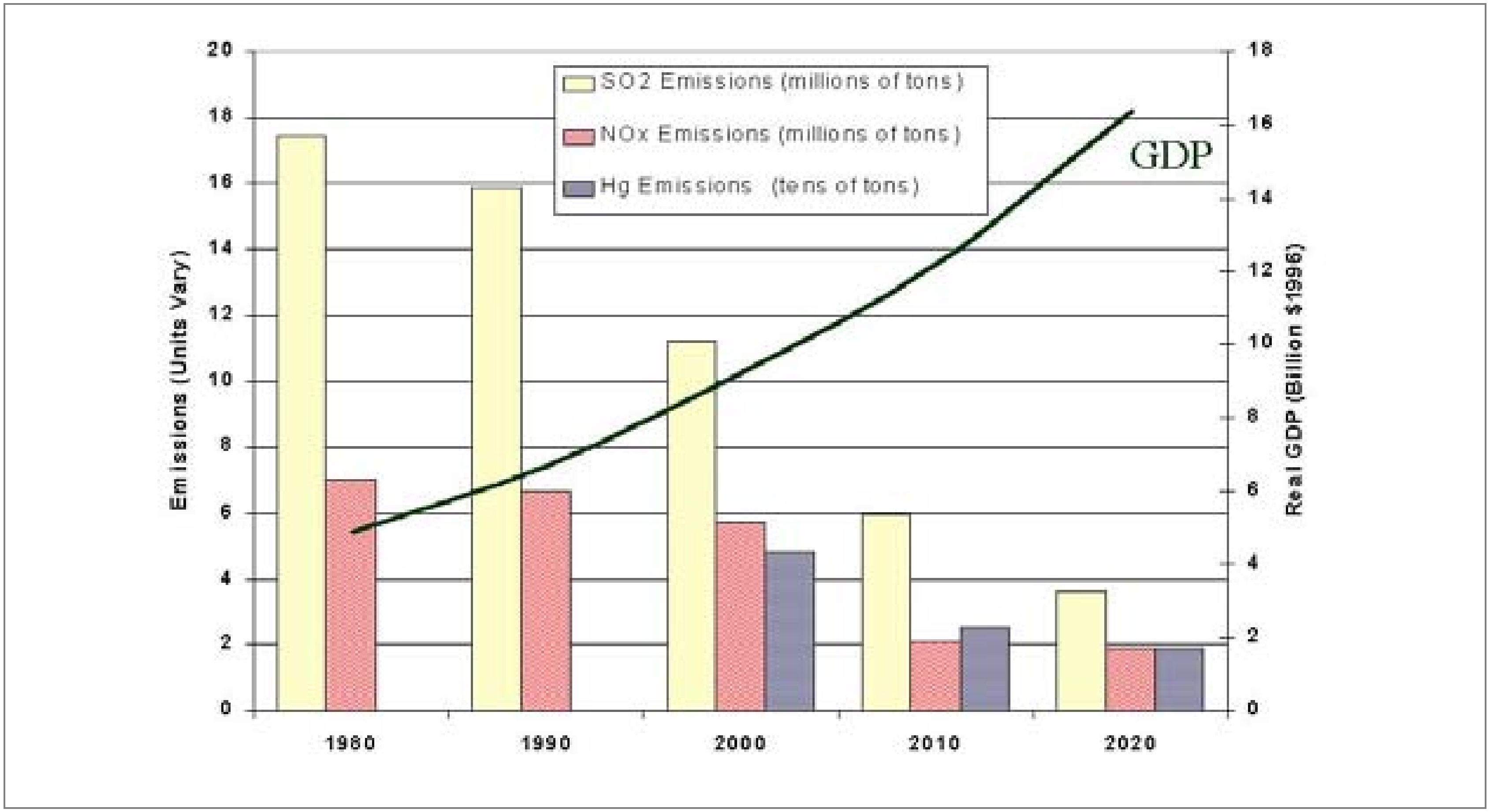






Note: Projected emissions data for SO_2, NOx and mercury are from IPM.

Economic Growth and Environmental Improvement



Sources: 1980 - 1999 emissions data are from the National Air Pollutant Emissions Trend Report (EPA, March 2000). Projections for SO_2, NOx and mercury are derived from the Integrated Planning Model (IPM). GDP data for 1980, 1990 and 2000 is from the Bureau of Economic Analysis, U.S. Department of Commerce. The GDP projection for 2010 is from OMB's Analytical Perspectives Report for 2003, Table 2-1. The 2010 to 2020 projection follows EIA's assumptions in AEO 2001 of 3% growth per year.

Section B:

Human Health and Environmental Benefits

Overview of the Assessment

This assessment analyzes the impacts of the Clear Skies Act. It compares air quality, atmospheric deposition, and ecosystem conditions projected to occur under Clear Skies to current conditions and to those expected to occur in the future under EPA regulations that have been finalized but not yet fully implemented (the Base Case).

Specifically, this assessment analyzes the effects of reducing power plant emissions on multiple human health and environmental issues, including:

- Fine Particles ($PM_{2.5}$)
- Ozone
- Visibility
- Acid Deposition (sulfur and nitrogen deposition)
- Freshwater Acidification
- Mercury Emissions
- Mercury Deposition

The assessment estimates monetized benefits due to reduced $PM_{2.5}$ and ozone concentrations, including improvements in human health and visibility.

Summary of Results

The Clear Skies Act would improve human health, visibility, and a diverse range of ecosystems by further reducing emissions and deposition of SO_2, NOx, and Hg.

By 2020, the benefits of reductions in $PM_{2.5}$ and ozone are estimated to be $96 billion annually (1999$), including:

- $93 billion in annual human health benefits. This would include the value of avoiding:
    - 11,900 premature deaths;
    - 7,400 new cases of chronic bronchitis;
    - 11,900 total hospitalizations and emergency room visits for cardiovascular and respiratory symptoms;
        - 2,900 fewer emergency room visits for asthma attacks.
    - 15 million days with respiratory-related symptoms, including work loss days, restricted activity days, and asthma attacks;
        - 370,000 days with asthma attacks;
- An alternative estimate projects over 7,000 premature deaths prevented and $11 billion in health benefits annually by 2020.
- $3 billion in annual visibility benefits from improving visibility at select National Parks and Wilderness Areas. Note that visibility benefits would likely increase if emissions reductions under the WRAP were included in this analysis.
- There are additional health and environmental benefits, such as reduced human exposure to mercury and fewer acidified lakes, that cannot currently be quantified or monetized but nevertheless are expected to be significant.

By 2020, based on initial modeling, Clear Skies is expected to:

- bring 54 additional counties, home to approximately 21 million people, into attainment with the new fine particle standard as compared to existing programs (Base Case). The remaining counties are expected to move closer to attainment.
- bring 8 additional counties, home to 4 million people, into attainment with the new ozone standard as compared to existing programs. The remaining counties are expected to move closer to attainment.

Summary of Results *cont'd*

Compared to current conditions, by 2020 the Clear Skies Act, along with implementation of existing programs, would:

- Reduce $PM_{2.5}$ concentrations in large portions of the East and Midwest by more than 20%;
- Improve visibility in a large portion of the East and Midwest by 2-3 deciviews from current levels; in areas of the southern Appalachian Mountains (e.g. Great Smoky Mountain National Park) visibility would improve more than 3 deciviews;*
- Reduce sulfur deposition (one component of acid deposition) over much of the sensitive eastern U.S. by 30-60%;
- Reduce nitrogen deposition (the other component of acid deposition) over much of the sensitive eastern U.S., including coastal areas, by up to 60%; and
- Virtually eliminate chronic acidity -- the most serious form of acidification -- in Northeastern lakes (including those in Adirondack Park) and prevent further deterioration of acidic Southeastern streams.

Compared to the Base Case in 2020, Clear Skies would:

- Reduce fine particle concentrations in the East and Midwest by 10-20%;
- Improve visibility in the East and Midwest by 1-2 deciviews;
- Reduce sulfur deposition to sensitive ecosystems in the East by more than 30%; and
- Reduce nitrogen deposition across the East by 15-30%.

Note: A deciview is a measure of visibility which captures the relationship between air pollution and human perception of visibility. When air is free of the particles that cause visibility degradation, the Deciview Haze Index is zero. The higher the deciview level, the poorer the visibility; a one or two deciview change translates to a noticeable change in visibility for most individuals.

Air Quality Modeling: Base Case and Clear Skies

What is included in the air quality modeling Base Case?

The air quality Base Case includes all finalized EPA regulations that are expected to be in effect in 2010 and 2020. It includes such recent actions as:

- the Title IV Acid Rain Program for controlling SO_2 and NOx from electric generating units
- the NOx SIP Call
- the Tier 2 rule for new cars and light trucks
- the Heavy Duty Diesel truck rules for 2004 and 2007 covering new vehicles
- additional state regulatory requirements in finalized form by 2000

What is not included in the air quality modeling Base Case?

The air quality Base Case does not include:

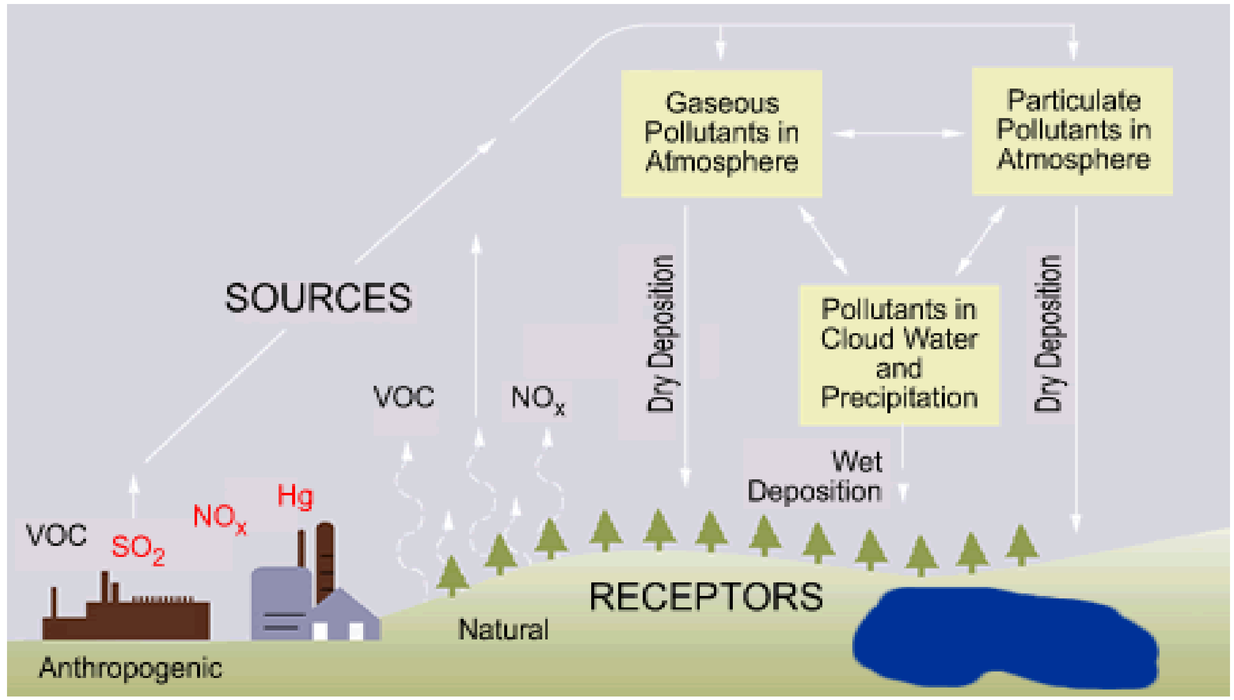
- Proposed or planned major regulations that the EPA will pursue in addition to the Clear Skies Act to lower emissions across the country. (e.g. EPA plans to propose substantial controls on non-road diesel sources).
- Voluntary emissions reduction programs, such as the diesel retrofit program, and pending federal enforcement actions that are not predictable.
- Additions to State Implementation Plans to ensure compliance with the NAAQS or some *very* recent/pending state laws, such as the one in North Carolina, that address air pollution.

What is included in the Clear Skies air quality Case?

The Clear Skies Case includes all projected Base Case emissions minus the reductions in SO_2,NOx, and mercury that would be achieved by the Clear Skies Act.

Overview of SO_2, NOx, and Mercury Emissions, Transport, and Transformation

- When emitted into the atmosphere, sulfur dioxide, nitrogen oxides, and mercury undergo chemical reactions to form compounds that can travel long distances.
- These chemical compounds take the form of tiny solid particles or liquid droplets and can remain in the air for days or even years.
- These and other pollutants can return to the earth through the processes of wet and dry atmospheric deposition.



- Wet deposition removes gases and particles in the atmosphere and deposits them to the Earth's surface by means of rain, sleet, snow, and fog.
- Dry deposition is the deposition of particles and gases to land and water surfaces without precipitation.
- Depending on the chemical form in which it is emitted, mercury is a pollutant of concern at local, regional, and global scales. Mercury emissions in the ionic form are prone to deposit closest to their source.

Overview of the Health and Environmental Effects of SO_2, NOx, and Mercury

Effects of Nitrogen Oxides (NOx)

- Contributes to premature death and serious respiratory illness (e.g., asthma, chronic bronchitis) due to fine particles and ozone.
- Lowers worker productivity due to ozone.
- Acidifies surface water, reducing biodiversity and killing fish.
- Damages forests through direct impacts on leaves and needles, and by soil acidification and depletion of soil nutrients.
- Damages forest ecosystems, trees, ornamental plants, and crops through ozone formation.
- Contributes to coastal eutrophication, killing fish and shellfish.
- Contributes to decreased visibility (regional haze).
- Contributes to “brown clouds” in some major western cities.
- Speeds weathering of monuments, buildings, and other stone and metal structures.

Effects of Sulfur Dioxide (SO_2)

- Contributes to premature death and serious respiratory illness (e.g., asthma, chronic bronchitis) due to fine particles.
- Acidifies surface water, reducing biodiversity and killing fish.
- Damages forests through direct impacts on leaves and needles, and by soil acidification and depletion of soil nutrients.
- Contributes to decreased visibility (regional haze).
- Speeds weathering of monuments, buildings, and other stone and metal structures.

Effects of Mercury (Hg)

- Impairs cognitive and motor skills with children of women who consume large amounts of fish during pregnancy being at the highest risk.
- Increases risk of cardiovascular effects (blood pressure regulation, heart rate variability and heart coronary heart disease) in children and adults.
- Impairs reproductive, immune and endocrine systems.
- Causes adverse effects, including reproductive and neurological effects, in loons, mink, otter, and other fish-eating animals.
- Bioaccumulates so that the concentrations in the fish and animals who eat fish are many times the concentration of mercury in the water.

How Do Fine Particles ($PM_{2.5}$) Affect Human Health?

- Particulate matter is the term used for a mixture of solid particles and liquid droplets found in the air; fine particles are smaller than 2.5 microns (millionths of a meter) in diameter ($PM_{2.5}$).
- Power plants emit particles directly into the air, but the major contribution of power plant emissions to fine particulate matter air pollution is the emissions of SO_2 and NOx, which are converted into sulfate and nitrate particles in the atmosphere and can be transported for hundreds of miles.

- The health effects of exposure to fine particles include:
  - Increased premature deaths, primarily in the elderly and those with heart or lung disease;
  - Aggravation of respiratory and cardiovascular illness, leading to hospitalizations and emergency room visits, particularly in children, the elderly, and individuals with heart or lung conditions;
  - Decreased lung function and symptomatic effects such as those associated with acute bronchitis, particularly in children and asthmatics;
  - New cases of chronic bronchitis;
  - Increased work loss days, school absences, and emergency room visits; and
  - Changes to lung structure and natural defense mechanisms.

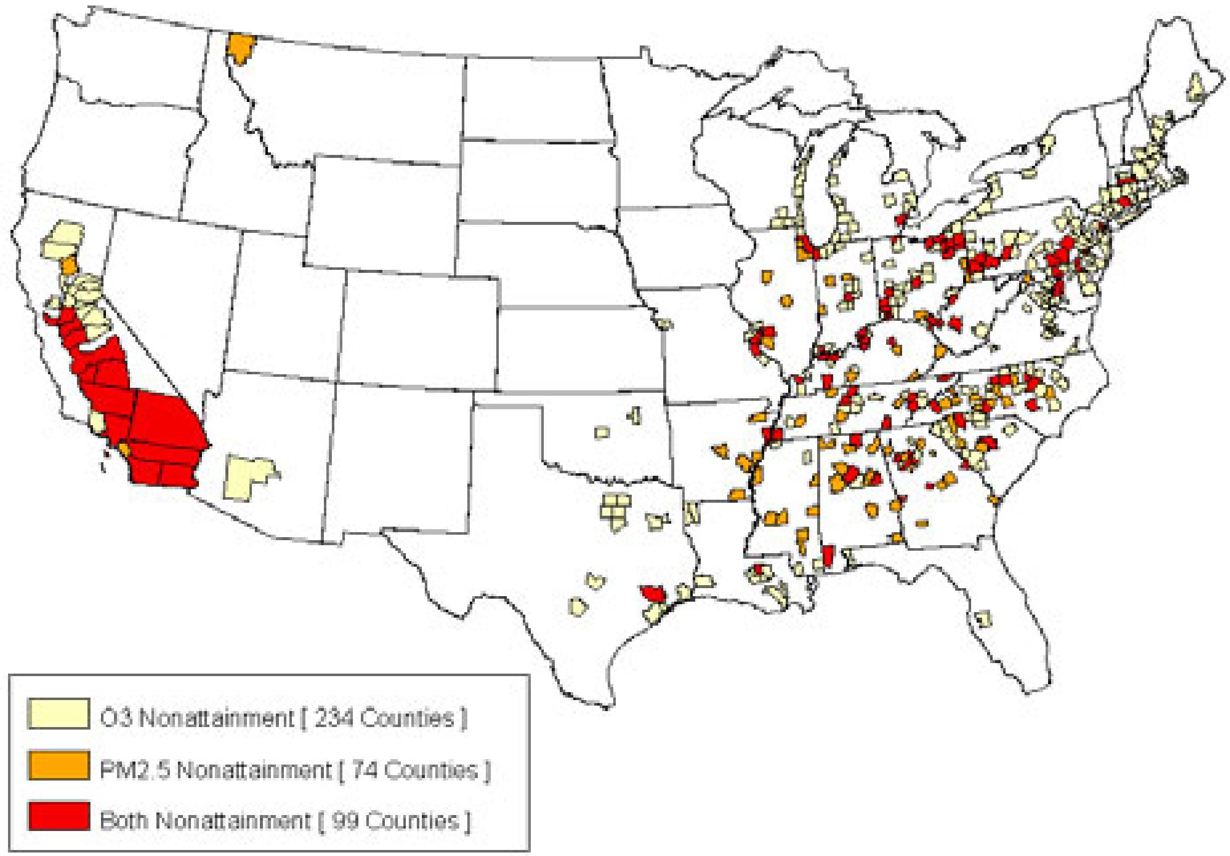
How Does Ozone (Smog) Affect Human Health and Vegetation?

- Nitrogen oxides and volatile organic compounds react in the atmosphere in the presence of sunlight to form ground-level ozone.
- Ground-level ozone is a major component of smog in our cities and other areas of the country. Though naturally-occurring ozone in the stratosphere provides a protective layer high above the earth, the ozone that we breathe at ground level worsens or causes respiratory illness and other health and environmental problems.

- Health and environmental effects from high levels of ozone include:
  - Moderate to large (more than 20%) decreases in lung function resulting in difficulty in breathing, shortness of breath, and other symptoms;
  - Respiratory symptoms such as those associated with bronchitis (e.g., aggravated coughing and chest pain);
  - Increased respiratory problems (e.g. aggravation of asthma, susceptibility to respiratory infection), which often result in hospital admissions and emergency room visits;
  - Reduced productivity for workers in outdoor jobs;
  - Repeated exposure to ozone could result in chronic inflammation and irreversible structural changes in the lungs that can lead to premature aging of the lungs and other long-term respiratory illnesses; and
  - Damage to forest ecosystems, trees and ornamental plants, and crops.

Attainment with $PM_{2.5}$ and 8 hour Ozone Standards (Current Data*)

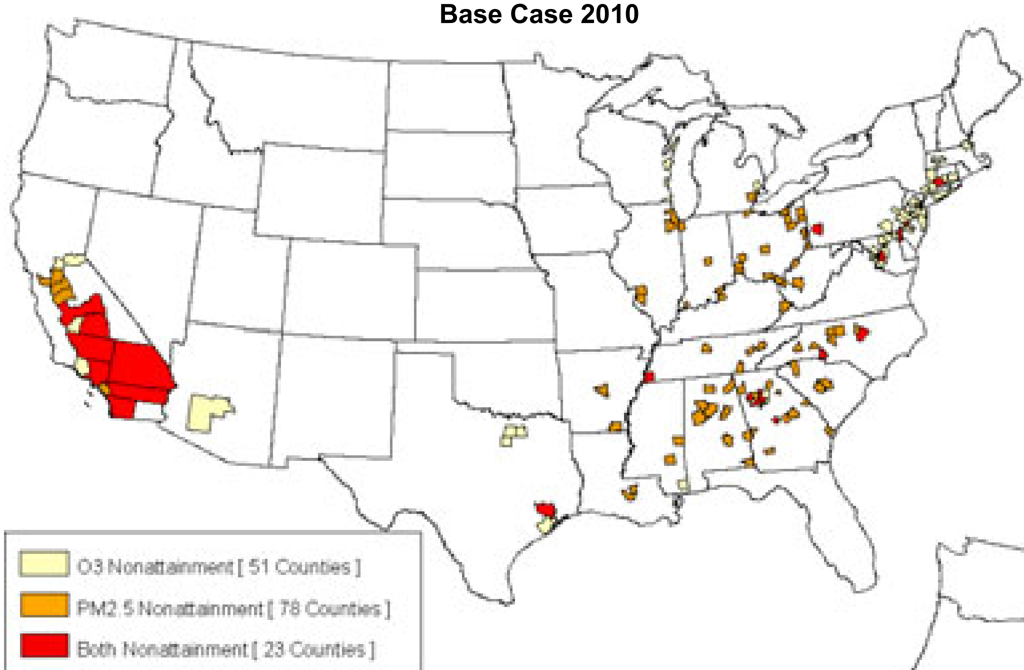
- Based on available 1999-2000 $PM_{2.5}$ data, 157 counties in the East and 173 counties nationwide are likely to exceed the fine particle standard (projected concentrations greater than 15 μ/m^3, which is the annual fine particle standard).
    - Currently 82 million people nationwide, including 59 million in the East, live in counties that would not meet the standard.
- There are currently 333 counties (306 counties in the east) estimated to exceed the 8-hour ozone standard.
    - Currently 120 million people live in counties with projected ozone concentrations greater than 85 ppb (the 8-hour ozone standard).



Note: To permit comparisons among various analyses, the air quality data were the most complete and recently available as of mid-2001 (1997-1999 ozone monitoring data and 1999-2000 $PM_{2.5}$ data). More complete and recent air quality data for ozone and fine particles (1999-2001 data) is now available. This updated data indicate differences in the likely attainment status of some counties compared to what is shown here. Future analyses of Clear Skies will incorporate the most recent data available.

Projected Attainment with $PM_{2.5}$ and 8-hour Ozone Standards under Clear Skies (2010)

Base Case 2010



The Clear Skies Act would result in a substantial number of counties meeting the $PM_{2.5}$ and 8-hour ozone standards sooner than they would under the existing Clean Air Act.

$PM_{2.5}$ attainment status in 2010:

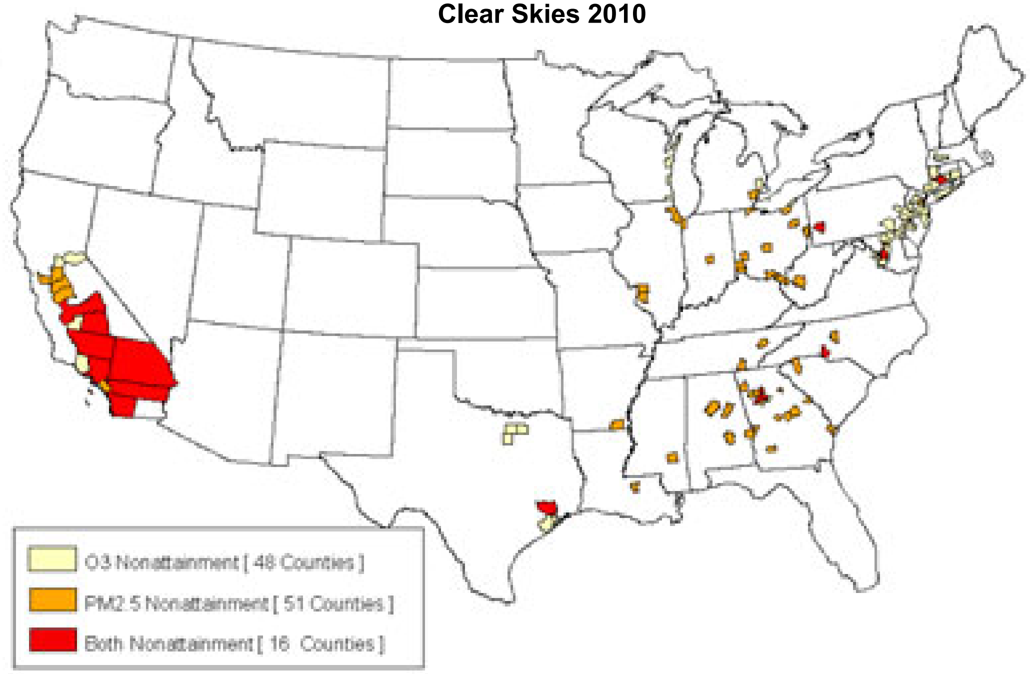
- Based on initial modeling, the Clear Skies Act would bring 34 additional counties (home to approximately 10 million people) into attainment with the fine particle standard (as compared to the Base Case).

Ozone attainment status in 2010:

- Based on initial modeling, the Clear Skies Act would bring 10 additional counties (home to over 7 million people) into attainment with the 8-hour ozone standard in 2010 (as compared to the Base Case).

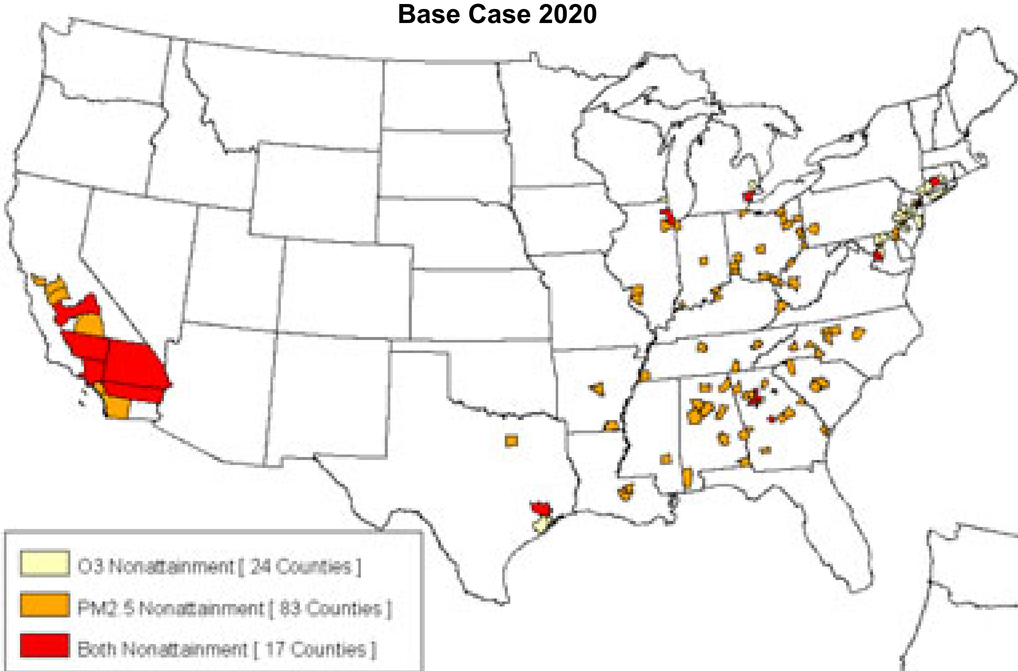
Note: This analysis shows the counties that would come into attainment due to Clear Skies alone in 2010. Additional federal and state programs are designed to bring all counties into attainment by 2017 at the latest.

Clear Skies 2010



Projected Attainment with $PM_{2.5}$ and 8-hour Ozone Standards under Clear Skies (2020)

Base Case 2020



$PM_{2.5}$ attainment status in 2020:

- Based on initial modeling, the Clear Skies Act would bring 54 additional counties (home to approximately 21 million people) into attainment with the fine particle standard (as compared to the Base Case).

Ozone attainment status in 2020:

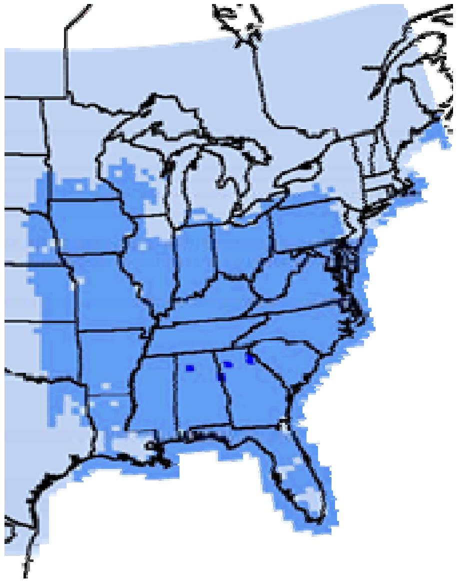
- Based on initial modeling, the Clear Skies Act would bring 8 additional counties (home to over 4 million people) into attainment with the 8-hour ozone standard (as compared to the Base Case).

Note: This analysis shows the counties that would come into attainment due to Clear Skies alone in 2020. Additional federal and state programs are designed to bring all counties into attainment by 2017 at the latest.

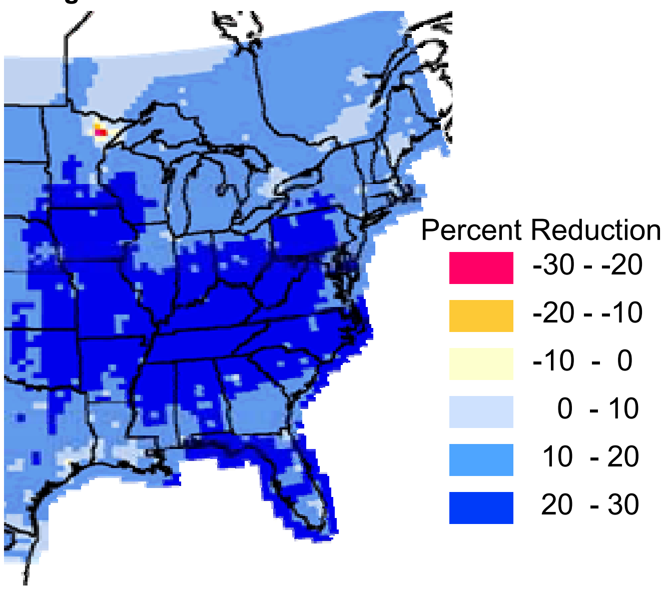
Clear Skies 2020

Fine Particle Concentrations (2020)

Percent Change Base Case vs. Clear Skies in 2020



Percent Change 1996 vs. 2020 with Clear Skies



- SO_2 and NOx emissions produce a substantial fraction of fine particle concentrations, particularly in the East.
- The top map shows that Clear Skies would reduce fine particle concentrations in the East and Midwest 10-20% beyond what is expected under the Base Case.
- The bottom map demonstrates that fine particle concentrations in a large portion of the East and Midwest would improve more than 20% from current levels under Clear Skies and existing programs.

Notes: Title IV reduced over 3 million tons of SO_2 between 1990 and 1996 that are not captured by the improvements shown on the map because the base year for the analysis was 1996.

Emissions from certain sources, such as mining and metals processing, are expected to increase in the future. These sources, which are not affected by Title IV or Clear Skies, contribute to increases in fine particle concentrations in certain areas (e.g. Northern Minnesota).

The western U.S. is not shown in these maps because the SO_2emissions reductions expected from the WRAP have not yet been included in the air quality modeling analysis.

Human Health Benefits of Reducing Fine Particulate Matter and Ozone (2020)

- Reductions in $PM_{2.5}$ and ozone[1] under Clear Skies would improve public health. By 2020, Americans would annually experience approximately;
  - 11,900 fewer premature deaths;
    - An alternative estimate projects 7,200 fewer premature deaths.[2]
  - 7,400 fewer cases of chronic bronchitis;
  - 11,900 fewer hospitalizations/emergency room visits for cardiovascular and respiratory symptoms; and
  - 15 million fewer days with respiratory illnesses and symptoms, including work loss days, restricted activity days, and days with asthma attacks
- The monetized benefits of the Clear Skies Act would total approximately $96 billion annually in 2020. This includes:
  - $93 billion dollars in health benefits.
    - An alternative estimate projects annual health benefits of $11 billion.[2]
  - $3 billion in benefits from improving visibility at select National Parks and Wilderness Areas. Note that visibility benefits would likely increase if emissions reductions under the WRAP were included in this analysis.
- Many additional, unquantified health benefits, including the benefits of reduced exposure to mercury, would also occur under Clear Skies.

[1] The ozone benefits were calculated for the eastern U.S. and portions of the West where significant ozone changes are expected; therefore the total national benefits from reductions in ozone may be slightly higher than what is reflected here.

[2] The two sets of estimates reflect alternative assumptions and analytical approaches regarding quantifying and evaluating the effects of airborne particles on public health. All estimates assume that particles are causally associated with health effects, and that all components have the same toxicity. Linear concentration-response relationships between PM and all health effects are assumed, indicating that reductions in PM have the same impact on health outcomes regardless of the absolute level of PM in a given location. The base estimate relies on estimates of the potential cumulative effect of long-term exposure to particles, while the alternative estimate presumes that PM effects are limited to those that accumulate over much shorter time periods. All such estimates are subject to a number of assumptions and uncertainties. It is of note that, based on recent preliminary findings from the Health Effects Institute, the magnitude of mortality from short-tern exposure (alternative estimates) and hospital/ER admissions estimates (both estimates) may be overstated. The alternatives also use different approaches to value health effects damages. The key assumptions, uncertainties, and valuation methodologies underlying the approaches used to produce these results are detailed in *Technical Addendum: Methodologies for Benefit Analysis of the Clear Skies Act, 2002*.

Human Health Benefits of Reducing Fine Particulate Matter and Ozone (2010)

- The Clear Skies Act would result in substantial **early** human health and visibility benefits due to reductions in $PM_{2.5}$ and ozone.
- By 2010, Americans would annually experience approximately:
  - 6,400 fewer premature deaths;
    - An alternative estimate projects 3,800 fewer premature deaths;[1]
  - 3,900 fewer cases of chronic bronchitis;
  - 6,300 fewer hospitalizations/emergency room visits for cardiovascular and respiratory symptoms; and
  - 8 million fewer days with respiratory illnesses and symptoms, including work loss days, restricted activity days, and days with asthma attacks.
- The monetized benefits of the Clear Skies Act would total approximately $44 billion annually in 2010. This would include:
  - $43 billion dollars in health benefits.
    - An alternative estimate projects annual health benefits of $5 billion.[1]
  - $1 billion in benefits from improving visibility at select National Parks and Wilderness Areas. Note that visibility benefits would likely increase if emissions reductions under the WRAP were included in this analysis.
- Many additional, unquantified health benefits, including the benefits of reduced exposure to mercury, would also occur under Clear Skies.

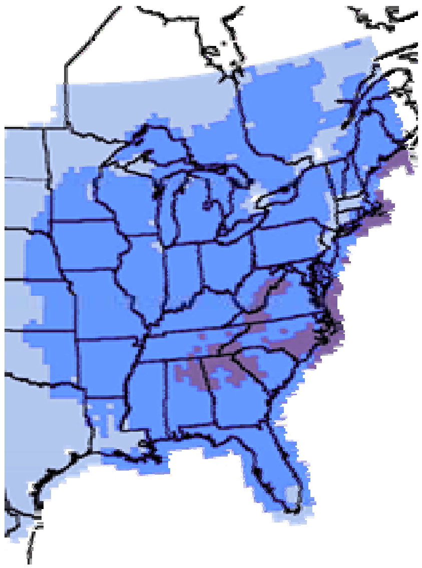
[1] The two sets of estimates reflect alternative assumptions and analytical approaches regarding quantifying and evaluating the effects of airborne particles on public health. All estimates assume that particles are causally associated with health effects, and that all components have the same toxicity. Linear concentration-response relationships between PM and all health effects are assumed, indicating that reductions in PM have the same impact on health outcomes regardless of the absolute level of PM in a given location. The base estimate relies on estimates of the potential cumulative effect of long-term exposure to particles, while the alternative estimate presumes that PM effects are limited to those that accumulate over much shorter time periods. All such estimates are subject to a number of assumptions and uncertainties. It is of note that, based on recent preliminary findings from the Health Effects Institute, the magnitude of mortality from short-tern exposure (alternative estimates) and hospital/ER admissions estimates (both estimates) may be overstated. The alternatives also use different approaches to value health effects damages. The key assumptions, uncertainties, and valuation methodologies underlying the approaches used to produce these results are detailed in *Technical Addendum: Methodologies for Benefit Analysis of the Clear Skies Act, 2002*.

Fine Particles in the Air Decrease Visibility

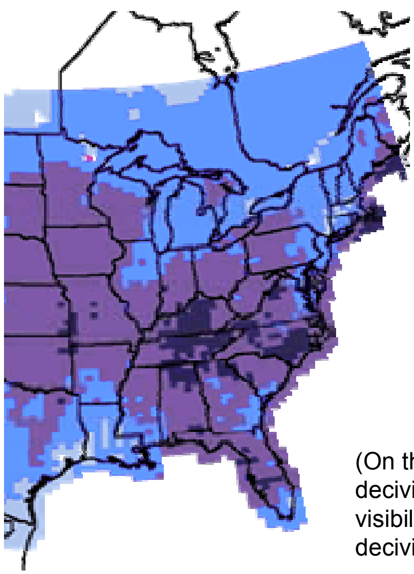
- SO_2 and NOx emissions form sulfate and nitrate particles in the atmosphere that can be transported many miles downwind from emissions sources.
- Fine particles (including sulfates and nitrates) in the air scatter light and create hazy conditions, decreasing visibility. Decreased visibility is sometimes known as “regional haze.” Humidity intensifies the visibility degradation caused by fine particles, particularly in the East.
- Effects of visibility impairment include:
  - Spoiled scenic vistas across broad regions of the country, including those in many National Parks and Wilderness Areas;
  - Reduced visual range by as much as 80% to 10 miles or less on the haziest days in some National Parks;
  - Impaired urban vistas nationwide.
- In the western U.S.:
  - The primary goal is to maintain clean conditions, although some National Parks and Wilderness Areas currently experience decreased visibility.
  - Sulfates account for 25-50% of haze in the West.
  - Nitrates contribute between 5% and 45% of visibility problems, with the biggest impacts in California National Parks and many urban areas.
  - Visibility impairment for the worst days has remained unchanged over the decade of the 1990s.
- In the eastern U.S.:
  - Substantial visibility impairment exists due to regionally high levels of fine particles;
  - Sulfates cause up to 60-80% of haze in eastern parks and urban areas;
  - Nitrates contribute less, but are more significant in winter;
  - Visibility has improved in some areas during the 1990s, but remains significantly impaired throughout much of the East.

Visibility (2020)

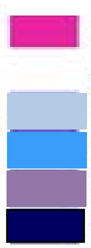
Deciview Change 2020 Base Case vs. Clear Skies



Deciview Change 1996 vs. 2020 with Clear Skies



Deciview Improvement



(On these maps, a positive change in deciviews is an improvement in visibility; a negative change in deciviews is a decrease in visibility.)

- Clear Skies would improve visibility over much of the East and Midwest 1-2 deciviews beyond what is expected under the Base Case in 2020.
  - The greatest improvements (2-3 deciviews) are projected along the Appalachians, including the Blue Ridge and Great Smoky Mountains - areas where visibility has been deteriorating.
- Under Clear Skies and existing programs, visibility in a large portion of the East and Midwest would improve 2-3 deciviews from current levels.
  - Visibility along the southern Appalachian Mountains would improve more than 3 deciviews.
- Under Clear Skies, the Western Regional Air Partnership agreement will be honored and the emissions reductions are expected to take effect.
  - This will allow future growth in the West to occur without degrading visibility.
- The EPA is also considering other actions, such as the non-road diesel rule, that will help reduce visibility-impairing fine particle concentrations throughout the western and eastern U.S.

Notes: Title IV reduced over 3 million tons of SO_2 between 1990 and 1996 that are not captured by the improvements shown on the map because the base year for the analysis was 1996.

Emissions from certain sources, such as mining and metals processing, are expected to increase in the future. These sources, which are not affected by Title IV or Clear Skies, contribute to increases in fine particle concentrations in certain areas (e.g. Northern Minnesota).

The western U.S. is not shown in these maps because the emissions reductions expected from the WRAP have not yet been included in the air quality modeling analysis.

Monetized Visibility Benefits

- This assessment projects benefits due to improvements in impaired visibility in National Parks and Wilderness areas in many Class I areas in the Southeast, Southwest, and California. Note that visibility benefits would likely increase if emissions reductions under the WRAP were included in this analysis.
- In these areas, Clear Skies would achieve approximately:
  - $0.9 billion in annual visibility benefits by 2010;
  - $2.8 billion in annual visibility benefits by 2020.
- This estimate includes benefits in Shenandoah National Park and Great Smoky National Park, two of the most heavily visited National Parks and areas where some of the greatest visibility improvements are expected under Clear Skies.
- This estimate does not include the value of improving visibility in residential areas. It also does not include the value of improving visibility at National Parks and Wilderness Areas in other areas of the country (such as the Northeast) that would be improved by Clear Skies.

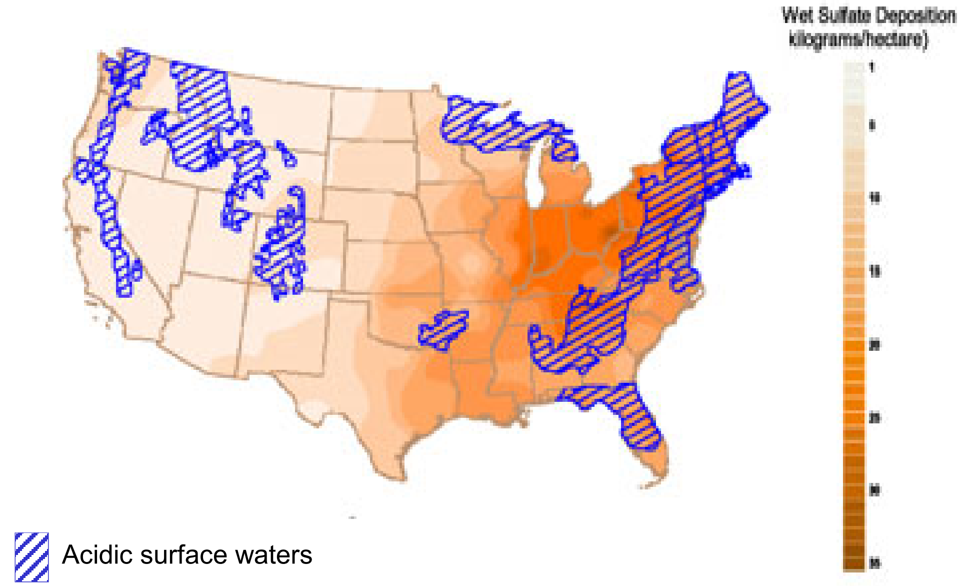
Visibility improves as the concentration of airborne fine particles declines. Based upon emissions reductions under Clear Skies, this analysis calculated changes in air quality and in visibility, measured in terms of deciviews. (A deciview is a standard measure of visibility change; a one or two deciview change translates to a noticeable change in visibility for most individuals.) Consistent with previous approaches, the valuation of visibility improvements is limited to a subset of National Parks and Wilderness Areas and does not include residential areas. Because of this limitation, visibility benefits of the Clear Skies Act are expected to be greater than this primary estimate.

Left: Acadia National Park on a day with good visibility
Right: Acadia National Park on a day with poor visibility

How Does Acid Rain Damage Lakes, Streams, Forests, and Buildings?

- Acid deposition occurs when emissions of SO_2 and NOx react in the atmosphere to create acidic gases and particles which reach the Earth in wet and dry forms.
- The greatest sulfur and nitrogen deposition occurs in areas of the Midwest and northeastern United States which are downwind of the highest SO_2 and NOx emission areas.
- Impacts occur in both the eastern U.S. and mountainous areas of the West.
- Effects of acid deposition include:
    - Acidification of lakes and streams, making them unable to support fish and other aquatic life;
    - Damage to forests through acidification of soil, depletion of soil nutrients, and direct injury to sensitive tree leaves and needles;
    - Harm to buildings, statues and monuments.

Wet Sulfate Deposition (1997-1999) and Acid-Sensitive Surface Waters

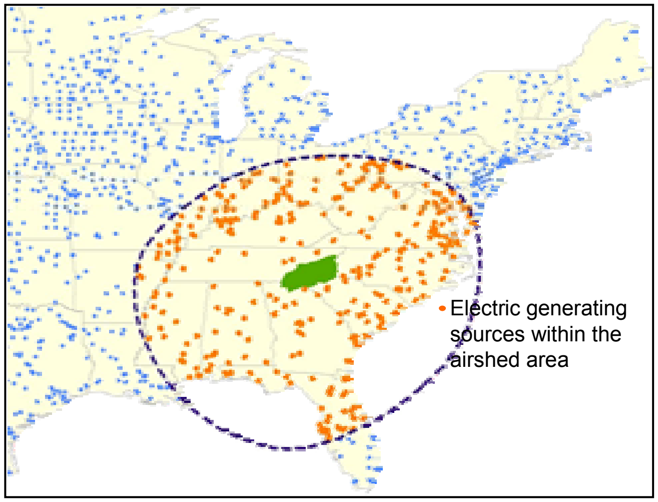


Source: CASTNet/NADP; National Surface Water Survey

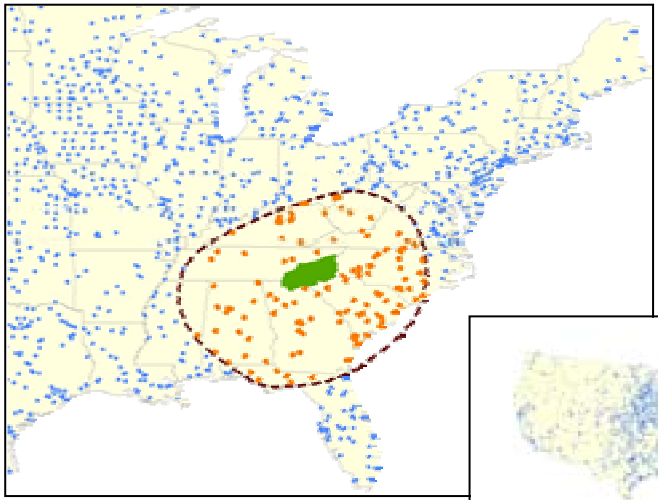
- Despite substantial emissions reductions over the last 20 years, high levels of sulfur and nitrogen deposition still enter acid-sensitive lakes and streams, leading to high levels of acidity.
- Southeastern streams would continue to grow **more** acidic without significant further reductions in sulfate and nitrogen deposition.
- Many scientists believe that significant further reductions in SO_2 and NOx emissions are necessary to fully protect acid-sensitive ecosystems.

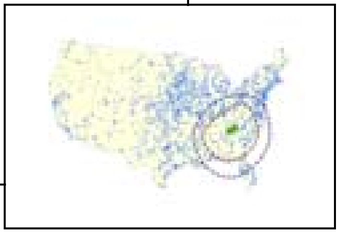
Case Study of Emissions Changes: Southern Blue Ridge Mountains

Sulfur Airshed*



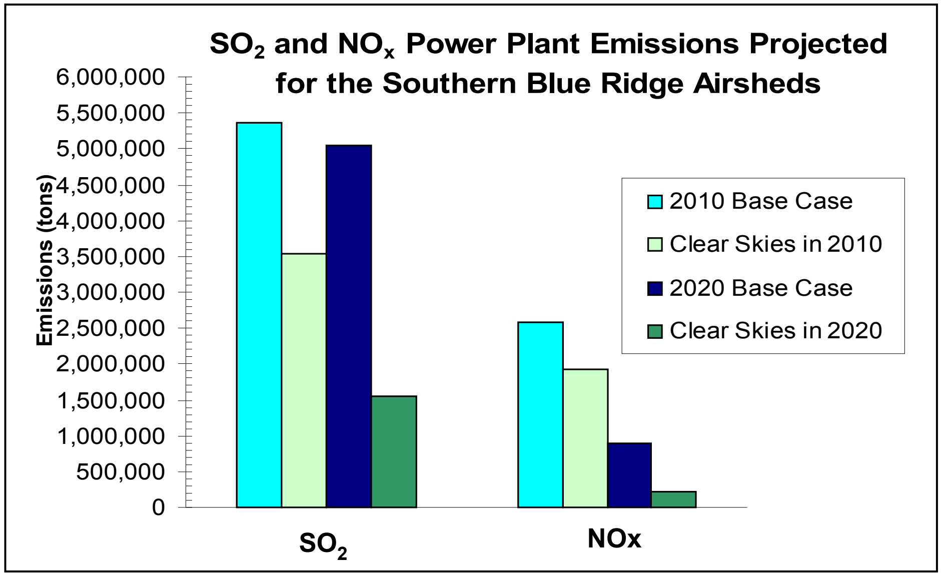
Nitrogen Airshed





Note: An "airshed" depicts a modeled approximation of a large proportion of sources contributing to air quality in a particular receptor region

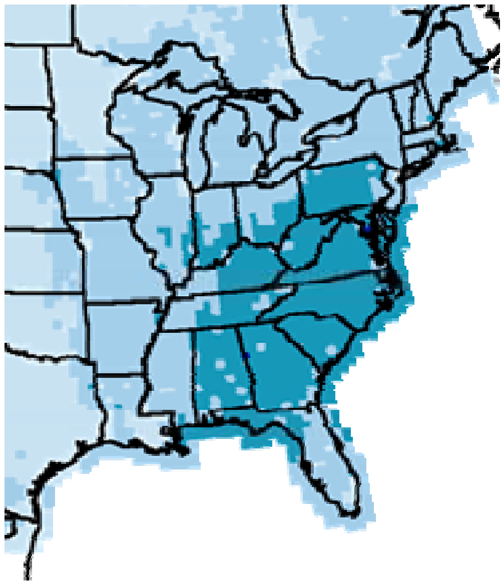
- This page shows regional airshed maps that were developed for the Southern Blue Ridge Mountains (which includes Great Smoky Mountain National Park).
- Multiple emission sources in numerous states contribute to air quality degradation and acid deposition in the Southern Blue Ridge region.



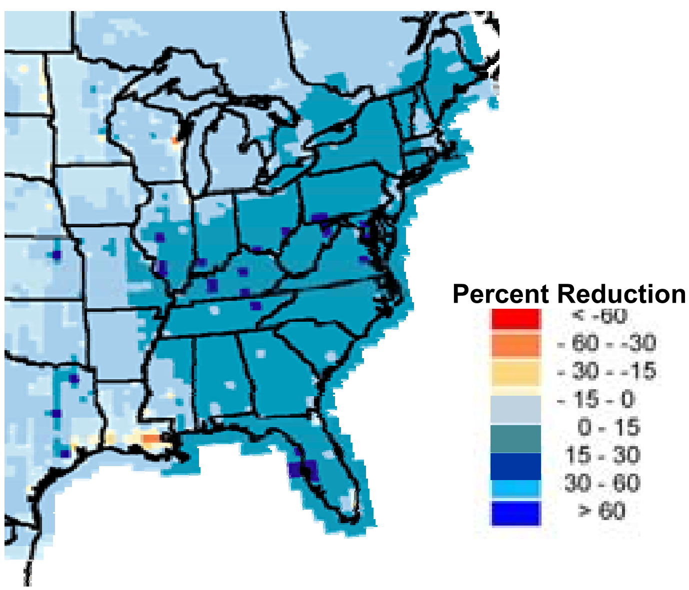
- Clear Skies is projected to result in a 34% reduction in SO_2 emissions and a 25% reduction in NOx emissions from power plants located in the airsheds in 2010, compared to the Base Case.
- In 2020, emission reductions from power plants in the Southern Blue Ridge region are projected to be substantially lower under Clear Skies than under the Base Case:
  - SO_2 emissions are projected to decrease 69%;
  - NOx emissions are projected to decrease 75%.

Sulfur Deposition (2020)

Percent Change 2020 Base Case vs. Clear Skies



Percent Change 1996 vs. 2020 with Clear Skies



- The upper map demonstrates that Clear Skies would achieve significant additional reductions of sulfur deposition of up to 60% beyond what is expected under the Base Case in 2020.
    - The greatest reductions would center on the Appalachian Mountains from central Pennsylvania to the southern Blue Ridge and across broad regions of the southeastern U.S.
    - Sensitive resources in the northeastern U.S., such as the Adirondack and Catskill Mountains, would experience reductions of 15-30%
- The lower map demonstrates that Clear Skies in combination with existing programs would contribute to significant reductions in sulfur deposition from current levels across much of the East.
    - Reductions of 30-60% would occur in sensitive resource areas of the Northeast, New England, and throughout the Appalachian Mountains.

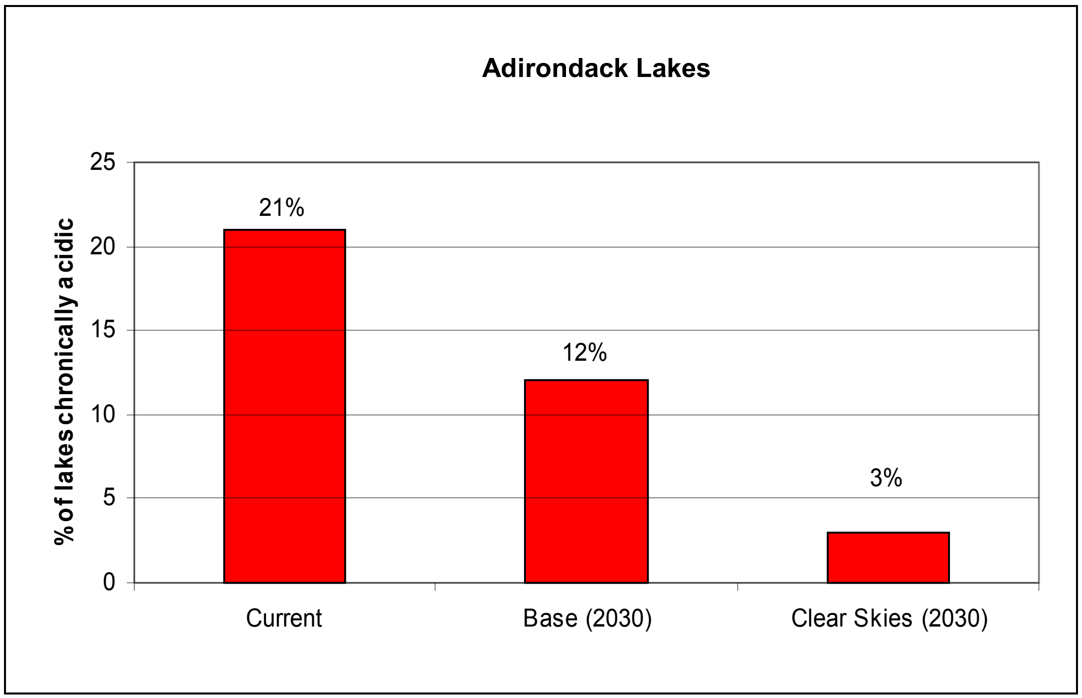
Notes: Title IV reduced over 3 million tons of SO_2 between 1990 and 1996 that are not captured by the improvements shown on the map because the base year for the analysis was 1996.

Emissions from certain sources, such as mining and metals processing and petroleum refining and chemical plants, are expected to increase in the future in some areas. These sources, which are not affected by Title IV or Clear Skies, contribute to increases in sulfur deposition in certain areas (e.g. Texas, Louisiana).

The western U.S. is not shown in these maps because the emissions reductions expected from the WRAP have not yet been included in the air quality modeling analysis.

Reduced Acidity of Adirondack Lakes

- Lakes in the Adirondack Mountains generally respond rapidly to changes in emissions and deposition: larger decreases in deposition lead to significant reductions in acidity.
- Under the Base Case, lake conditions improve but 12% of lakes would remain chronically acidic in 2030.*
- With Clear Skies, lake conditions would improve dramatically by 2030: only 3% of lakes would remain chronically acidic.*



- However, a significant proportion of Adirondack lakes would still become acidic periodically due to seasonal or storm events.

Note: This may be an overestimate of recovery under existing programs due to the fact that this modeling focuses only on sulfur deposition.

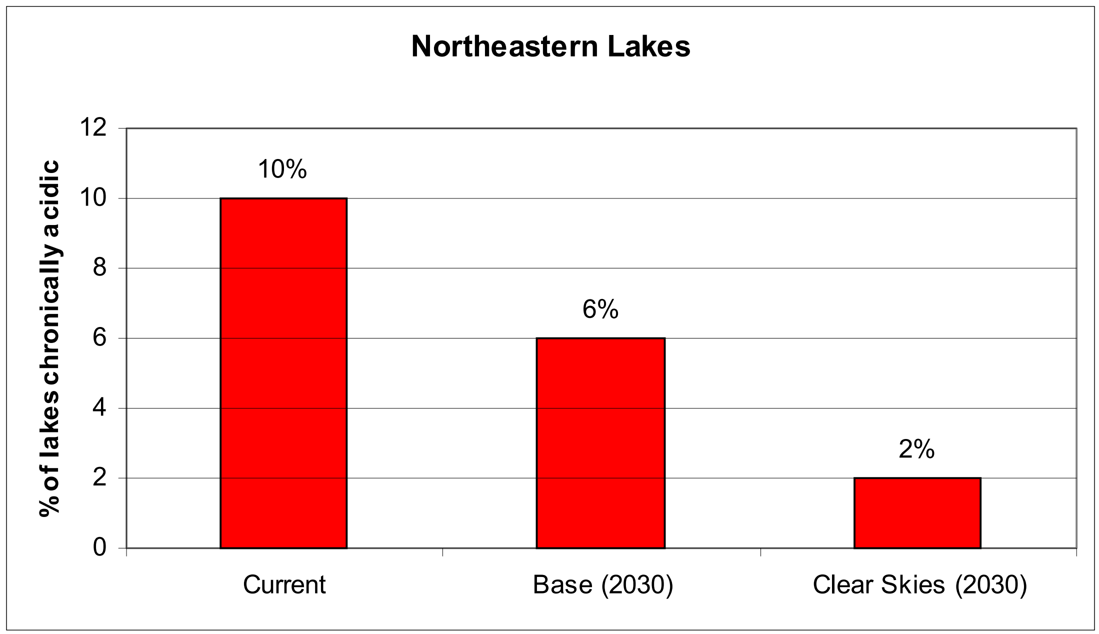
Reduced Acidity of Northeastern Lakes and Southeastern Streams

Northeast Region

- Lakes in the Northeast region (including Adirondack lakes) are both “direct” and “delayed response” systems; some lakes may not completely respond to the deposition changes considered here by 2030.
- Under the Base Case, lake condition improves slightly in the Northeast by 2030, but 6% of lakes remain chronically acidic.
- With the Clear Skies Act, chronic acidity would be virtually eliminated by 2030.*
- However, some lakes would still become acidic periodically due to seasonal or storm events.

Southeast Region

- Large reductions in emissions and deposition, such as those implemented under Clear Skies, are necessary simply to slow the long-term decline in stream condition in the Southeast.
- Under existing programs, stream condition worsens.
- Under Clear Skies, the rate of stream acidification would slow.



Note: This may be an overestimate of recovery under existing programs due to the fact that this modeling focuses only on sulfur deposition.

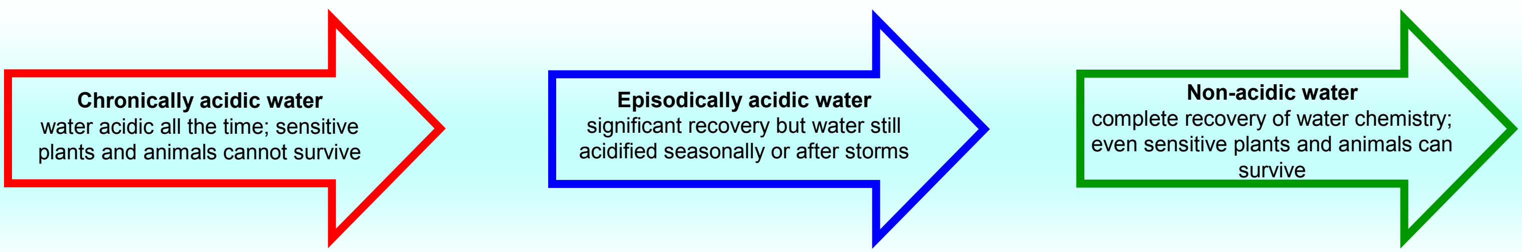
Impacts of Reductions in Sulfur Deposition on Acid-Sensitive Lakes and Streams

		Current	Base Case (2030)	Clear Skies (2030)
	Northeastern Lakes			
	chronically acidic	10%	6%	2%
	episodically acidic	21%	25%	28%
	non-acidic	69%	69%	70%
	Adirondack Lakes			
	chronically acidic	21%	12%	3%
	episodically acidic	43%	52%	61%
	non-acidic	36%	36%	36%
	Southeastern Streams			
	chronically acidic	17%	17%	17%
	episodically acidic	19%	27%	25%
	non-acidic	64%	56%	58%

This table shows the percentage of waterbodies in regions of the Eastern U.S. that are chronically, episodically, and non-acidic under Clear Skies as compared to current conditions and the Base Case.

- A key indicator of the health of acid-sensitive lakes and streams is their ability to buffer or neutralize acid deposition. This capacity is measured as acid neutralizing capacity (ANC).
- Chronically acidic waters have low ANC (less than 0). As ANC increases, waters first become episodically acidic (ANC of 0-50 μeq/l) and finally non-acidic (ANC > 50). However, waters can also become more acidic if acid deposition increases.
- In addition to reducing the number of chronically acidic lakes in the Northeast and Adirondacks, Clear Skies would improve the acid buffering capacity of lakes in those regions.
- In the Southeast, Clear Skies would slow the deterioration of stream health expected under the Base Case.

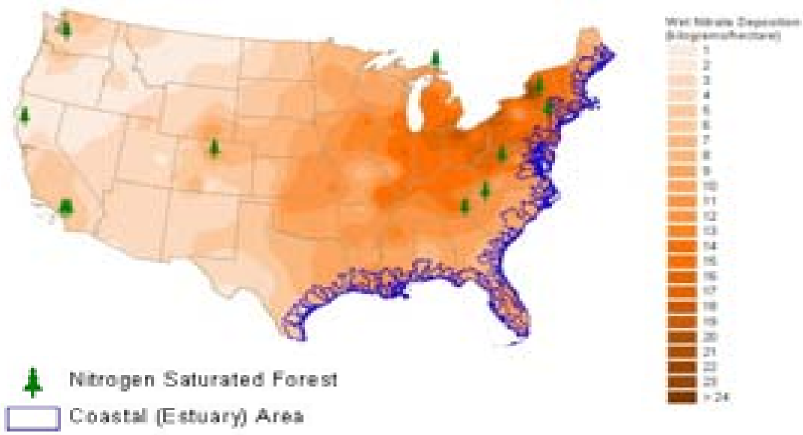
The Road to Recovery



How Does Nitrogen Deposition Harm Forests and Coastal Ecosystems?

- NOx emissions from power plants contribute significant amounts of nitrogen to coastal waters and affected forests.
- For example, 10-40% of the nitrogen reaching East and Gulf coast estuaries is transported and deposited via the atmosphere.
- Excess nitrogen in coastal waters causes “eutrophication” and results in:
  - Algal blooms, some of which are toxic (e.g. red and brown tides);
  - Depletion of dissolved oxygen (hypoxia), stressing or killing marine life;
  - Loss of important habitat, such as seagrass beds and coral reefs;
  - Changes in marine biodiversity and species distribution;
  - Economic and social impacts due to loss of fisheries and tourism.
- Two thirds of U.S. estuaries (over 80) experience symptoms of moderate to high eutrophication.
- High nitrogen deposition levels can lead to loss of soil nutrients and declines in sensitive forest ecosystems.
- Nitrogen saturation occurs when too much nitrogen enters sensitive forest soils and begins to leach out, stripping soil nutrients and impacting water quality.
- Signs of nitrogen saturation have been observed in various sensitive forests in the Eastern and Western U.S. (e.g., Great Smoky Mountains, Adirondack/ Catskill Mountains, Colorado Front Range, southern California).

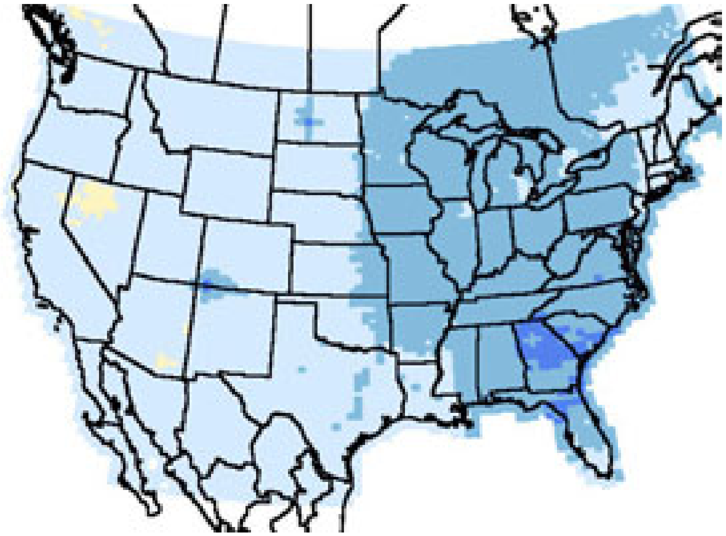
Annual Wet Nitrate Deposition to Sensitive Resources



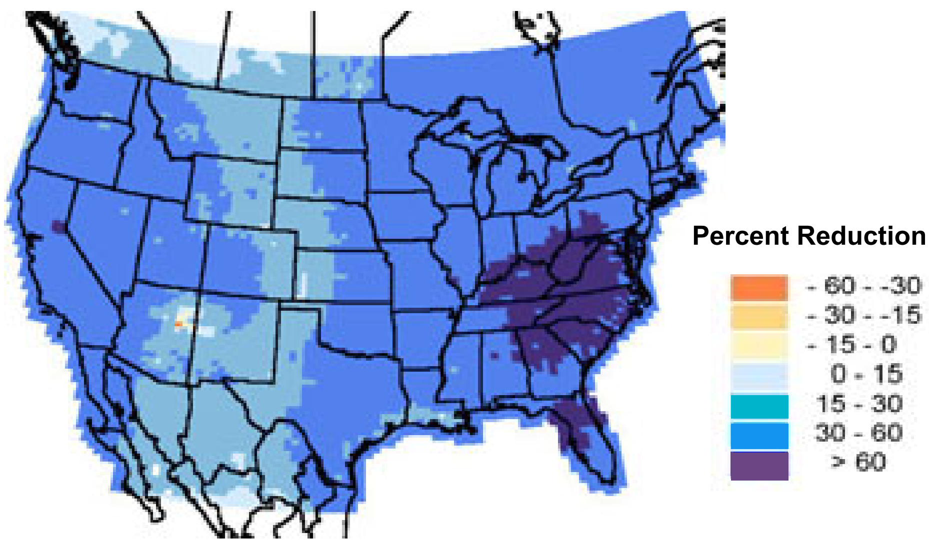
Deposition data measured by CASTNet and NADP, 1997-1999

Nitrogen Deposition (2020)

Percent Change 2020 Base Case vs. Clear Skies



Percent Change 1996 vs. 2020 with Clear Skies

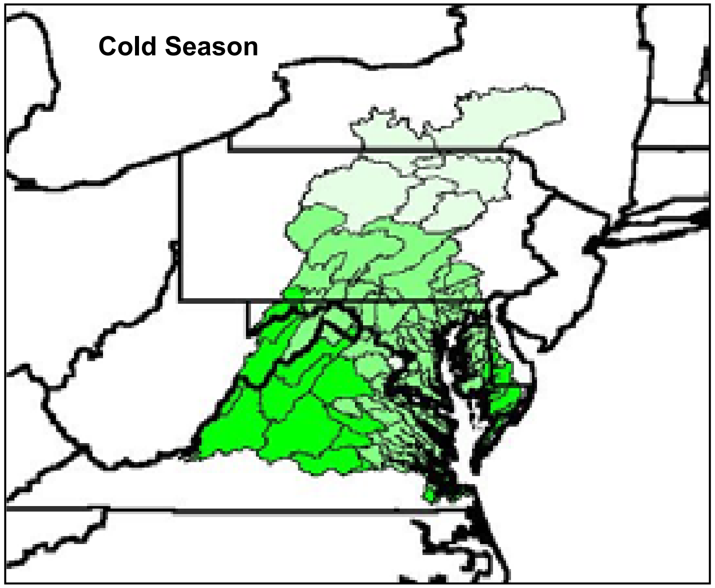


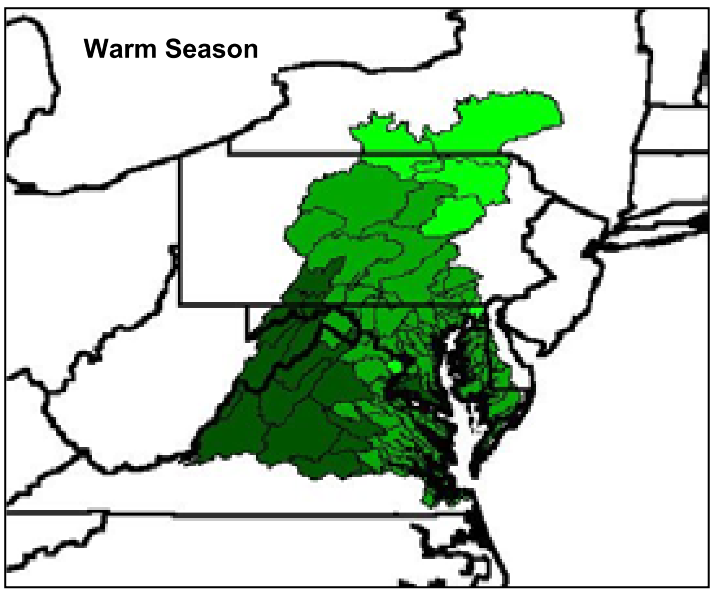
- The upper map demonstrates that Clear Skies would achieve significant additional reductions of nitrogen deposition of 15-30% across much of the East beyond what is expected under the Base Case.
  - The greatest reductions of 30-60% would center on the southeastern portions of the Appalachian Mountains, including Great Smoky Mountain National Park.
  - Sensitive resources in the northeastern U.S., such as the Adirondack and Catskill Mountains, would experience reductions of up to 30%.
- The lower map demonstrates that Clear Skies and existing programs would reduce nitrogen deposition in the Southeast and mid-Atlantic by 60% or more from current levels.
- The projected large reductions in nitrogen deposition on the West coast are due to existing programs not yet fully implemented, such as the Tier II and Diesel Rules.
- In the West, Clear Skies would prevent further deterioration of air quality, including visibility.
  - Clear Skies would allow growth to occur in the West without increasing NOx emissions.

Note: The increase in nitrogen deposition at a location in Arizona is the result of a significant increase in utilization from the baseline at a power generating facility in that state. This increase is an artifact of the baseline year choice (because this baseload facility was only partially utilized in 1996), and would not have otherwise appeared as an increase.

Nitrogen Deposition to the Chesapeake Bay Watershed (2020)

Percent Change 1996 vs. 2020 with Clear Skies



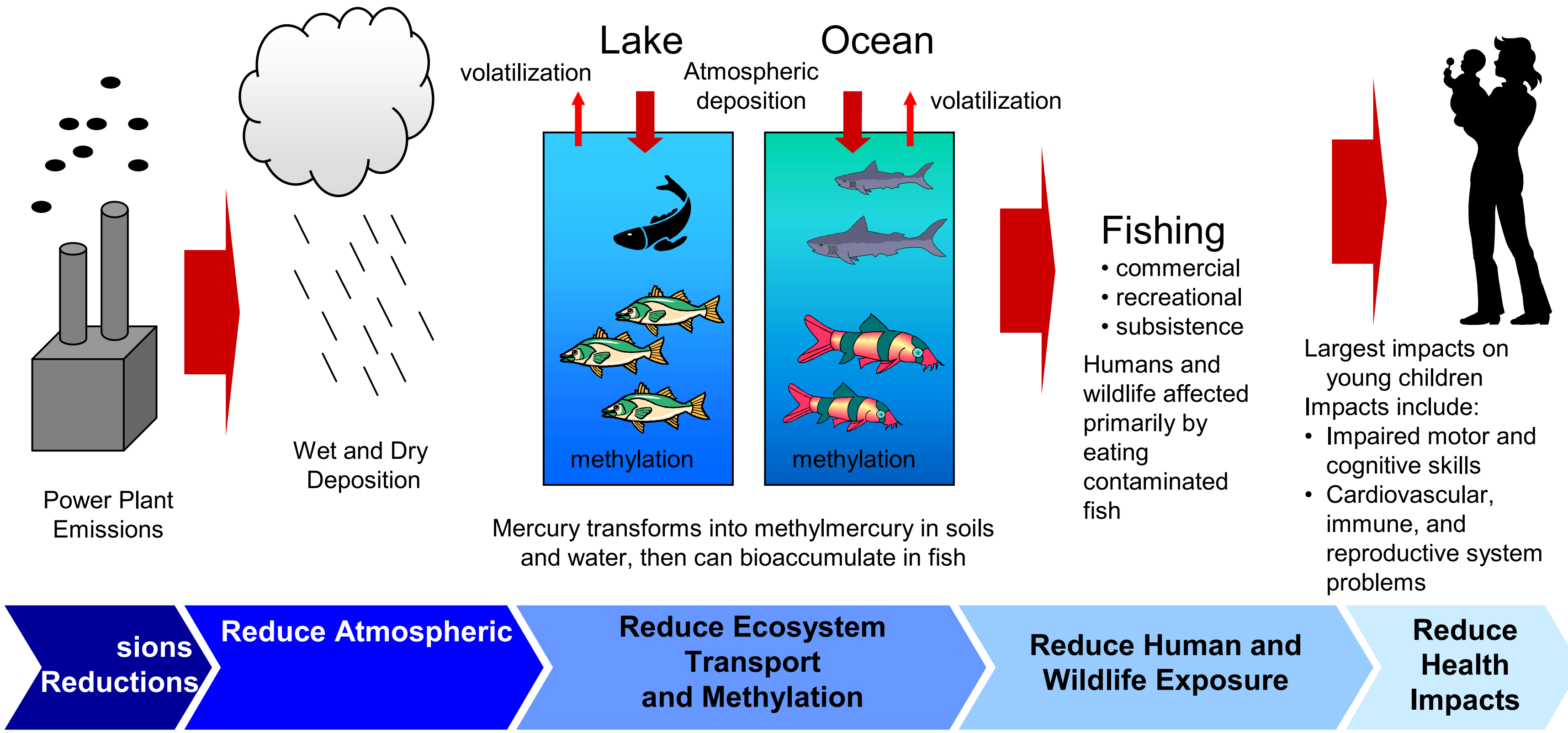


- Under the Clear Skies Act, in 2020, oxidized nitrogen deposition to the Chesapeake Bay watershed would be reduced by more than 50% from current levels.
- Reductions in oxidized nitrogen deposition would be greatest during the warm season, ranging from 50-70% across much of the watershed.

Percent Reduction
1996 vs. 2020 with Clear Skies
(oxidized nitrogen)

- 65-70%
- 60-65%
- 55-60%
- 50-55%
- 45-50%

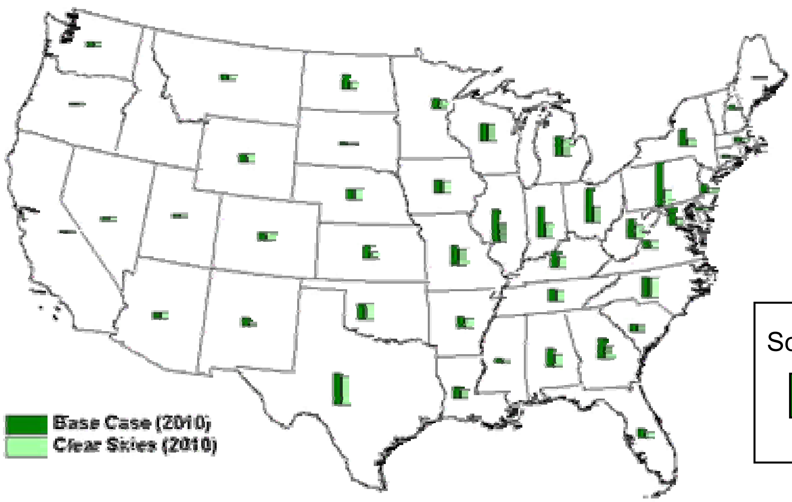
Mercury Emissions from Power Plants Contaminate Fish



- By 2020, Clear Skies implementation will double the use of scrubber technology, meaning that approximately 67% of power generation capacity under Clear Skies will use technology that efficiently reduces the ionic form of mercury from total mercury emissions.
- As a result of Clear Skies, ionic mercury emissions are projected to be 50% lower than emissions levels under the Base Case.
- Ionic mercury emissions are responsible for the majority of short-range transport and deposition, the local impacts of mercury emissions.
- Mercury deposition is a significant source of mercury to many waterbodies. For example, mercury deposited from the atmosphere accounts for more than 50% of the mercury input to the Chesapeake Bay and to Lake Michigan.
- Most people are exposed to mercury through eating contaminated fish.

State-By-State Mercury Emissions

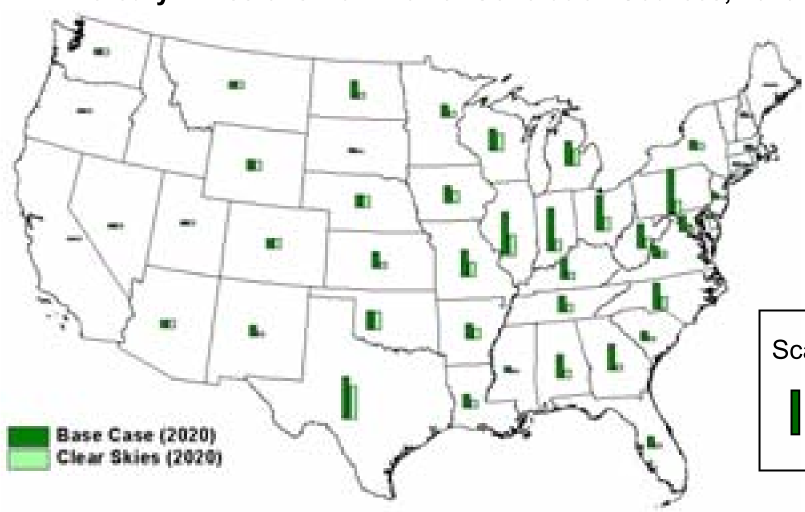
Mercury Emissions from Power Generation Sources, 2010



Scale:

= approximately 3.3 tons

Mercury Emissions from Power Generation Sources, 2020



Scale:

= approximately 2.6 tons

- The trading provisions included in Clear Skies do not result in mercury emissions increases in any state.

Notes: While state-level emissions decrease, emissions may increase at specific sources in some states. Total emissions under Clear Skies in 2010 would be 26 tons; total emission under Clear Skies in 2020 would be 18 tons.

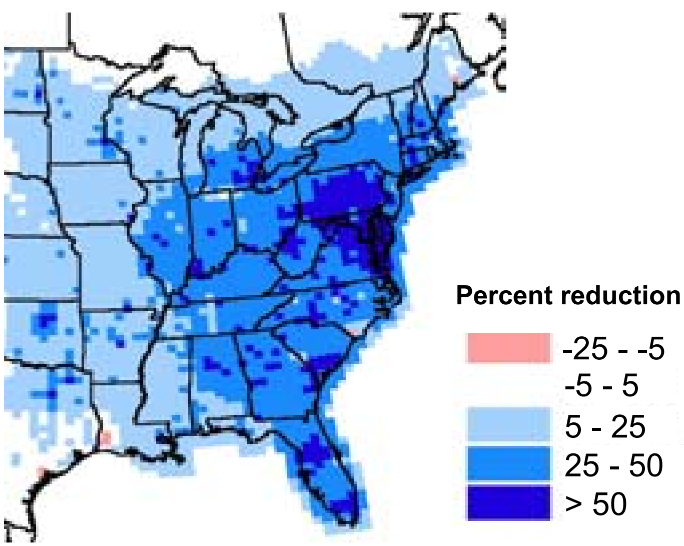
Emissions are from coal-fired electric generating facilities greater than 25MW.

The EPA Base Case does not include any potential future regulations under the CAA to reduce mercury from power plants.

Mercury Deposition (2020)

Percent Change 2020 Base Case vs. Clear Skies

Percent Change 1996 vs. 2020 with Clear Skies



- The top map demonstrates that Clear Skies would achieve significant additional reductions of up to 25% across much of the East beyond what is expected under the Base Case.
  - The greatest reductions of up to 50% would occur along the Ohio River, in portions of the mid-Atlantic region, and in northern sections of Georgia and Alabama.
- The lower map indicates the large reductions in mercury deposition expected from Clear Skies in addition to those expected from recently-implemented programs, including the municipal waste combustor and medical waste incinerator MACT standards.
  - Many areas would see large decreases in mercury deposition of more than 50%, including the mid-Atlantic, many parts of the Southeast and Northeast, and southeastern Michigan.

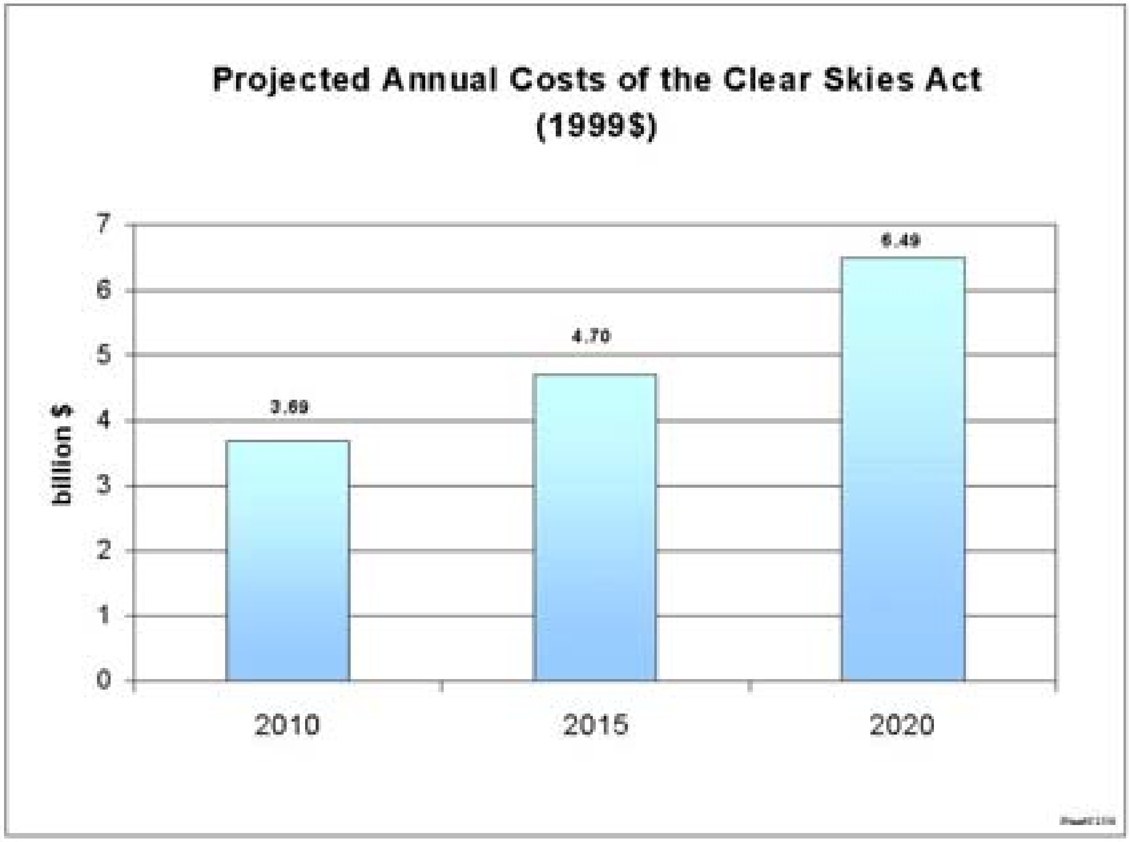
Notes: The small increase in mercury deposition at one location in the top map is attributable to a single facility mistakenly omitted from the Clear Skies mercury cap in the IPM analysis. Were this facility included in the cap, this increase would not have occurred. The increases in in the lower map are due to increases in emissions from sources that are not affected by the Clear Skies Act.

The western U.S. is not shown in these maps because the emissions reductions expected from the WRAP have not been included in the air quality modeling analysis.

Section C:

Projected Costs

Projected Costs of the Clear Skies Act

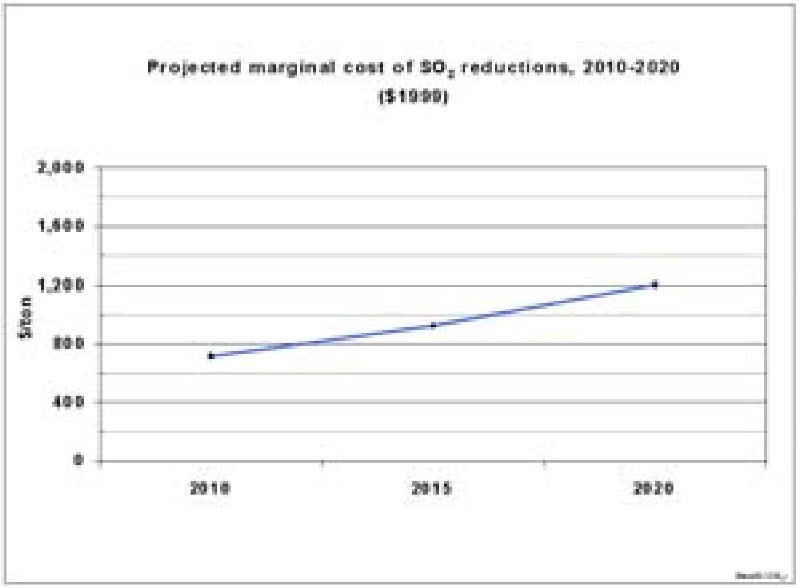


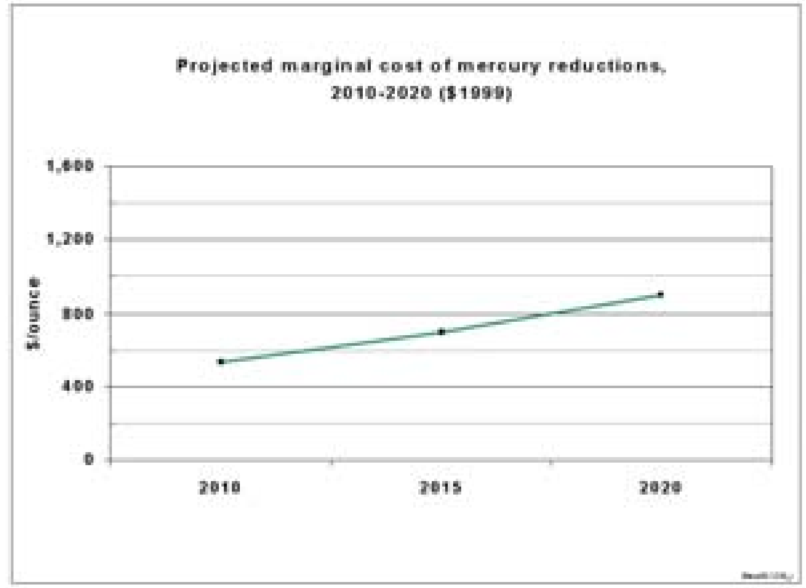
- The net present value (NPV) of the difference in costs between Clear Skies and the EPA Base Case is $65.37 billion ($1999) for the period between 2005 and 2030.

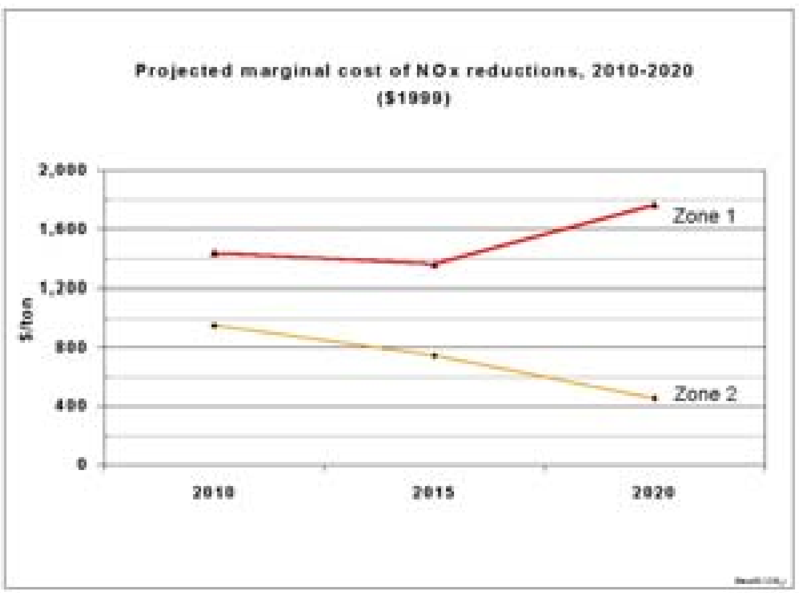
Note: Cost projections are based on modeling using IPM. These projections show the costs to power generators over and above the costs they will incur to meet statutory and regulatory requirements that are already in effect. The projections do not include costs associated with the purchase of allowances from the auction. In the absence of Clear Skies legislation, there are existing statutory provisions that will, in the future, require EPA and states to impose additional requirements (and thus additional costs) on power generators between now and 2020. When compared to existing Clean Air Act requirements, Clear Skies may actually result in cost savings because a cap-and-trade approach is much more efficient than existing regulatory programs. When the Acid Rain Program was implemented using a cap-and-trade program, compliance costs were significantly lower than predicted as sources took advantage of the flexibility provided by a cap and trade program.

The net present value calculations are also based on IPM. See chapter 7, table 7.1 of the IPM documentation for more information on the discount rates used for various plant types. (www.epa.gov/airmarkets/epa-ipm/index.html#documentation).

Projected Allowance Prices under Clear Skies







Note: under the Clear Skies Act, the marginal costs of SO_2 and NOx reductions are well below $2,000/ton and the marginal cost of mercury reductions are below $1,000/ounce.

The dollar value is the projected allowance price, representing the marginal cost (i.e., the cost of reducing the last ton) of emissions reductions. Marginal costs are based on modeling using IPM.

Distribution of Allowances under Clear Skies

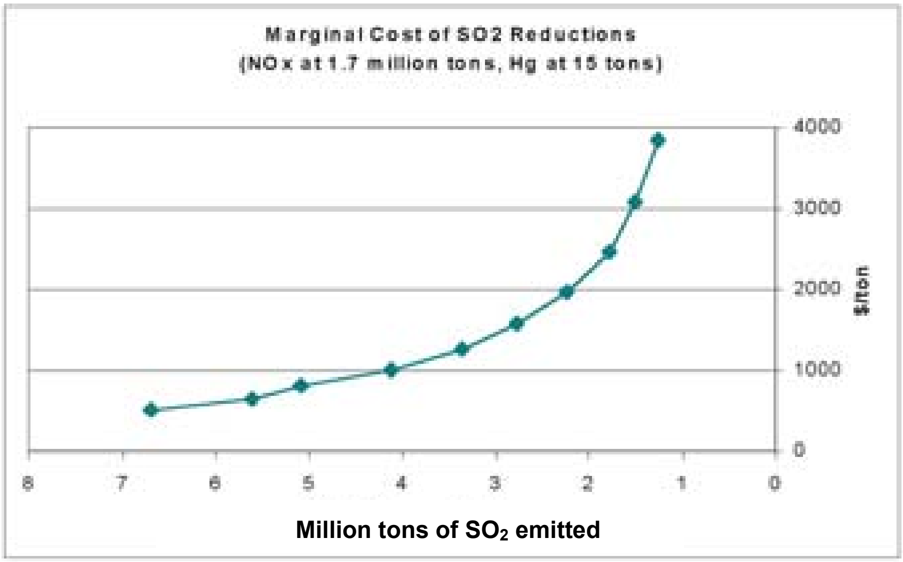
- **The distribution of allowances under the Clear Skies Act occurs through the combination of an auction and an allocation:**
  - During the first year of the new trading program, 99% of the SO_2, NOx and mercury allowances would be allocated to affected units with an auction for the remaining 1%.
  - Each subsequent year, an additional 1% of the allowances for twenty years, and then an additional 2.5% thereafter, will be auctioned until eventually all the allowances are auctioned.
- **For the first twenty years of the trading programs, the majority of allowances are distributed *for free* via the allocation. Because of the time value of money, allowances allocated for these earlier years are generally more valuable in the allowance market than allowances allocated for later years.**
  - EPA analyzed the net present value (NPV) of the stream of allowances that would be distributed through 2030, as well as through 2061.

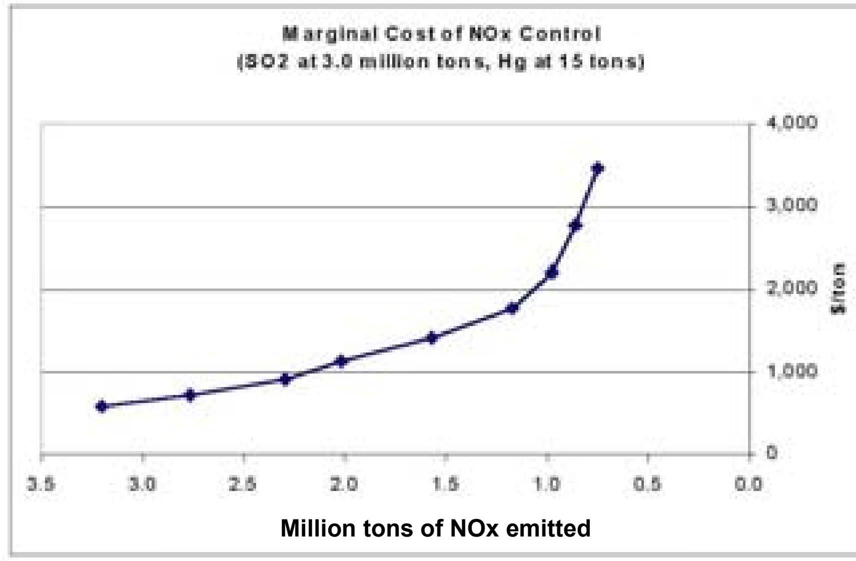
Despite the prevalence of the auction in the later years, EPA's analysis shows that the vast majority of the net present value of the allowances is distributed for free via allocation:

For the period between 2008/2010 and 2030, 90-92% of the total NPV is allocated.
For the period between 2008/2010 and 2061, approximately 80% of the total NPV is allocated.

Note: The net present value calculations are based on allowances prices in IPM.

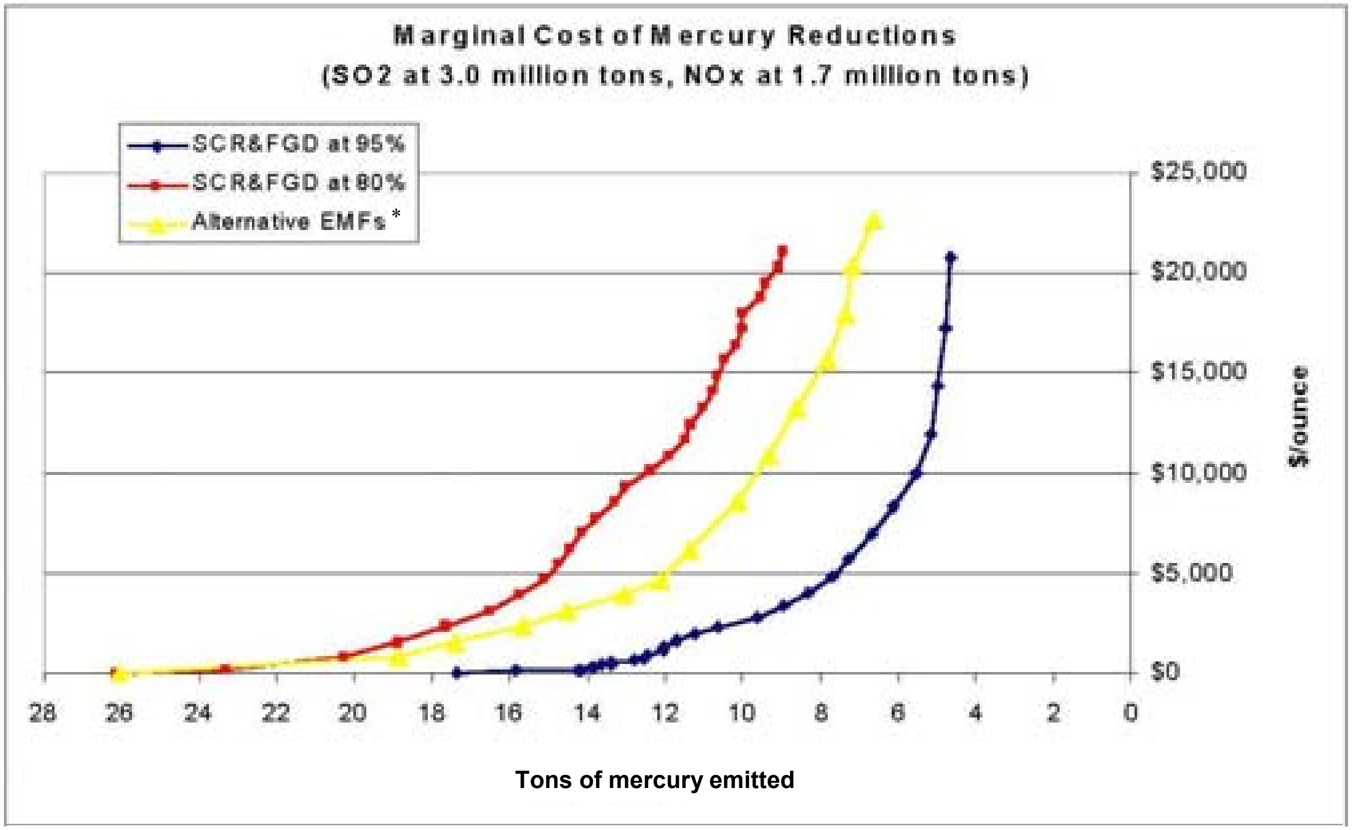
Marginal Costs for SO_2 and NOx reductions





Note: Analysis uses the Technology Retrofit and Updating Model which tends to over predict SO_2 marginal costs because it has fewer degrees of freedom than IPM (see Section G for a description of this model); costs projected by IPM would be lower. Analysis assumes that NOx and Hg emissions are at the levels of the caps.

Marginal Costs for Mercury Reductions



- Selective Catalytic Reduction (SCR) and Flue Gas Desulfurization (FGD) -- more commonly known as scrubbers -- are post-combustion NOx and SO_2 controls, respectively.

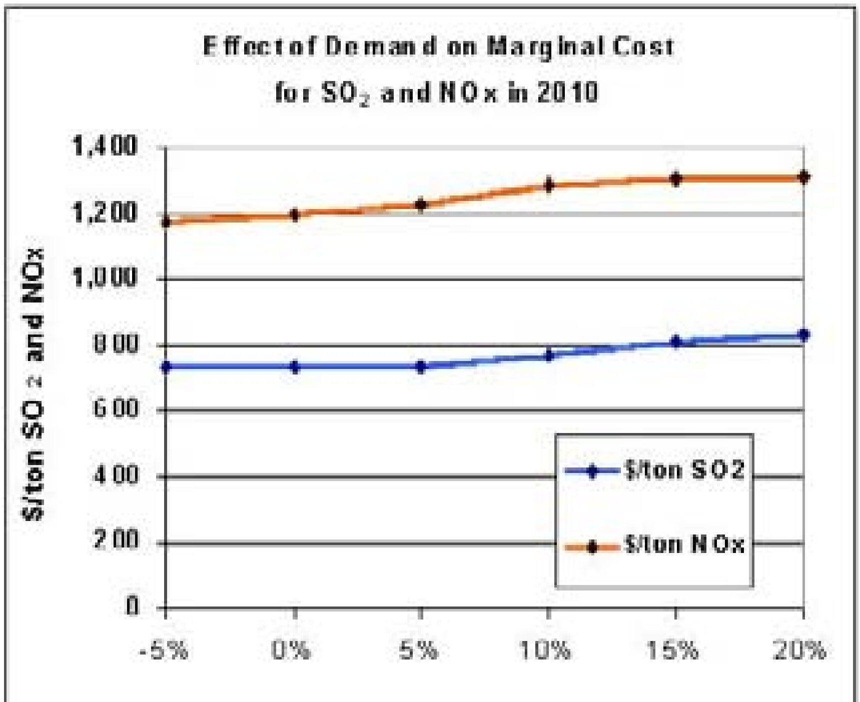
Note: Curves are based on different assumptions regarding the Hg removal efficiency of a combination of SCR and FGD. Analysis uses the Technology Retrofit and Updating Model which tends to over predict Hg marginal costs because it has fewer degrees of freedom than IPM (see Section G for a description of this model); costs projected by IPM would be lower.

In the IPM model, EPA assumes that mercury removal efficiencies for control technology configurations vary depending on coal type and control technology. See the IPM documentation, chapter 5, table 5.7a (http://www.epa.gov/airmarkets/epa-ipm/index.html#documentation) for more information and 5.3.2 for a definition of “Alternative Emission Modification Factors (EMFs)”. An EMF is the ratio of outlet mercury concentration to inlet mercury concentration; EMF’s capture the mercury reductions attributable to different unit configurations and different configurations of SO_2, NOx, and particulate controls.

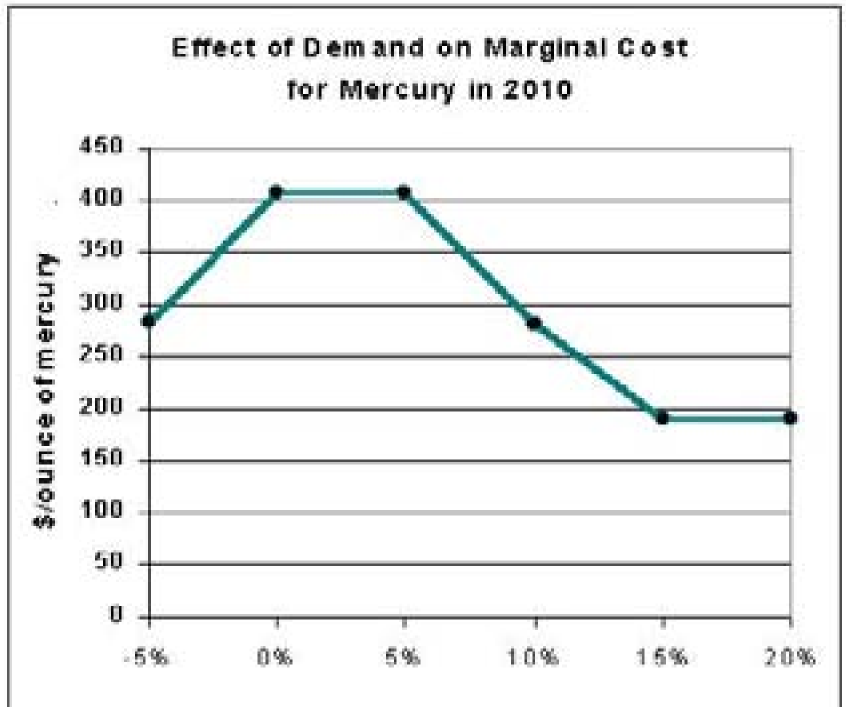
Varying Industry Growth Rates

• If electricity demand were 15-20% higher than assumed in the Integrated Planning Model, the marginal cost of controlling SO_2 and NOx would be approximately 10% higher, though the marginal cost of mercury would be lower.

• As demand rises, there is greater constraint on sources under the NOx cap than under the mercury cap since new gas-fired generating capacity has some NOx emissions, but no mercury emissions. The decline in the marginal costs of mercury abatement arises because of the increased use of the NOx controls, which enables the mercury cap to be achieved at a lower cost.



Change in electricity demand from 2010 baseline

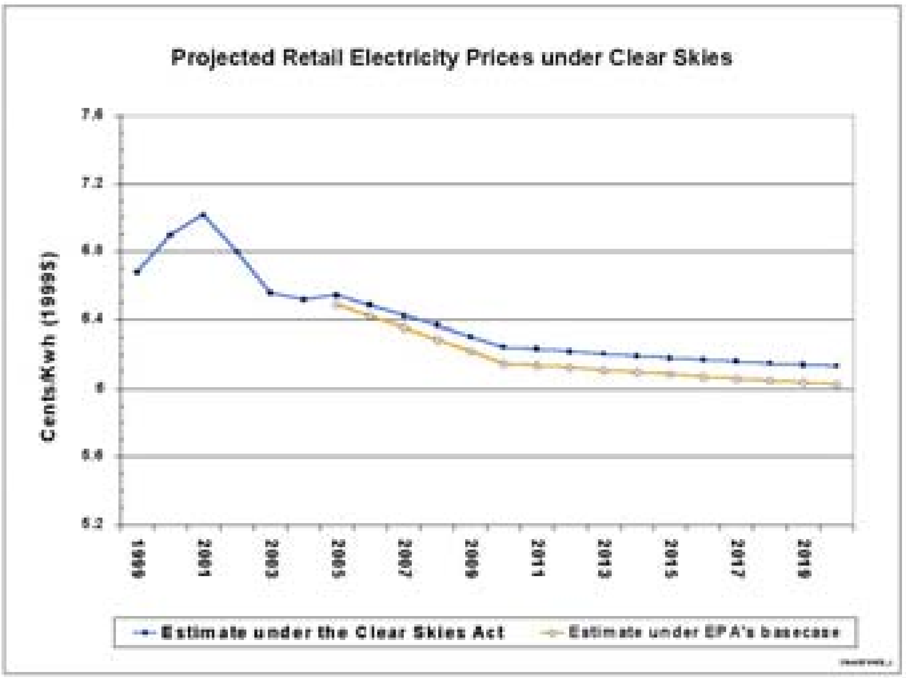


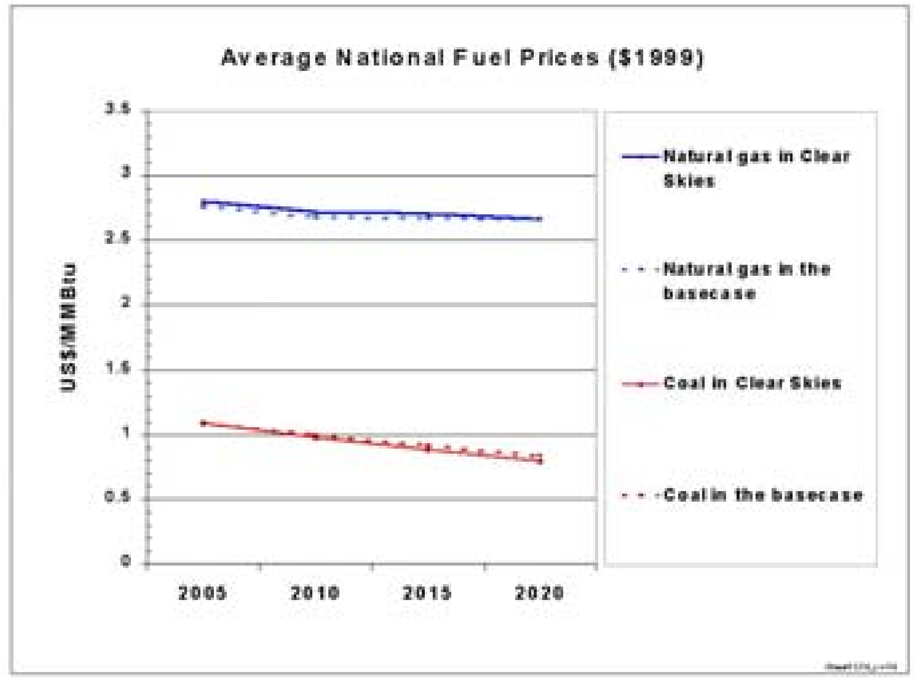
Change in electricity demand from 2010 baseline

Note: The projected *emissions* under the Clear Skies Act in 2010 were used for this analysis. Analysis uses the Technology Retrofit and Updating Model (see Section G for a description).

Impact on Electricity Prices and Fuel Prices

- Retail electricity prices are expected to gradually decline *with or without* Clear Skies because of efficiency improvements and ongoing restructuring in the electricity generating sector.





Note: Retail prices through 2003 are from AEO2000. Prices for the period after 2003 were calculated using the Retail Electricity Price Model (see Section G for a description of the Model).

The coal price represents an average minemouth price across all twelve grades of coal in the model. The natural gas price is the Henry Hub price. Average national fuel prices are EPA's estimates.

Section D:

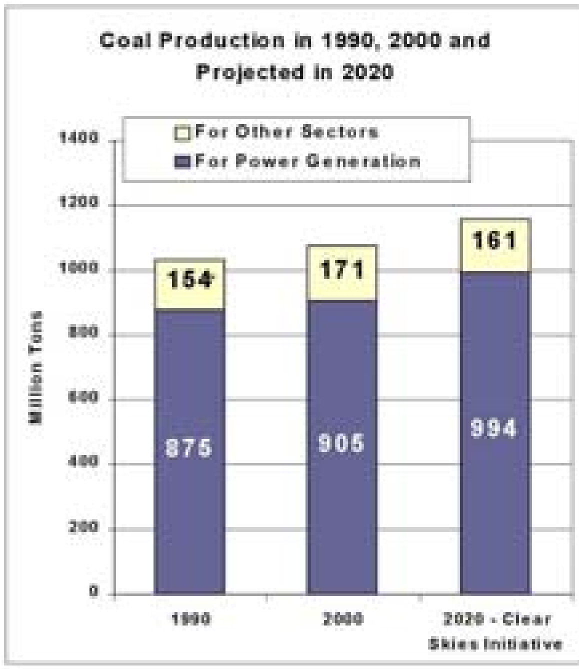
Projected Impacts on Generation and Fuel Use

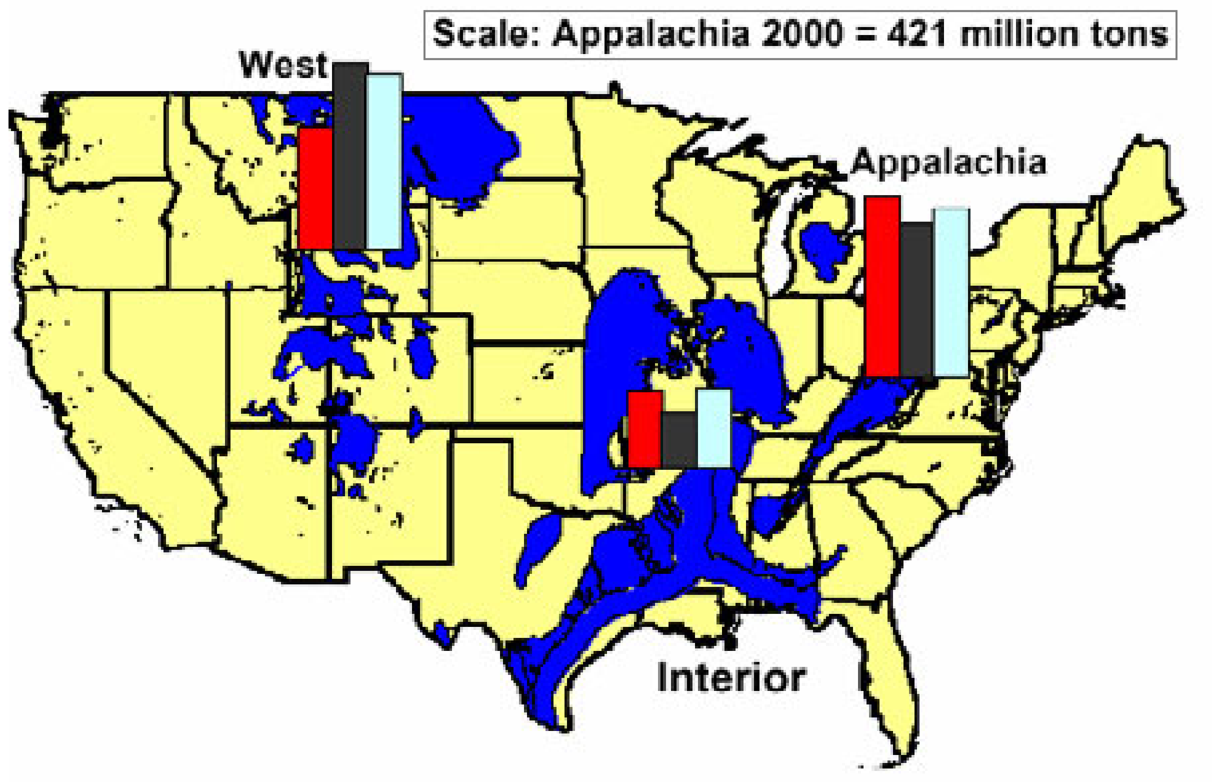
National Coal Production in 1990 and 2000, and Projected Production under Clear Skies in 2020

1990 National Coal Production

2000 National Coal Production

2020 National Coal Production under CSA





Note: In 1990, EIA did not report the coal produced for power generators. From 1998-2000, 85% of coal produced was for the power generation sector. For an estimate of coal produced for the power generation sector in 1990, EPA assumed the same percentage (85%).

Note: 2020 national coal production projections are EPA estimates from IPM.

1990 data: Coal Industry Annual 1994, Table 4 (DOE/EIA-0584 (2000)).

2000 data: Coal Industry Annual 2000, Table 4 and Table 63 (DOE/EIA-0584 (2000)), January, 2002.

2020 production for the power generation sector: Derived from the Integrated Planning Model.

2020 production for other sectors: Derived from the National Energy Modeling System.

Coal Production and Employment Impacts

Coal Production in 1990 and 2000, and Projected in 2020 under Clear Skies (million tons)			
Region	**1990**	**2000**	**2020 under Clear Skies**
Appalachia	489	421	461
Interior	206	145	214
West	334	510	481
Total	**1,029**	**1,076**	**1,155**

Note: 2020 national coal production projections are EPA estimates from IPM. Totals may not sum due to rounding. Regions are based on DOE regional definitions. Appalachia includes Northern, Central and Southern Appalachia. Interior includes Midwest, Central West and Gulf. West includes far West.

1990 and 2000 data: Coal Industry Annual 1994, Table 4 (DOE/EIA-0584 (1994)), and Coal Industry Annual 2000, Table 4 (DOE/EIA-0584 (2000)).

2000 data: 2020 production under Clear Skies: Derived from the Integrated Planning Model and the National Energy Modeling System.

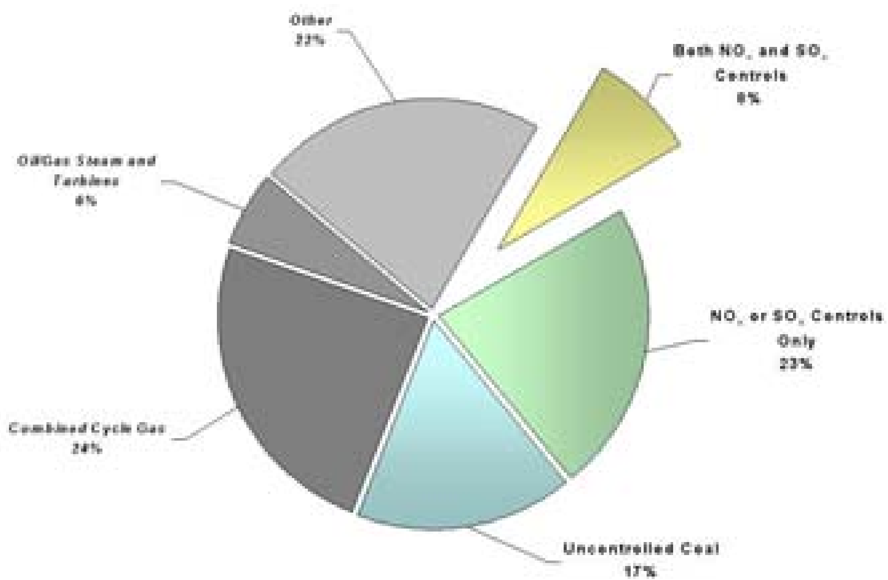
Coal Producing Region	2005	2020
Appalachia	-460	491
Interior	2,000	2,519
West	-588	-1,611
	952	**1,399**

Source: ICF Analysis, September 2002.

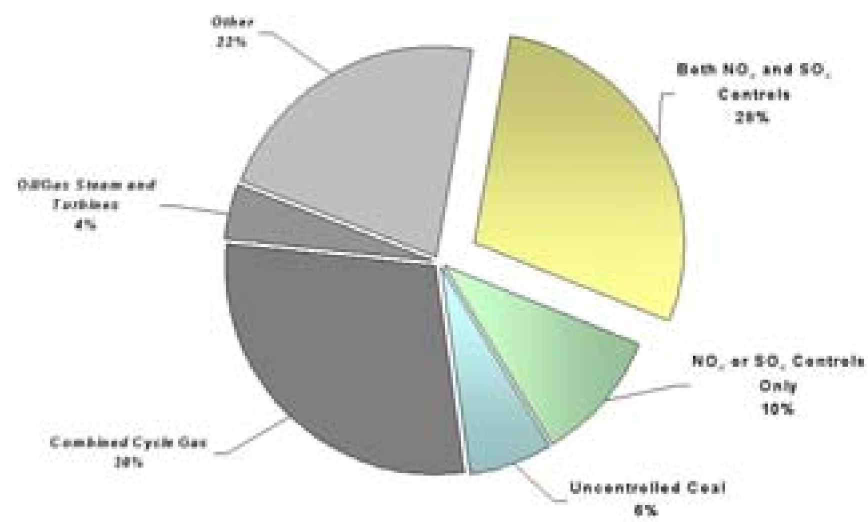
Notes: Regions are based on DOE regional definitions. Appalachia includes Northern, Central and Southern Appalachia. Interior includes Midwest, Central West and Gulf. West includes far West.

Projected Generation Mix in 2020

Generation mix in 2020 in EPA's Base Case



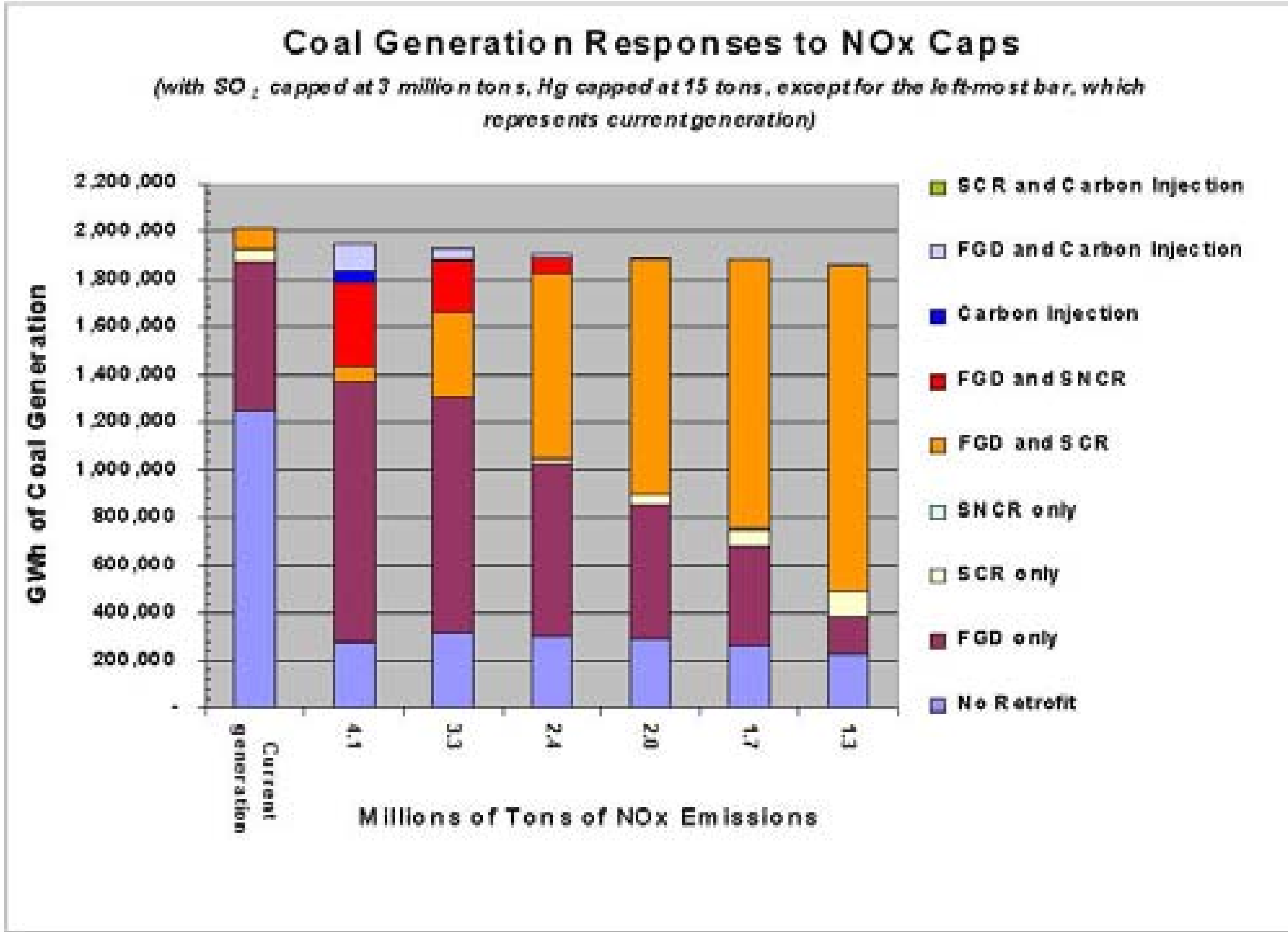
Generation mix in 2020 with Clear Skies



Note: Controlled Coal includes units with post-combustion SO_2 and/or NOx controls. "Uncontrolled Coal" could include PM and/or NOx combustion controls. The EPA 2000 Base Case in IPM includes Title IV, the NOx SIP Call, and state-specific caps in CT, MO and TX.

<u>2020 generation mix</u>: Projections are from EPA's modeling using IPM, The "Other" category includes generation from solar, wind, geothermal, biomass, landfill gas, and fuel cells. Control technology percentages are approximations. "Scrubbers and SCR" includes a very small amount of SNCR. "Scrubbers only" includes a very small amount of IGCC. "SCR only" includes a very small amount of SNCR. "SNCR only" includes a very small amount of gas reburn. "ACI" includes ACI retrofits on combinations of scrubbers and SCR.

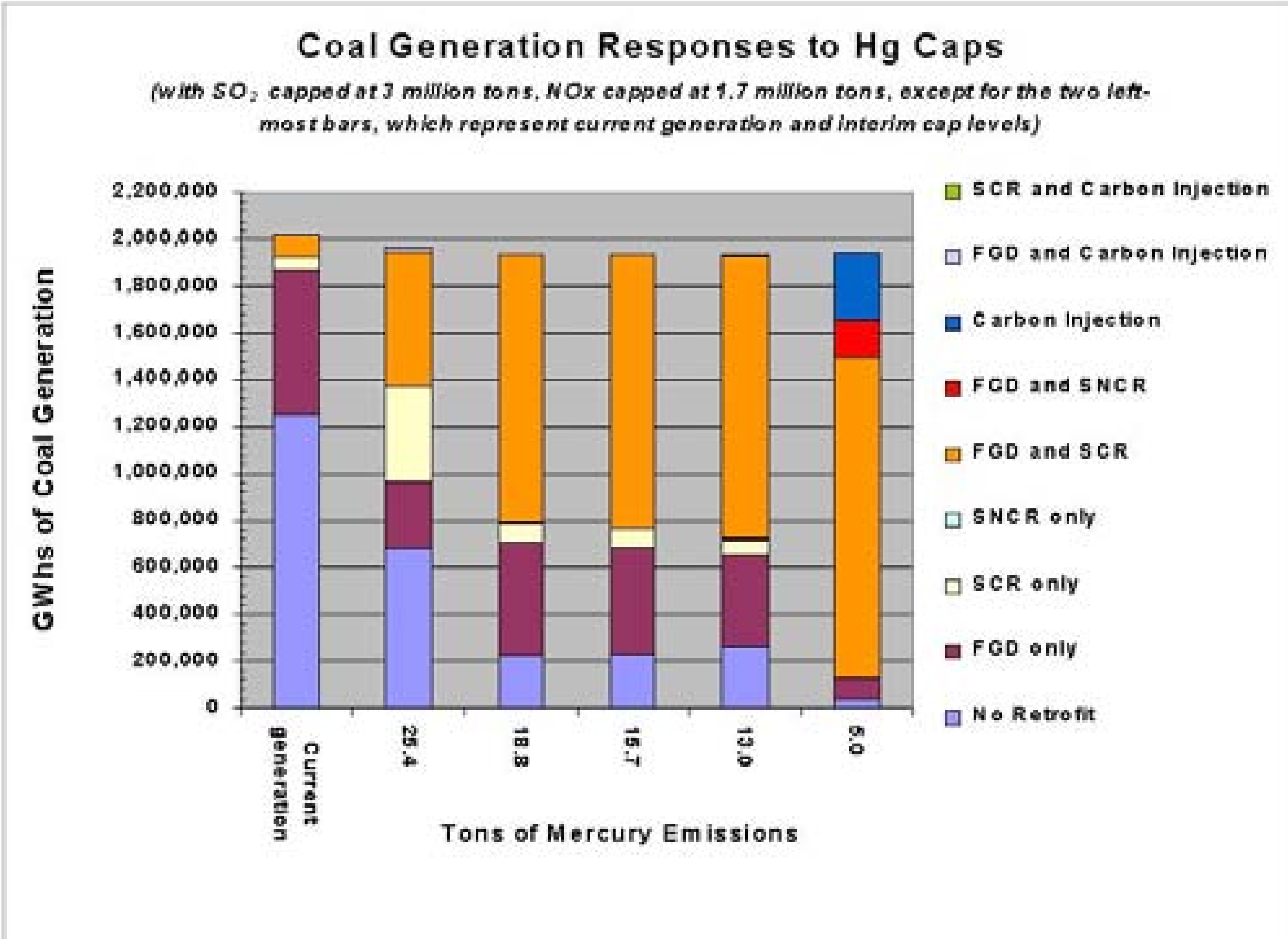
Technology Response to Varying Cap Levels



- At a 1.7 million ton NOx cap on electricity generators, only a small portion of the coal generation is projected to remain without controls. This uncontrolled portion is comprised primarily of smaller units. Most of the generation is projected to retrofit with FGD and/or SCR.

Note and Abbreviations: This analysis used the Technology Retrofit and Updating Model. This analysis did *not* consider the feasibility of installing controls in the 2010 timeframe. SCR is selective catalytic NOx reduction, carbon injection is a mercury control technology, FGD is flue gas desulfurization (i.e., scrubbers), and SNCR is selective non-catalytic NOx reduction.

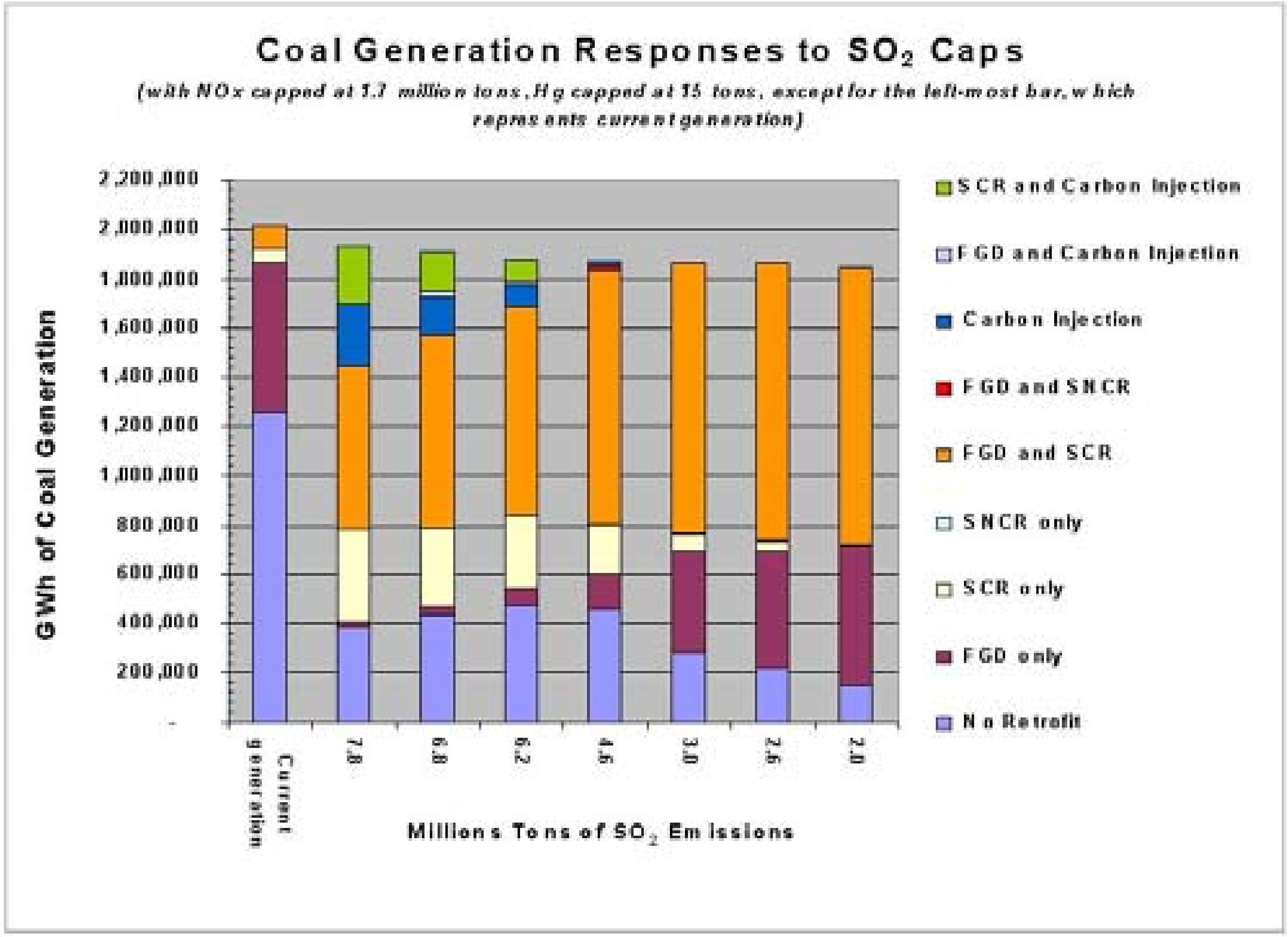
Technology Response to Varying Cap Levels



- At a 15 ton Hg cap on coal-fired electricity generators, only a small portion of the coal generation is projected to remain without controls. This uncontrolled portion is comprised primarily of smaller units. Most of the generation is projected to retrofit with scrubbers (FGD) and/or selective catalytic reductions (SCR).

Note and Abbreviations: This analysis used the Technology Retrofit and Updating Model. This analysis did *not* consider the feasibility of installing controls in the 2010 timeframe. SCR is selective catalytic NOx reduction, carbon injection is a mercury control technology, FGD is flue gas desulfurization (i.e., scrubbers), and SNCR is selective non-catalytic NOx reduction.

Technology Response to Varying Cap Levels

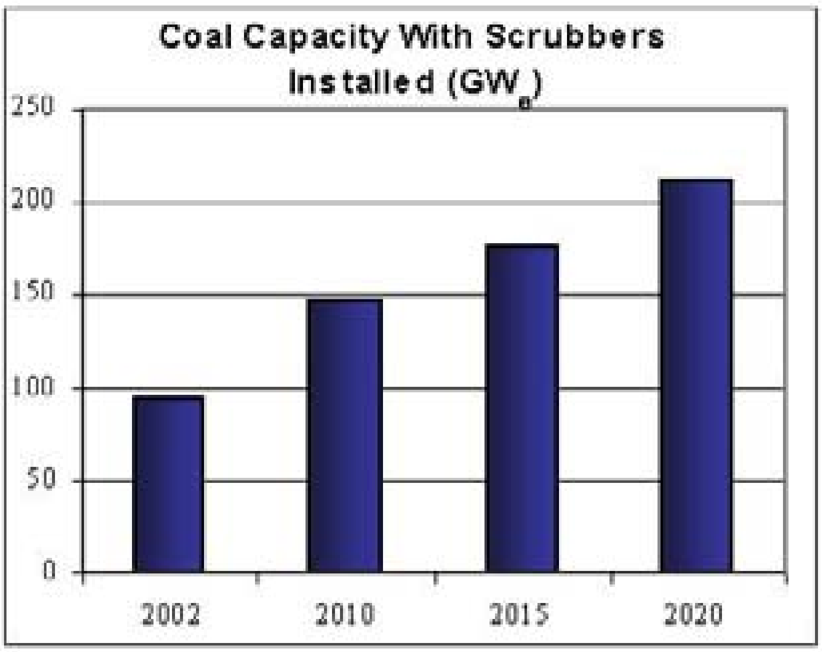


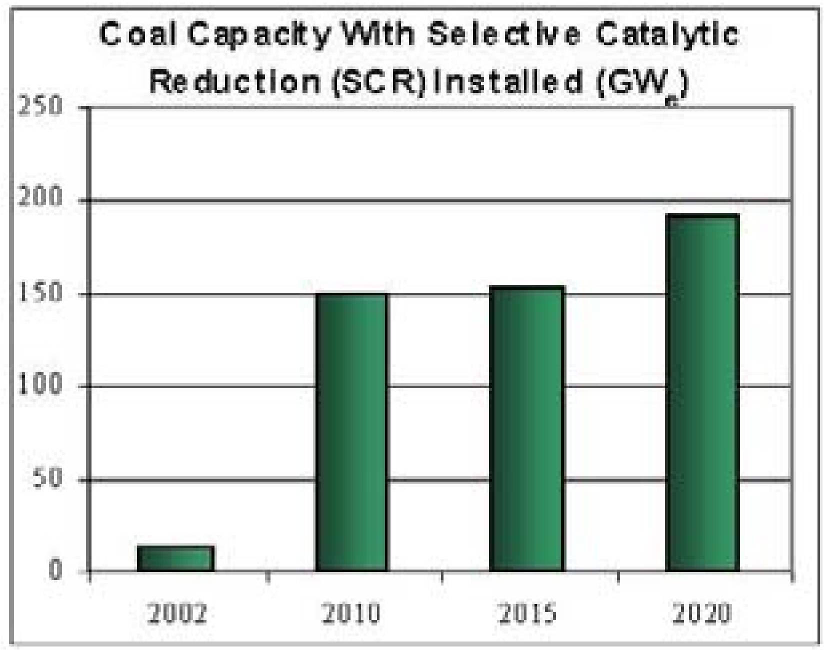
- At a 3 million ton SO_2 cap, a portion of the coal generation is projected to remain without controls. This uncontrolled portion is comprised primarily of smaller units. Most of the generation is projected to retrofit with FGD and/or SCR.

Note and Abbreviations: This analysis used the Technology Retrofit and Updating Model. This analysis did *not* consider the feasibility of installing controls in the 2010 timeframe. SCR is selective catalytic NOx reduction, carbon injection is a mercury control technology, FGD is flue gas desulfurization (i.e., scrubbers), and SNCR is selective non-catalytic NOx reduction.

Projected Coal Capacity with Emissions Controls

- In 2020 under Clear Skies, 85% of all coal-fired generation comes from controlled coal.*
- Graphics show cumulative capacity with existing controls, controls projected to be retrofitted under the NOx SIP call and Title IV, and controls projected to be retrofitted under Clear Skies.





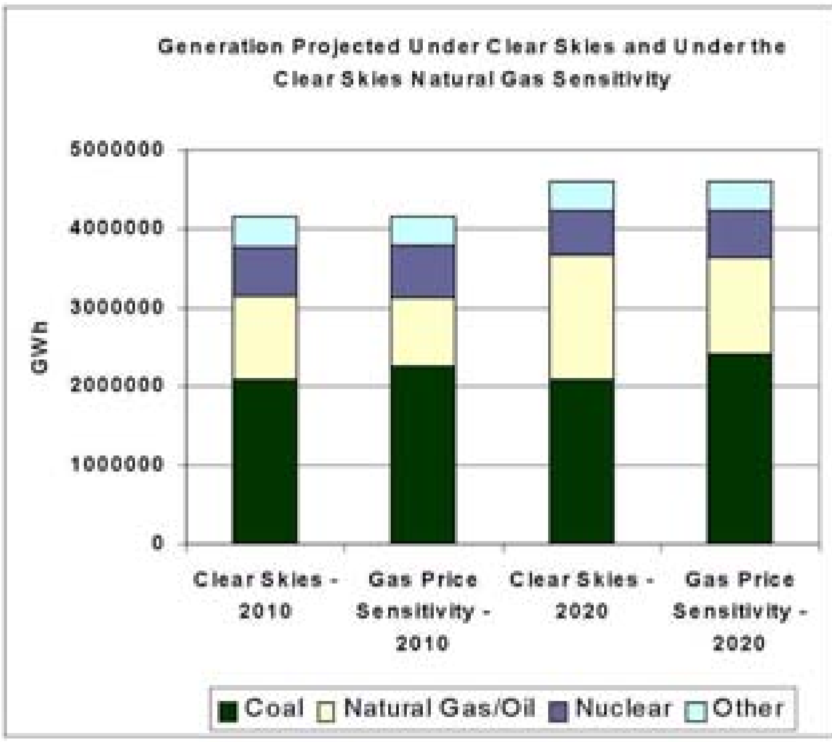
Note: Retrofit projections are EPA's analysis using IPM. "Controlled coal" includes one or more of the following: SCR, scrubbers, ACI, gas re-burn and SNCR.

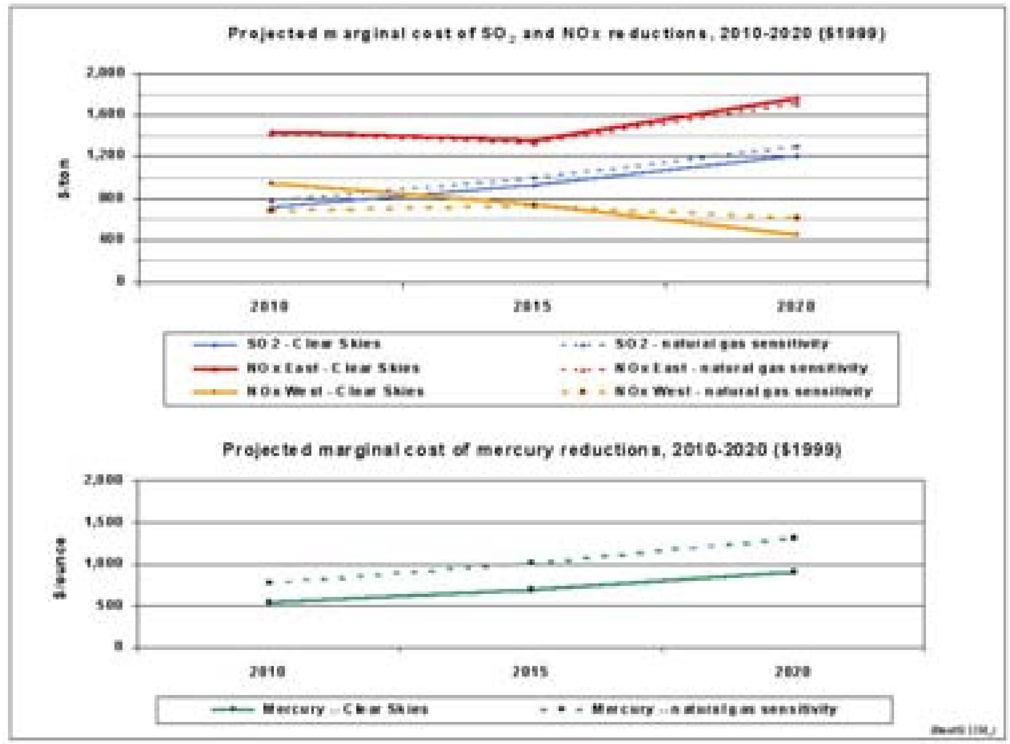
Impact of Changes in Natural Gas Prices and Mercury Control Efficiency

- **Several key modeling assumptions in IPM that underlie the analysis of Clear Skies have been challenged by stakeholders. These include:**
  - The natural gas prices in the model.
  - The mercury removal efficiency of a combination of scrubbers and SCR.
- **EPA has run a number of sensitivities that explore the impact of changes in these modeling assumptions. Specifically:**
  - EPA shifted the natural gas supply curve in IPM up $0.80/MMBtu, or approximately 30%, to analyze concerns about low natural gas prices in the model.
  - EPA reduced the mercury removal efficiency of the combination of scrubbers and SCR from 95% to 80.

Impact of Changes in Natural Gas Prices

- Shifting the natural gas supply curve in IPM up \$0.80/MMBtu, or approximately 30%, results in the following impacts on generation and marginal costs.

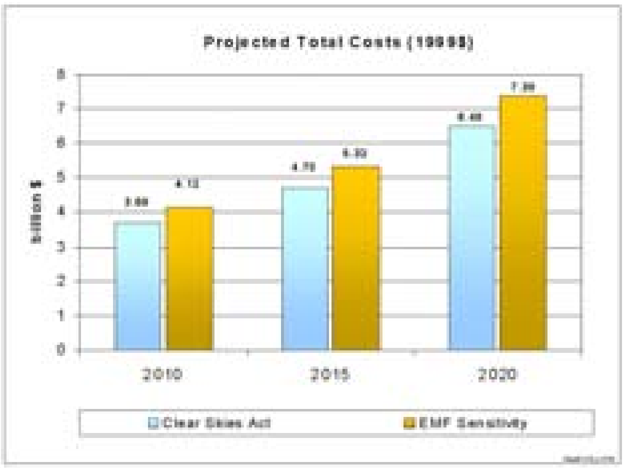


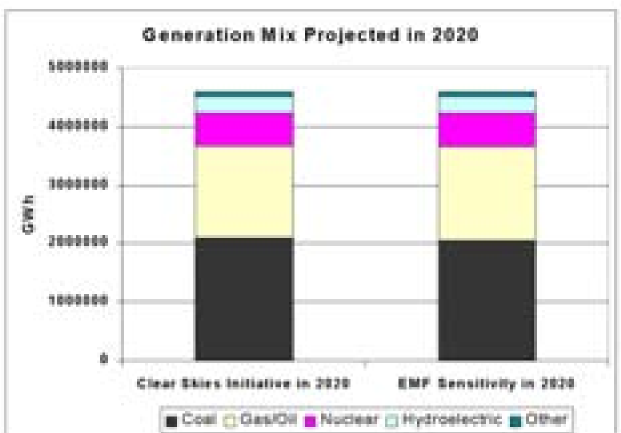


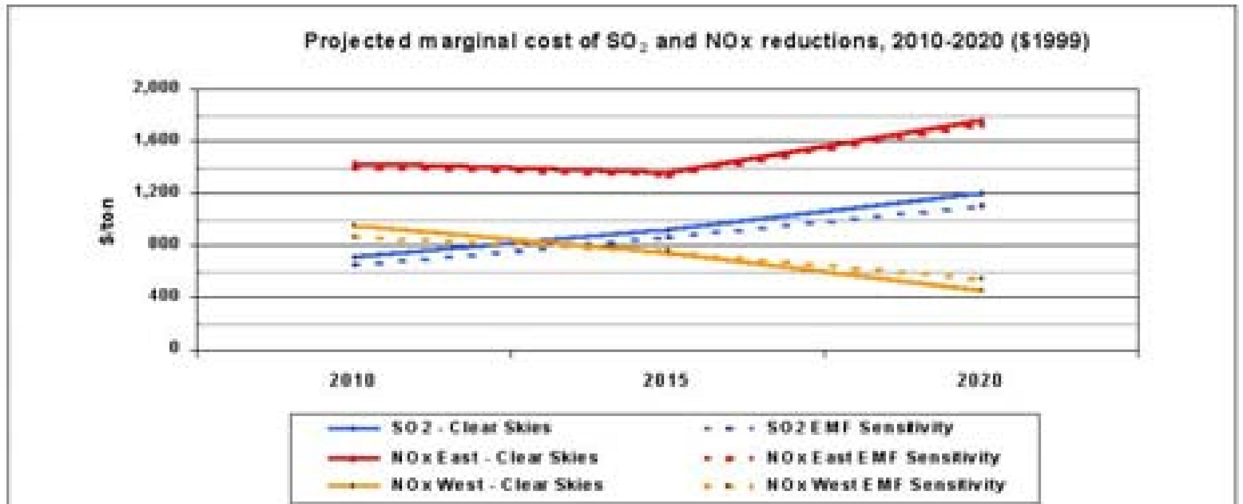
Note: For more information on the gas supply curves used in IPM see Chapter 8 and the Appendix to chapter 8 at http://www.epa.gov/airmarkets/epa-ipm/index.html#documentation,

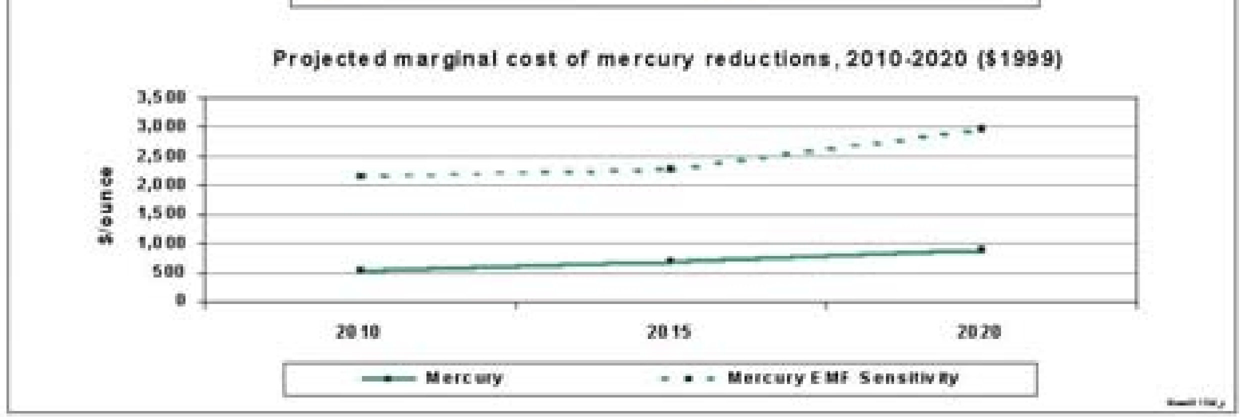
Varying Effectiveness of Mercury Control Technologies

- Impacts of varying the assumptions regarding the mercury removal efficiency of a combination of SCR and FGD were examined using IPM; the results are compared to the Clear Skies policy with standard assumptions.









Note: See the IPM documentation, chapter 5, table 5.7a (http://www.epa.gov/airmarkets/epa-ipm/index.html#documentation) for more information and 5.3.2 for a definition of "Alternative Emission Modification Factors (EMFs)". An EMF is the ratio of outlet mercury concentration to inlet mercury concentration; EMF's capture the mercury reductions attributable to different unit configurations and different configurations of SO_2, NOx, and particulate controls.

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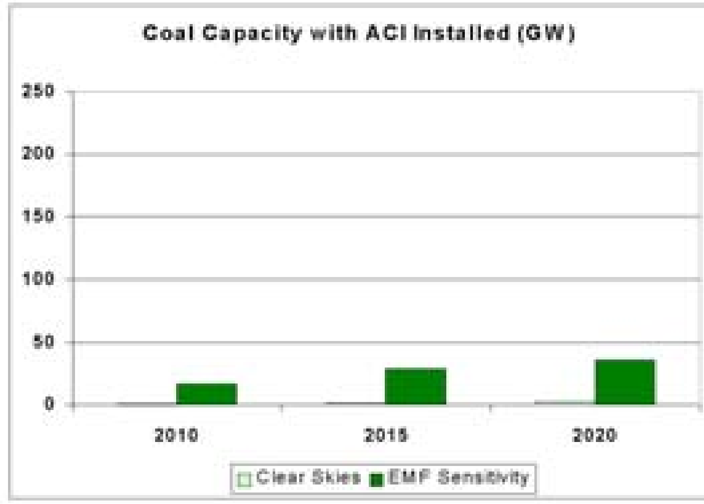
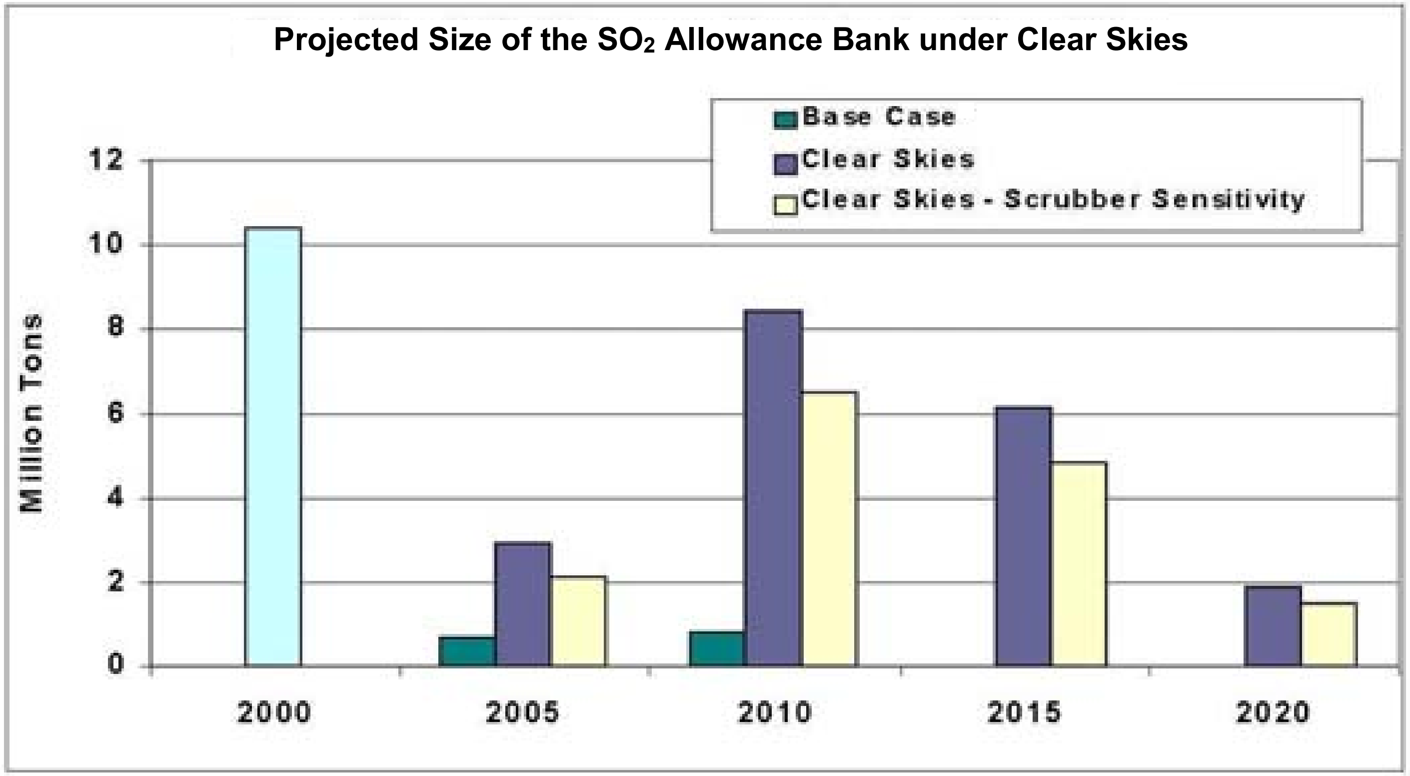


Note: See the IPM documentation, chapter 5, table 5.7a (http://www.epa.gov/airmarkets/epa-ipm/index.html#documentation) for more information and chapter 5.3.2 for a definition of “Alternative Emission Modification Factors (EMFs)”.

An EMF is the ratio of outlet mercury concentration to inlet mercury concentration; EMF’s capture the mercury reductions attributable to different unit configurations and different configurations of SO_2, NOx, and particulate controls.

Impact of Alternative Scrubber Projections on the Size of the SO_2 Allowance Bank

- IPM modeling for Clear Skies has projected that approximately 32 GW would be economical to install by 2005; many industry groups stated that it would not be able to retrofit this much capacity in such a short period, particularly since many units will already be installing controls to comply with the reduction requirements in the NOx SIP Call.
- EPA conducted a sensitivity analysis in which the scrubber installations were limited to only 10 GW in 2005, approximately 70% less than the model projects would occur. Even with fewer scrubbers installed by 2005, sources are projected to continue banking a significant number of SO_2 allowances.

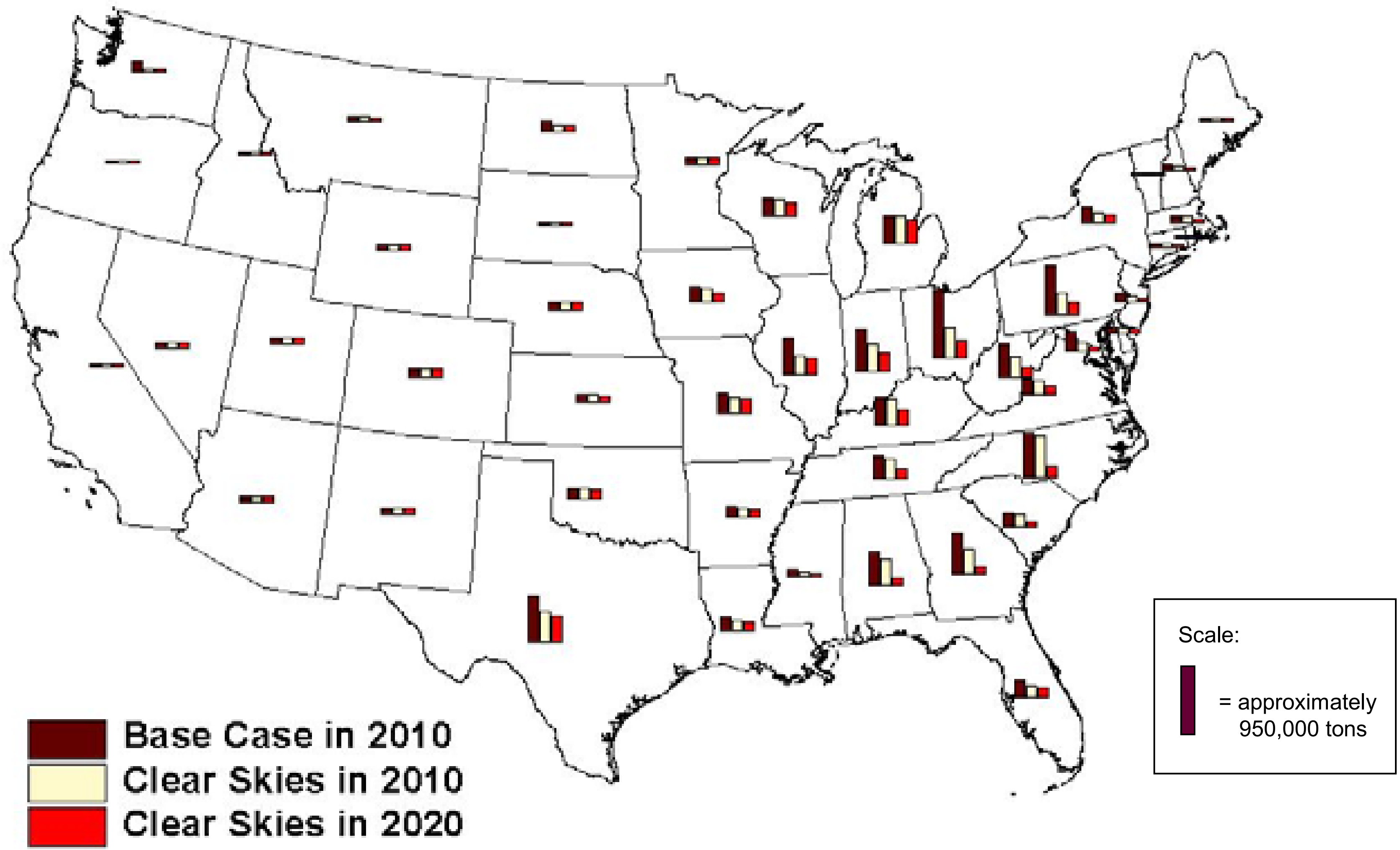


Note: Projected allowance banking data is from IPM.

Section E:

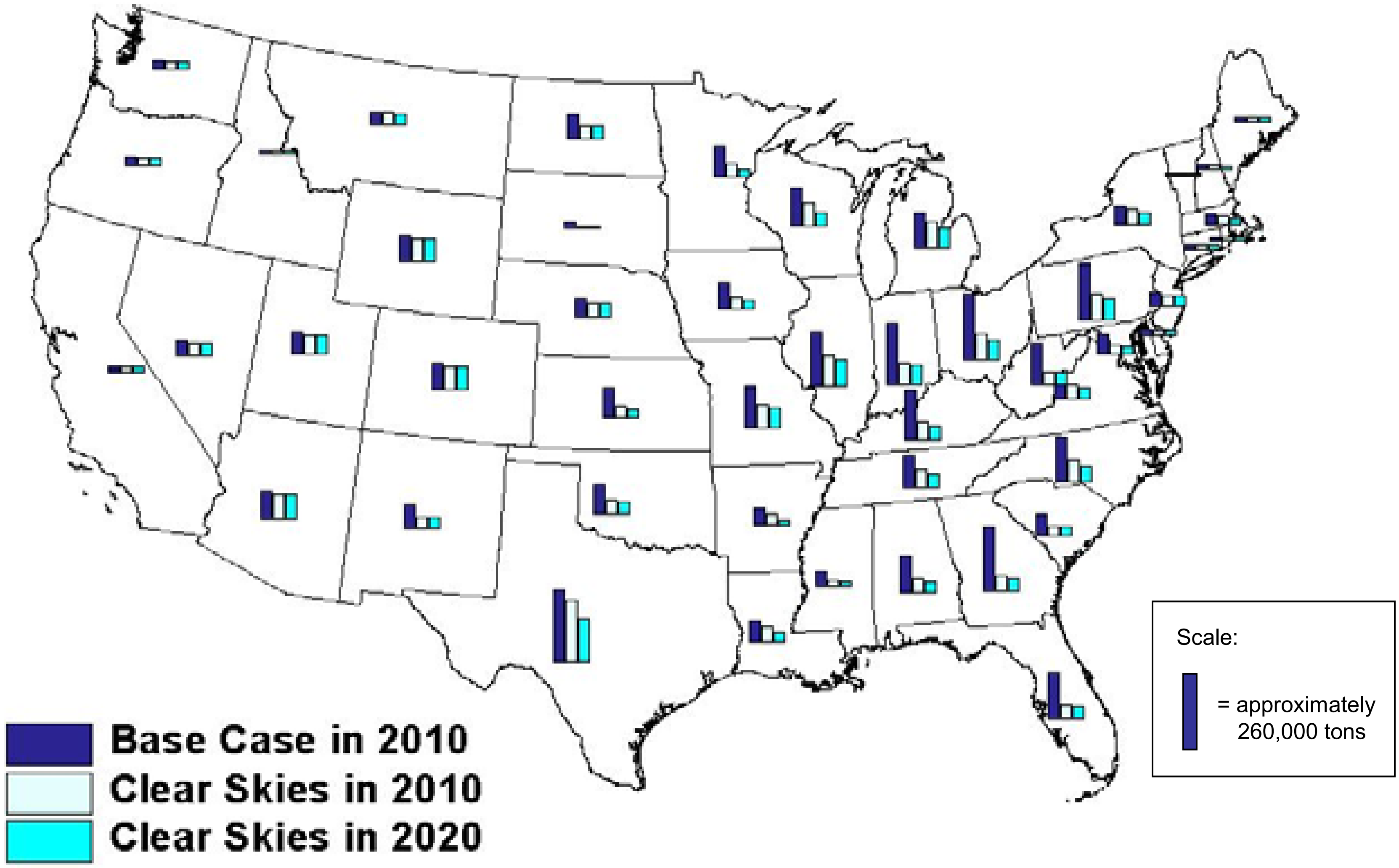
Projected Impacts on the State and Regional-Level

Emissions of Sulfur Dioxide



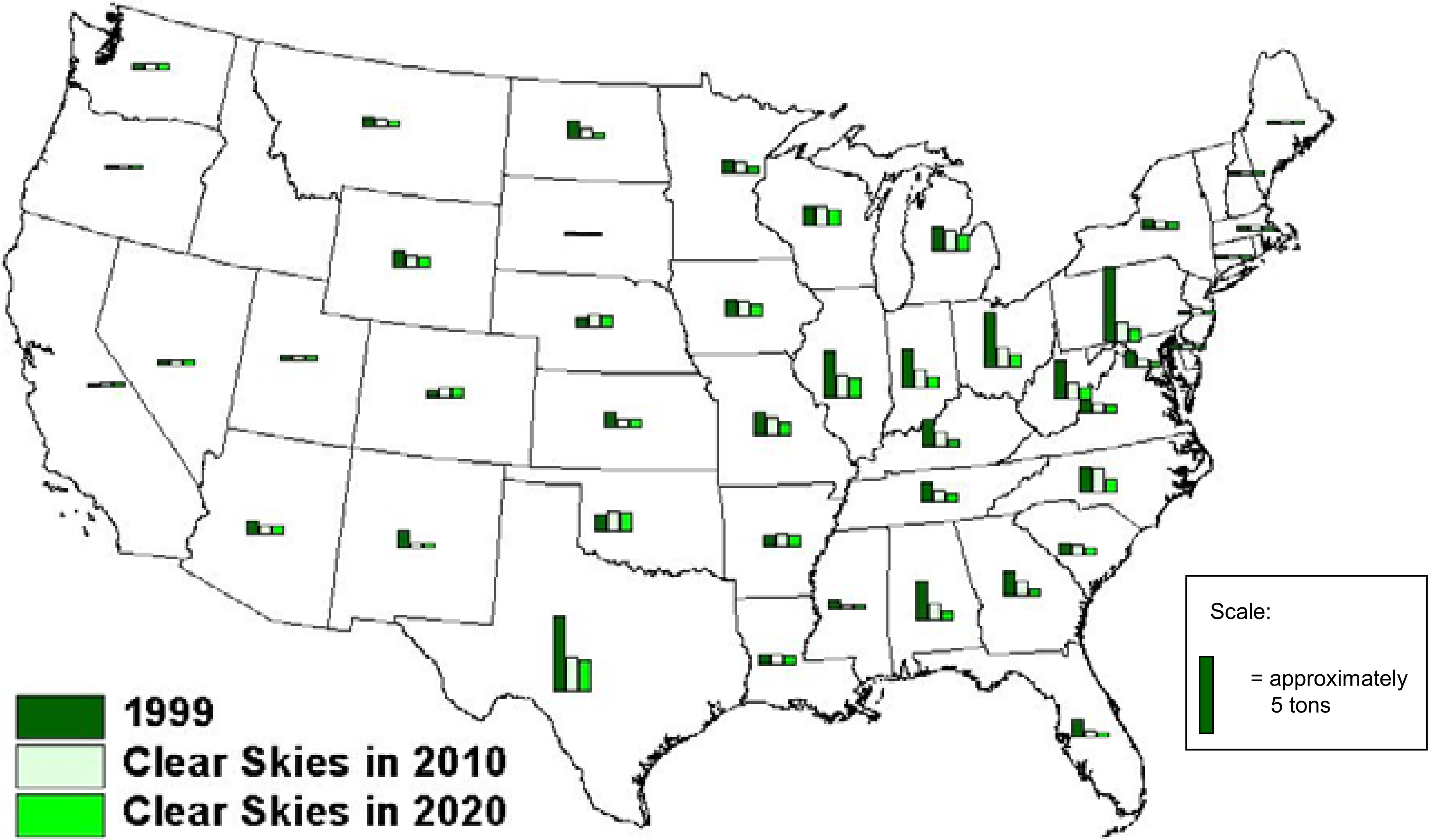
Note: Total emissions under the Base Case in 2010 would be 9.6 million tons; total emissions under Clear Skies in 2010 would be 6.6 million tons; total emissions under Clear Skies in 2020 would be 3.9 million tons. Emissions will continue to decline after 2020 until the cap level is reached. Emissions are from electric generating facilities greater than 25MW. The EPA 2000 Base Case in IPM includes Title IV, the NOx SIP Call, and state-specific caps in Connecticut, Missouri and Texas. The Base Case does not include any potential future regulations to implement the current CAA.

Emissions of Nitrogen Oxide



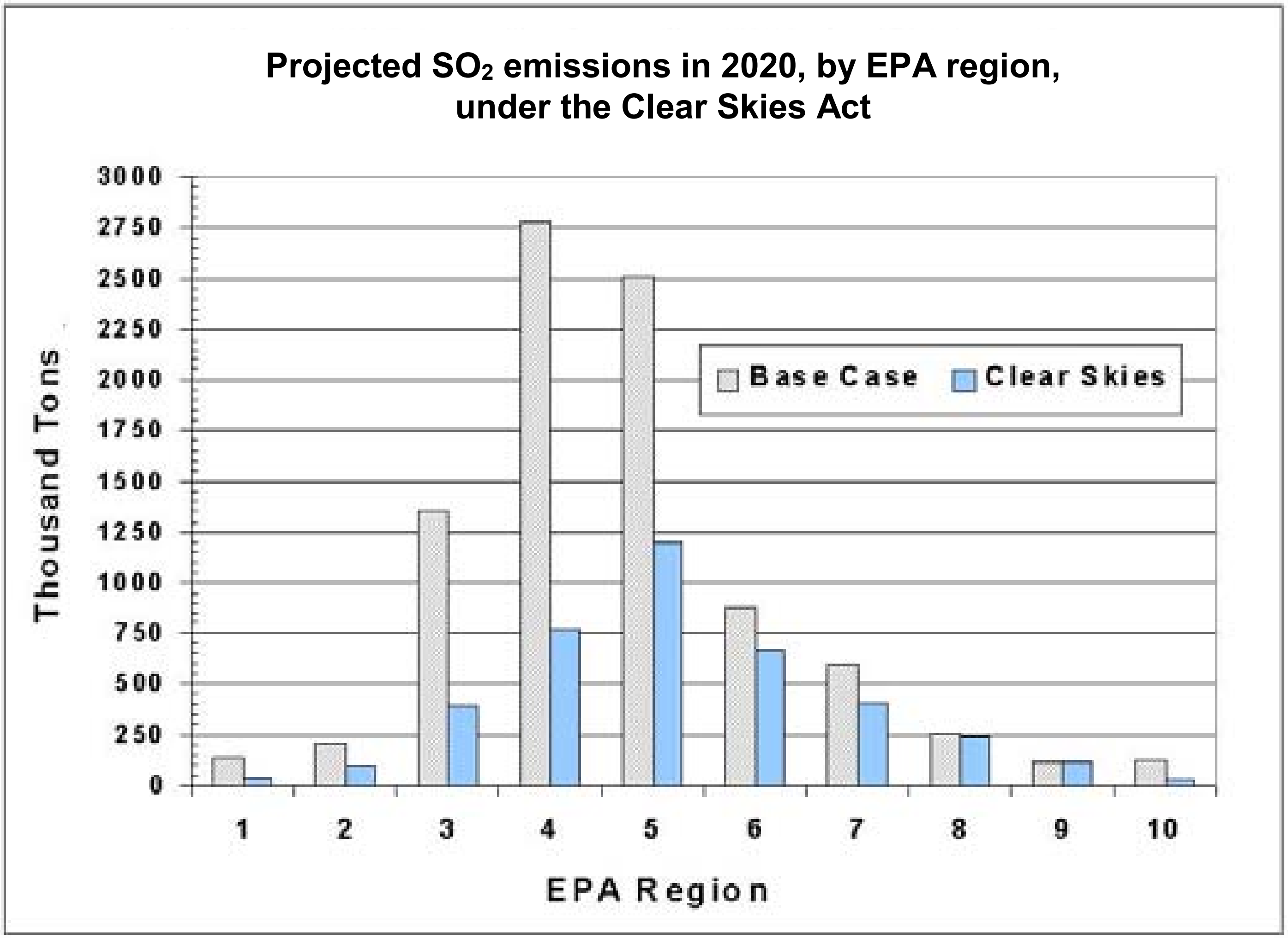
Note: Total emissions under the Base Case in 2010 would be 4.2 million tons; total emissions under Clear Skies in 2010 would be 2.1 million tons; total emissions under Clear Skies in 2020 would be 1.7 million tons. Emissions are from electric generating facilities greater than 25MW. The EPA 2000 Base Case in IPM includes Title IV, the NOx SIP Call, and state-specific caps in Connecticut, Missouri and Texas. The Base Case does not include any potential future regulations to implement the current CAA.

Emissions of Mercury



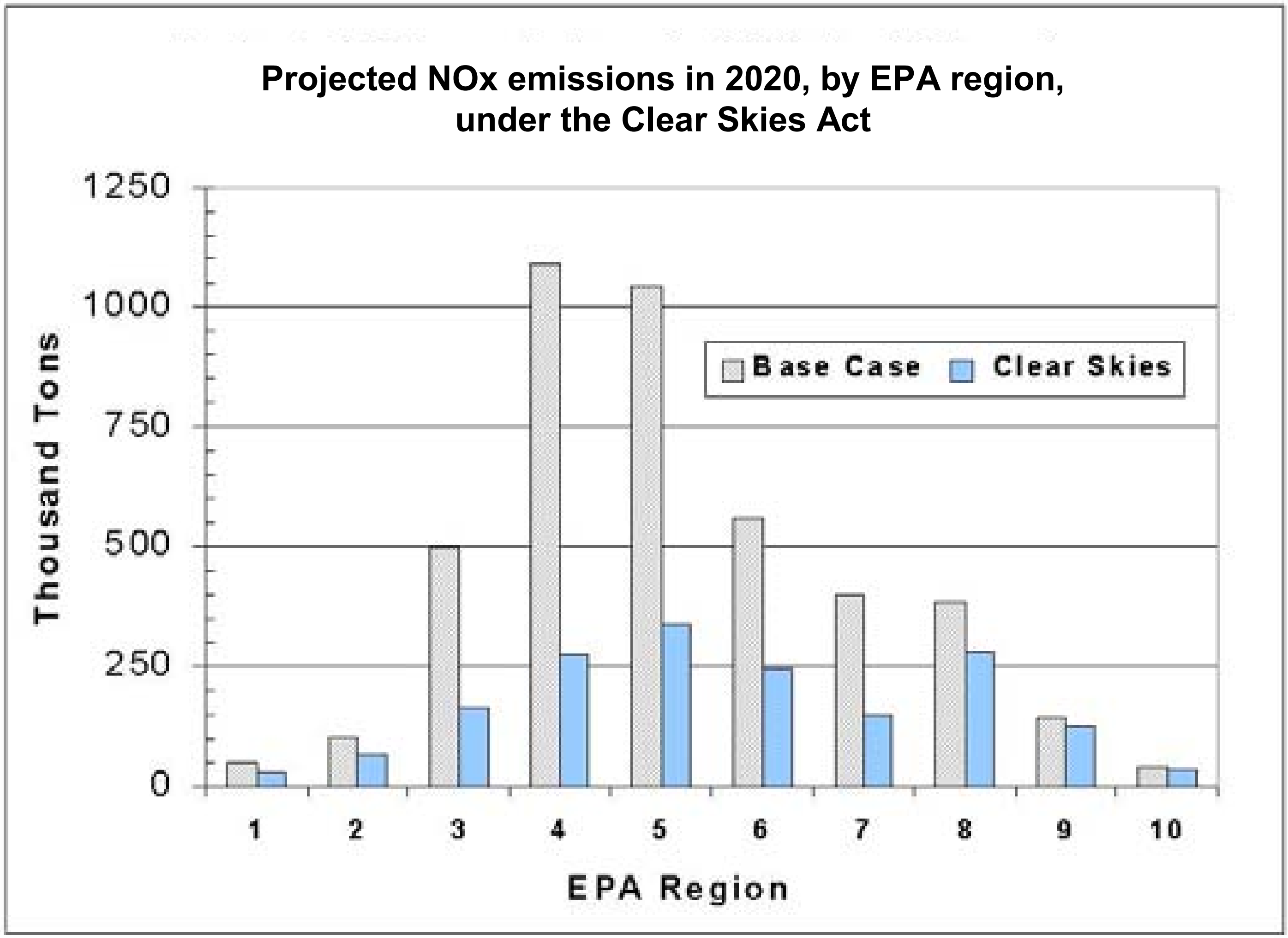
Note: Total emissions in 1999 were 48 tons; total emissions under Clear Skies in 2010 would be 26 tons; total emissions under Clear Skies in 2020 would be 18 tons. Emissions will continue to decline after 2020 until the cap level is reached. Emissions are from coal-fired electric generating facilities greater than 25MW.

Projected SO_2 Emissions from Power Plants



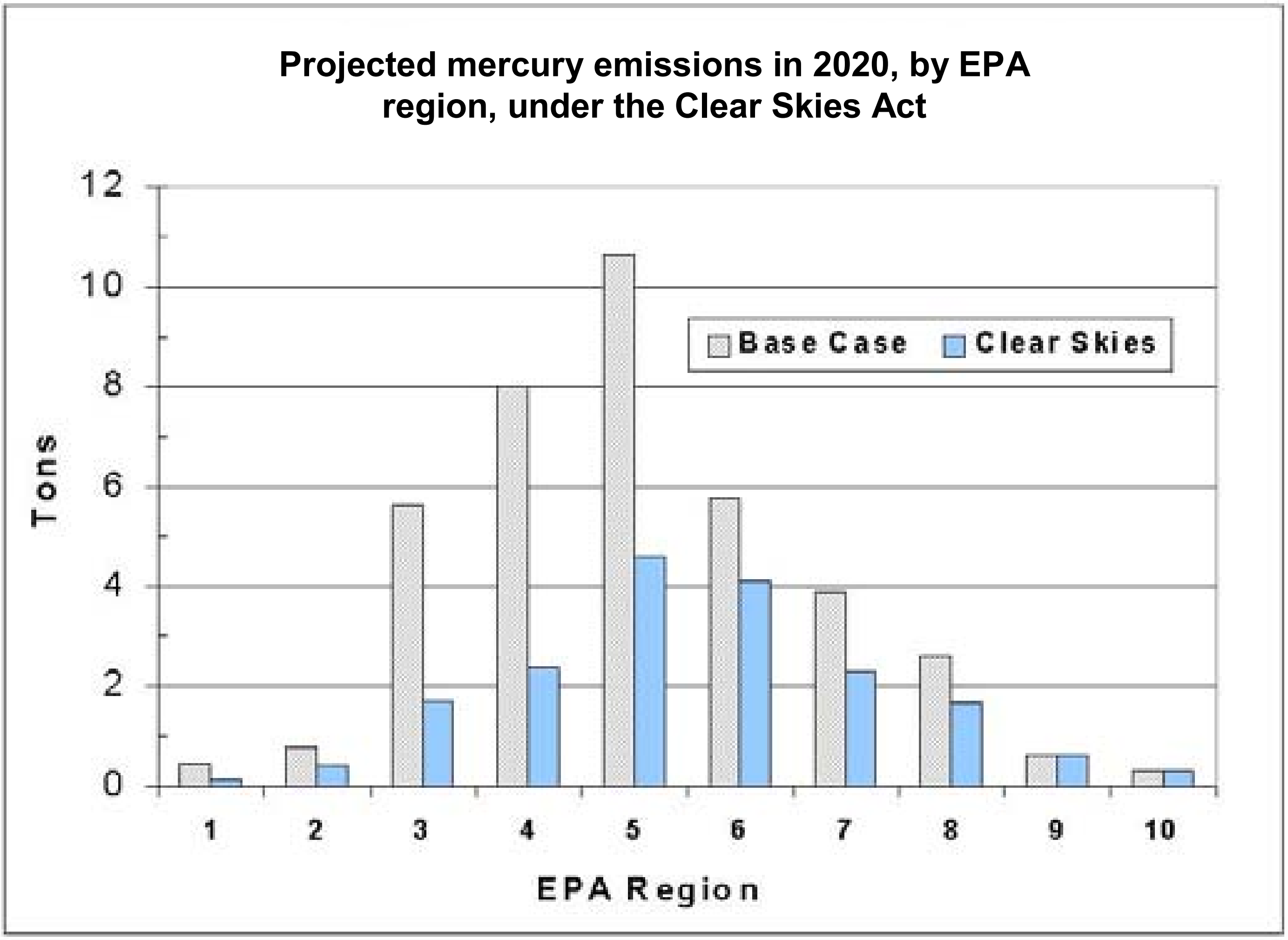
Note: The EPA 2000 Base Case in IPM includes Title IV, the NOx SIP Call, and state-specific caps in Connecticut, Missouri and Texas. The Base Case does not include any potential future regulations to implement the current CAA. Subsequent to the development of the latest version of the model used to project power plant emissions, SO_2 control equipment has been installed at the Centralia Plant in Washington. Since emission reductions from the installation of these controls were not included in the **base case** modeling, the amount of reductions expected under Clear Skies, as well as the benefits associated with those reductions, will be lower in the state of Washington (Region X) than projected.

Projected NOx Emissions from Power Plants



Note: The EPA 2000 Base Case in IPM includes Title IV, the NOx SIP Call, and state-specific caps in Connecticut, Missouri and Texas. The Base Case does not include any potential future regulations to implement the current CAA.

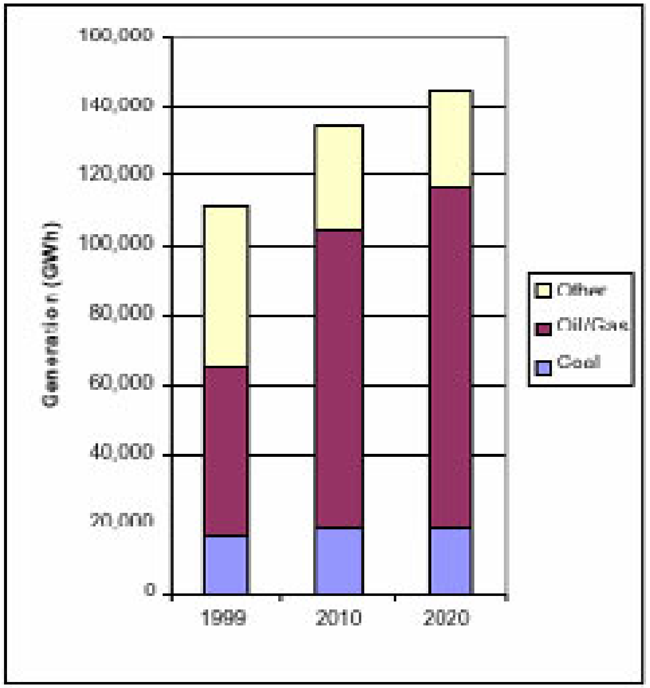
Projected Mercury Emissions from Power Plants



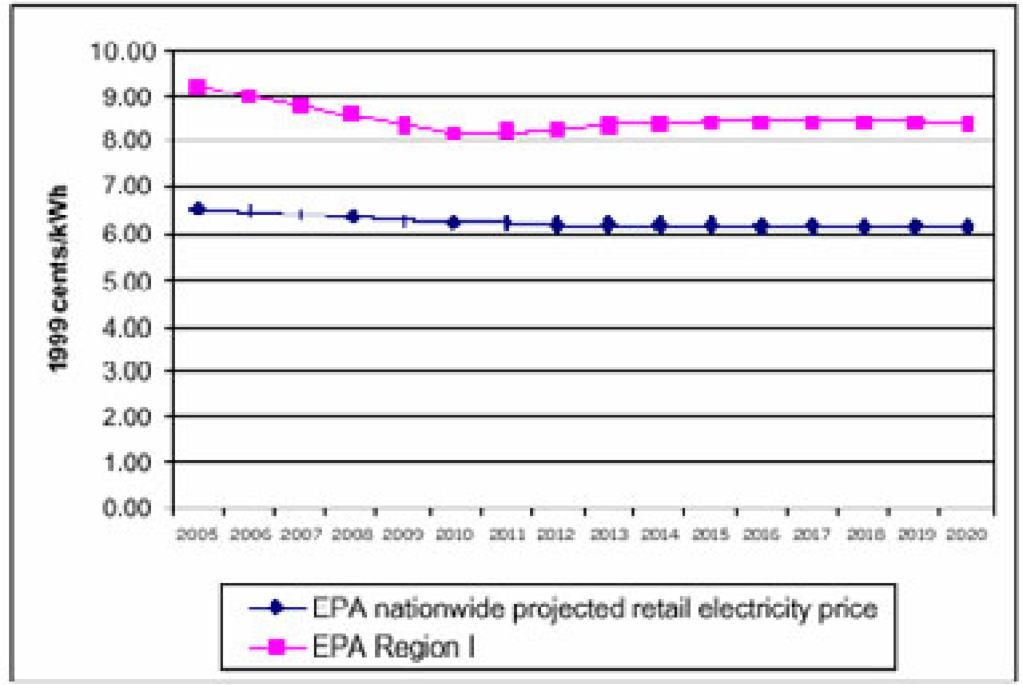
Note: The EPA 2000 Base Case in IPM includes Title IV, the NOx SIP Call, and state-specific caps in Connecticut, Missouri and Texas. The Base Case does not include any potential future regulations to implement the current CAA.

Summary of Projected Impacts in EPA Region I

Current Generation Mix and Projected Mix Under Clear Skies



Projected Retail Electricity Prices under Clear Skies (2005 - 2020)



Projected Emissions Rates from Power Generators

Year		SO_2	NOx			Hg
		Coal	All	Coal	Gas	Coal
	Units	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/TBtu
2010	Base Case	1.40	0.13	0.30	0.07	5.74
	Clear Skies	1.00	0.11	0.28	0.06	3.19
2020	Base Case	1.27	0.12	0.30	0.06	4.56
	Clear Skies	0.37	0.07	0.13	0.05	1.61

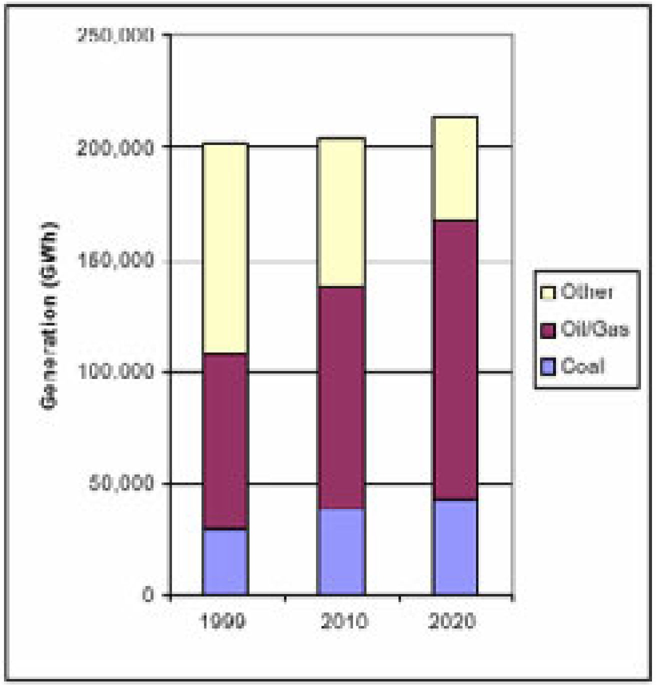
Note: Region I includes Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont.

2020 generation projections are EPA estimates using IPM. 1999 generation from EIA, aggregated from state-level data at: www.eia.doe.gov/cneaf/electricity/st_profiles/ (Table 5).

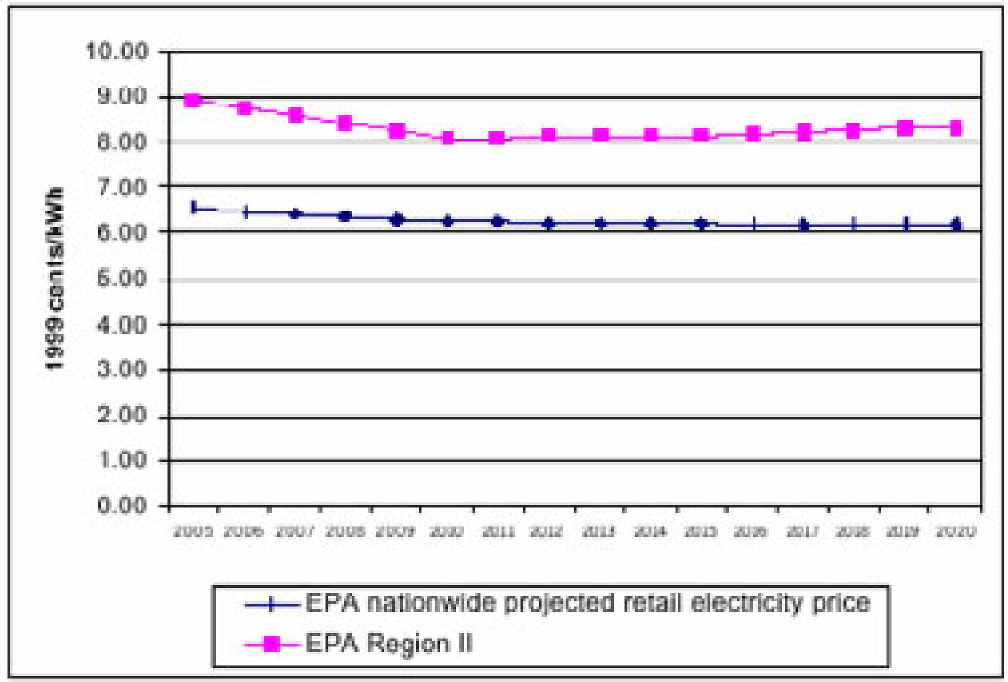
Electricity prices were calculated using the Retail Electricity Price Model (see Section G for a description of the Model).

Summary of Projected Impacts in EPA Region II

Current Generation Mix and Projected Mix Under Clear Skies



Projected Retail Electricity Prices under Clear Skies (2005 - 2020)



Projected Emissions Rates from Power Generators

Year		SO_2	NOx			Hg
		Coal	All	Coal	Gas	Coal
	Units	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/TBtu
2010	Base Case	1.42	0.18	0.42	0.05	8.62
	Clear Skies	0.89	0.14	0.32	0.05	3.30
2020	Base Case	1.03	0.17	0.42	0.05	3.98
	Clear Skies	0.47	0.11	0.24	0.05	2.05

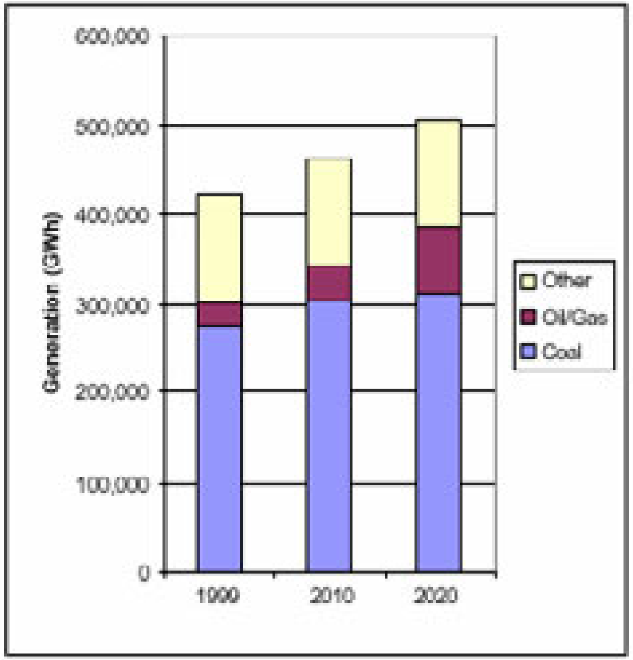
Note: Region II includes the states of New York and New Jersey.

2020 generation projections are EPA estimates using IPM. 1999 generation data from EIA, aggregated from state-level data at: www.eia.doe.gov/cneaf/electricity/st_profiles/ (Table 5).

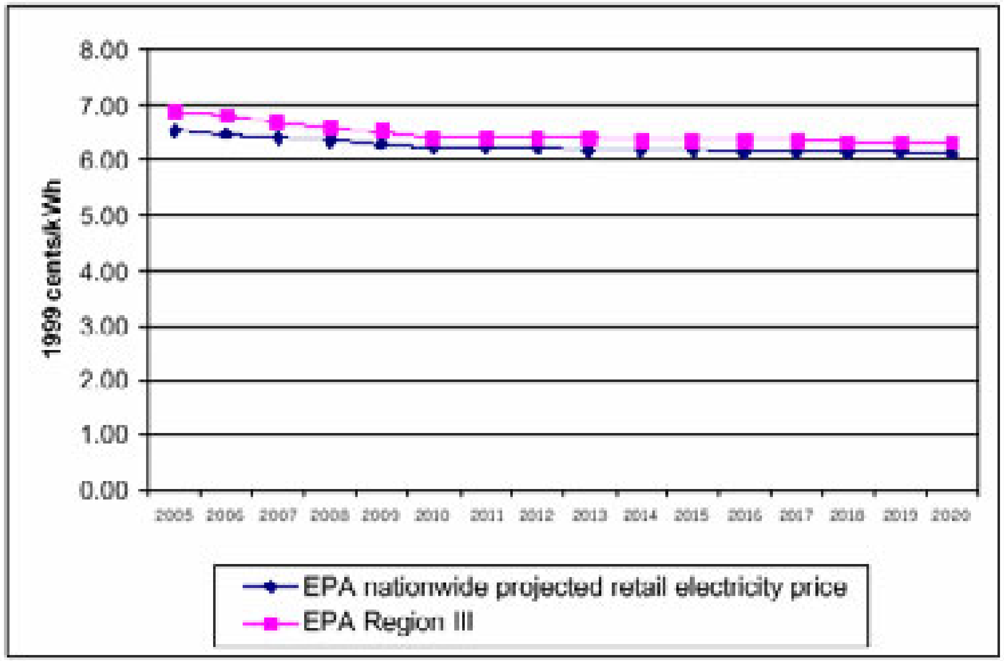
Electricity prices were calculated using the Retail Electricity Price Model (see Section G for a description of the Model).

Summary of Projected Impacts in EPA Region III

Current Generation Mix and Projected Mix Under Clear Skies



Projected Retail Electricity Prices under Clear Skies (2005 - 2020)



Projected Emissions Rates from Power Generators

Year		SO_2	NOx			Hg
		Coal	All	Coal	Gas	Coal
	Units	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/TBtu
2010	Base Case	1.04	0.30	0.31	0.09	4.40
	Clear Skies	0.57	0.12	0.13	0.09	1.99
2020	Base Case	0.89	0.28	0.31	0.08	3.69
	Clear Skies	0.26	0.09	0.10	0.07	1.14

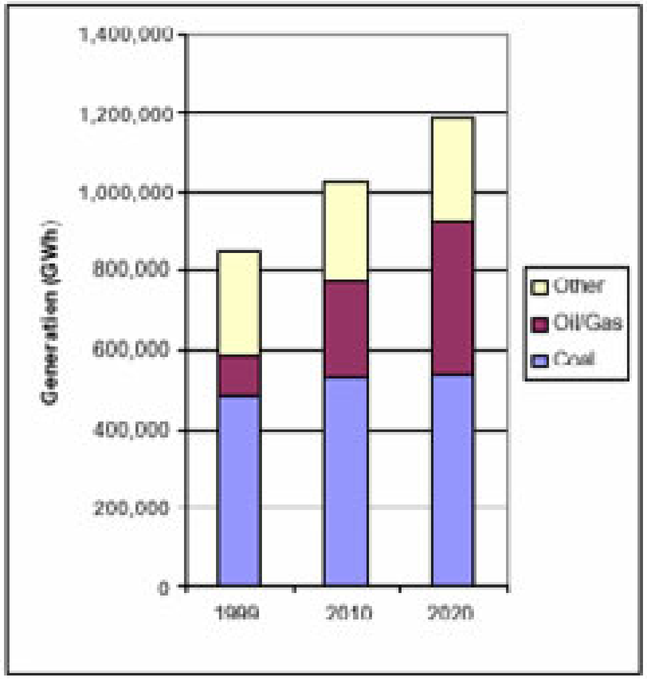
Note: Region III includes Delaware, the District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia.

2020 generation projections are EPA estimates using IPM. 1999 generation from EIA, aggregated from state-level data at: www.eia.doe.gov/cneaf/electricity/st_profiles/ (Table 5).

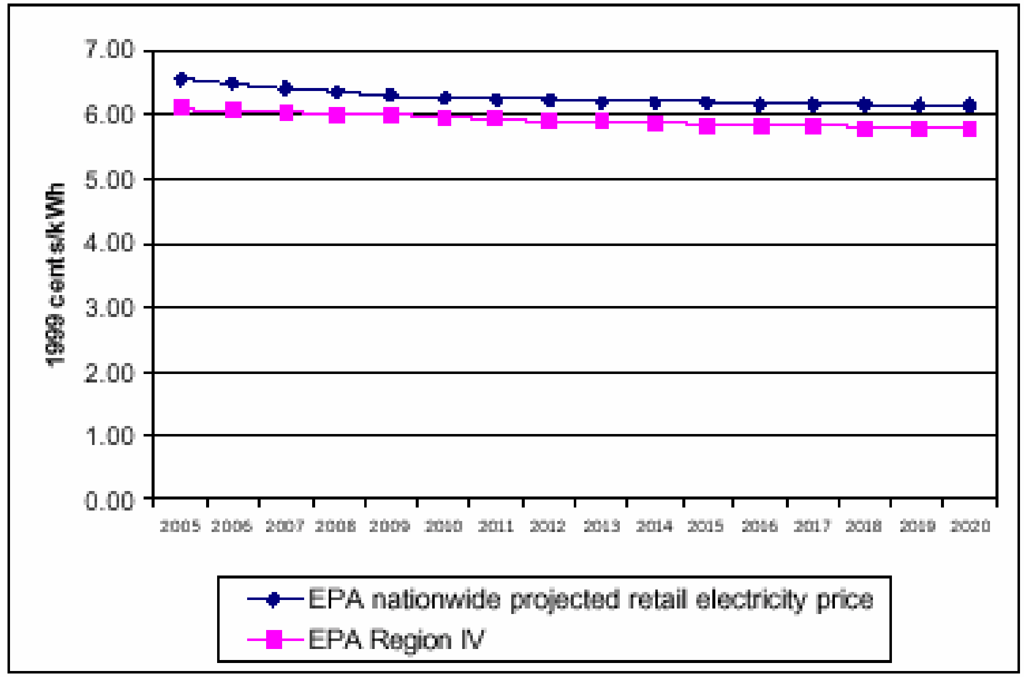
Electricity prices were calculated using the Retail Electricity Price Model (see Section G for a description of the Model).

Summary of Projected Impacts in EPA Region IV

Current Generation Mix and Projected Mix Under Clear Skies



Projected Retail Electricity Prices under Clear Skies (2005 - 2020)



Projected Emissions Rates from Power Generators

Year		SO_2	NOx			Hg
		Coal	All	Coal	Gas	Coal
	Units	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/TBtu
2010	Base Case	0.99	0.31	0.38	0.07	2.85
	Clear Skies	0.83	0.11	0.13	0.05	2.06
2020	Base Case	0.99	0.27	0.37	0.05	2.85
	Clear Skies	0.29	0.07	0.08	0.04	0.91

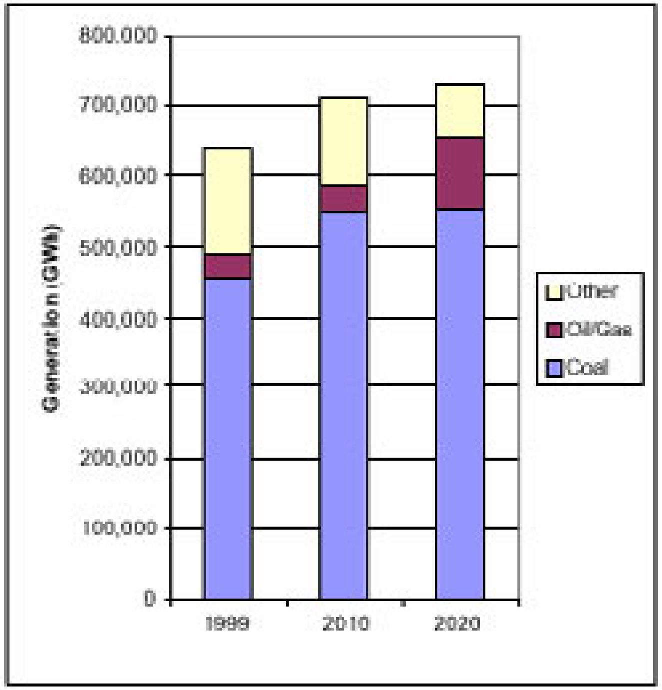
Note: Region IV includes Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina and Tennessee.

2020 generation projections are EPA estimates using IPM. 1999 generation from EIA, aggregated from state-level data at: www.eia.doe.gov/cneaf/electricity/st_profiles/ (Table 5).

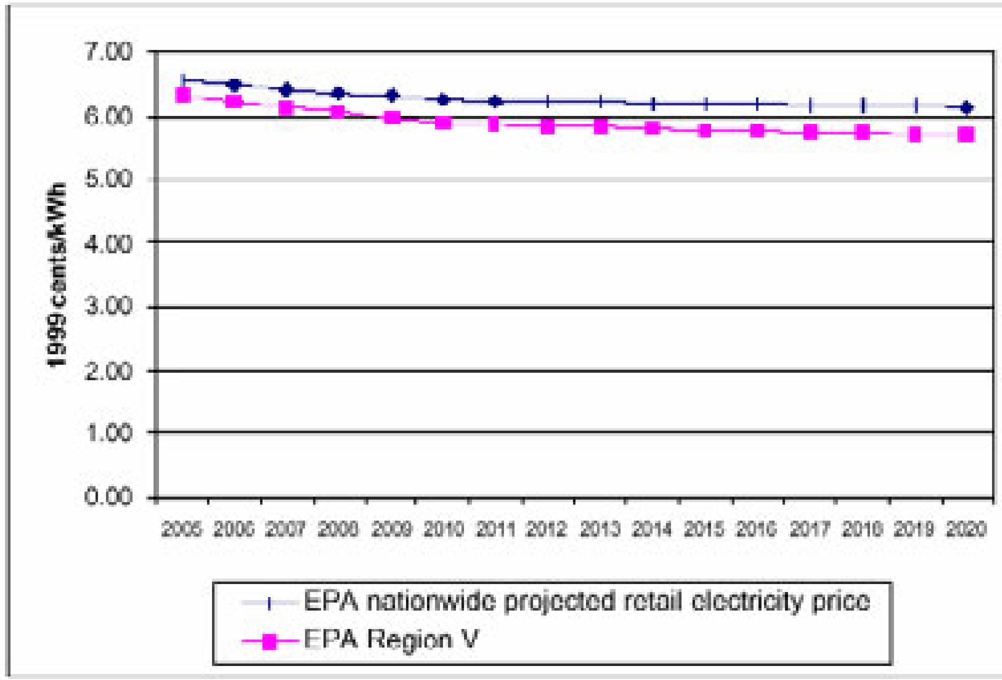
Electricity prices were calculated using the Retail Electricity Price Model (see Section G for a description of the Model).

Summary of Projected Impacts in EPA Region V

Current Generation Mix and Projected Mix Under Clear Skies



Projected Retail Electricity Prices under Clear Skies (2005 - 2020)



Projected Emissions Rates from Power Generators

Year		SO_2	NOx			Hg
		Coal	All	Coal	Gas	Coal
	Units	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/TBtu
2010	Base Case	0.99	0.35	0.36	0.12	4.00
	Clear Skies	0.62	0.16	0.17	0.11	2.44
2020	Base Case	0.88	0.33	0.36	0.11	3.74
	Clear Skies	0.45	0.11	0.11	0.09	1.71

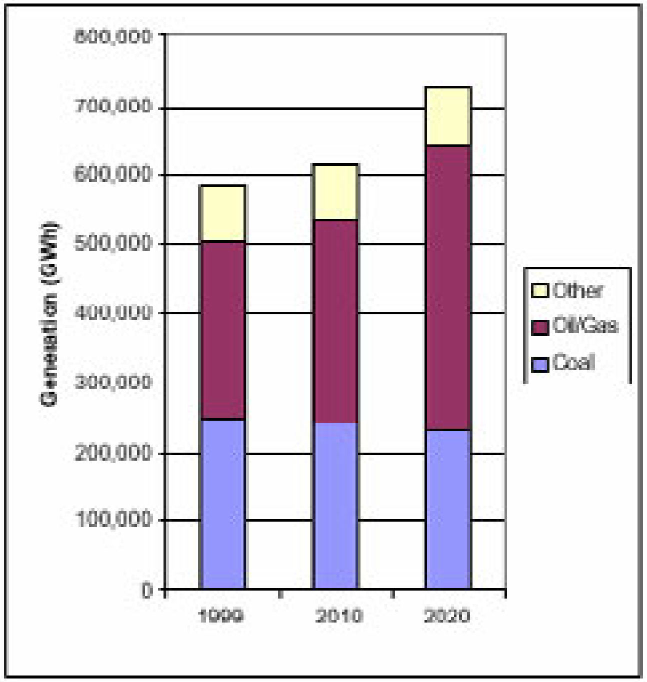
Note: Region V includes Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

2020 generation projections are EPA estimates using IPM. 1999 generation from EIA, aggregated from state-level data at: www.eia.doe.gov/cneaf/electricity/st_profiles/ (Table 5).

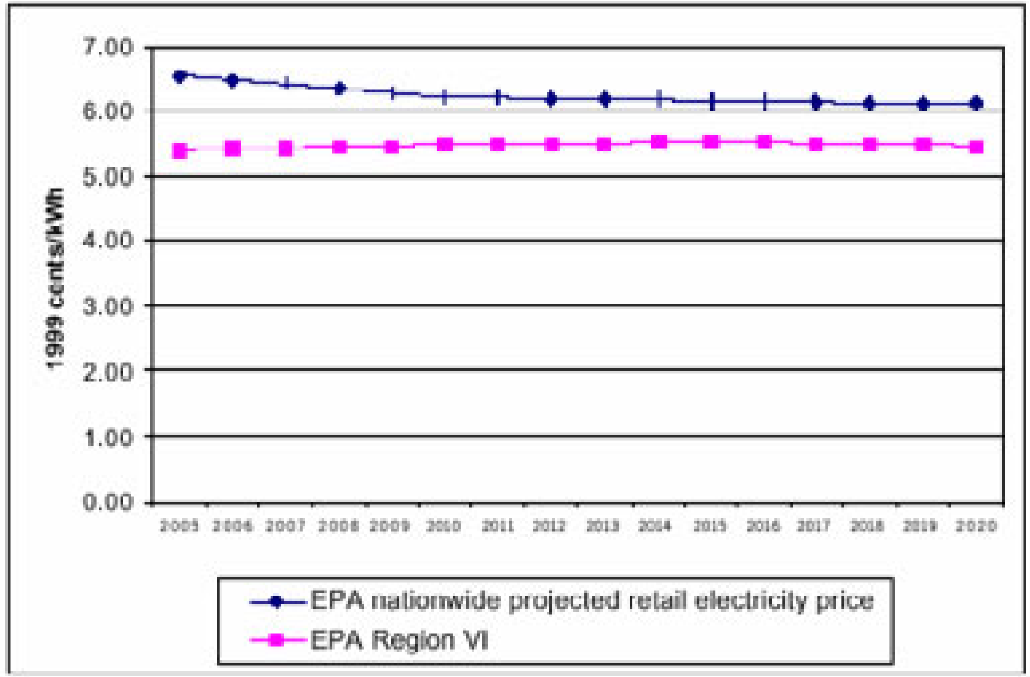
Electricity prices were calculated using the Retail Electricity Price Model (see Section G for a description of the Model).

Summary of Projected Impacts in EPA Region VI

Current Generation Mix and Projected Mix Under Clear Skies



Projected Retail Electricity Prices under Clear Skies (2005 - 2020)



Projected Emissions Rates from Power Generators

Year		SO_2	NOx			Hg
		Coal	All	Coal	Gas	Coal
	Units	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/TBtu
2010	Base Case	0.80	0.23	0.29	0.15	4.23
	Clear Skies	0.63	0.15	0.19	0.12	3.60
2020	Base Case	0.65	0.20	0.30	0.10	4.27
	Clear Skies	0.56	0.10	0.11	0.08	3.44

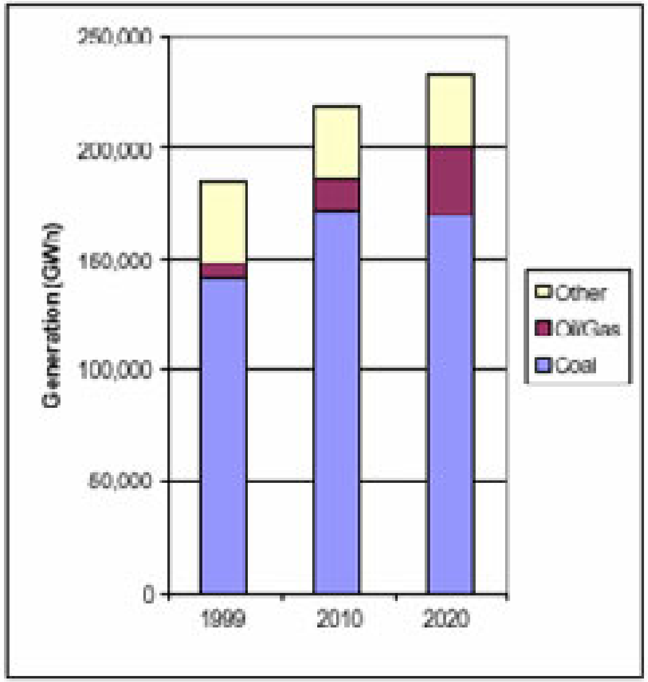
Note: Region VI includes Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

2020 generation projections are EPA estimates using IPM. 1999 generation from EIA, aggregated from state-level data at: www.eia.doe.gov/cneaf/electricity/st_profiles/ (Table 5).

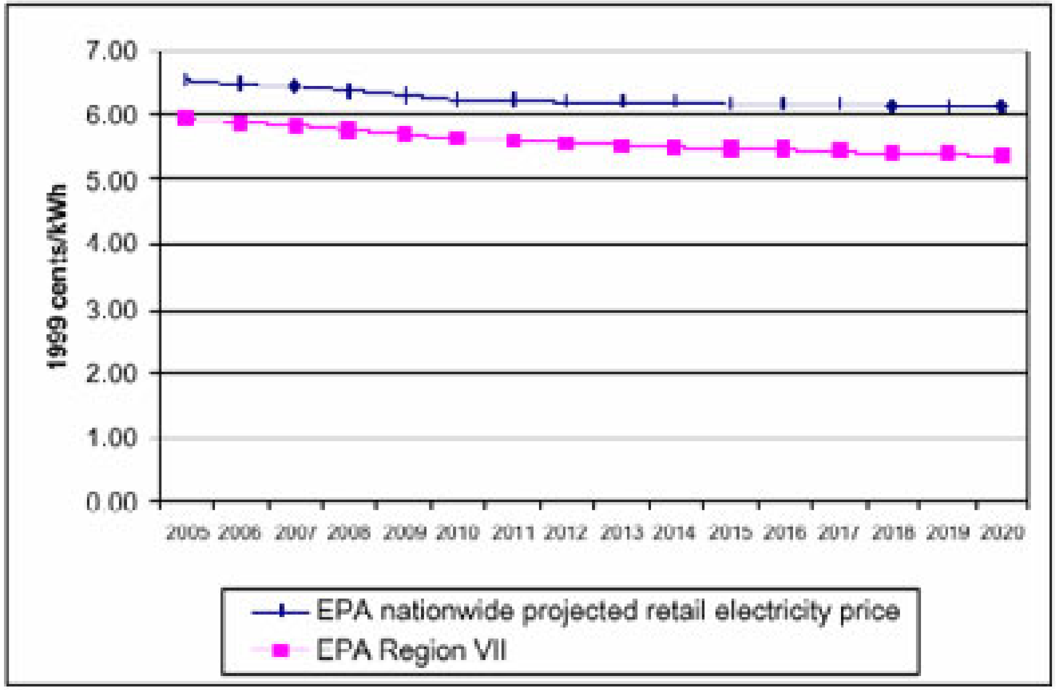
Electricity prices were calculated using the Retail Electricity Price Model (see Section G for a description of the Model).

Summary of Projected Impacts in EPA Region VII

Current Generation Mix and Projected Mix Under Clear Skies



Projected Retail Electricity Prices under Clear Skies (2005 - 2020)



Projected Emissions Rates from Power Generators

Year		SO_2	NOx			Hg
		Coal	All	Coal	Gas	Coal
	Units	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/TBtu
2010	Base Case	0.63	0.40	0.41	0.10	4.14
	Clear Skies	0.56	0.19	0.20	0.08	3.21
2020	Base Case	0.62	0.37	0.41	0.10	4.12
	Clear Skies	0.46	0.15	0.16	0.07	2.61

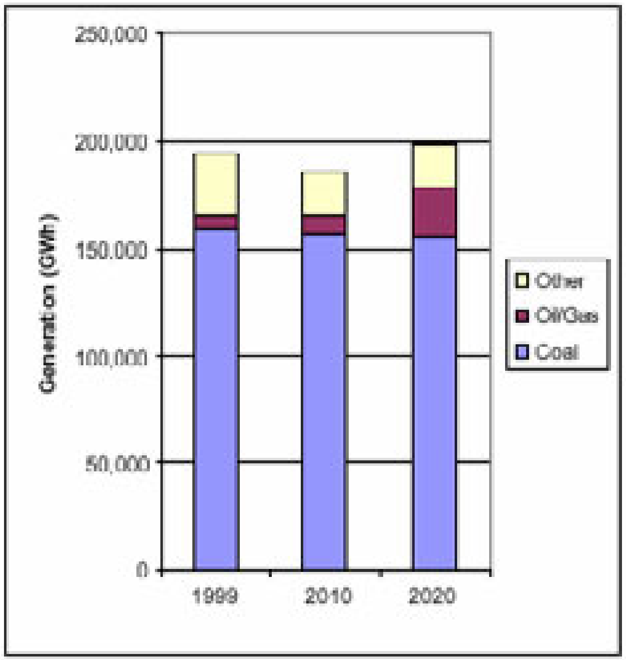
Note: Region VII includes Iowa, Kansas, Missouri, and Nebraska.

2020 generation projections are EPA estimates using IPM. 1999 generation from EIA, aggregated from state-level data at: www.eia.doe.gov/cneaf/electricity/st_profiles/ (Table 5).

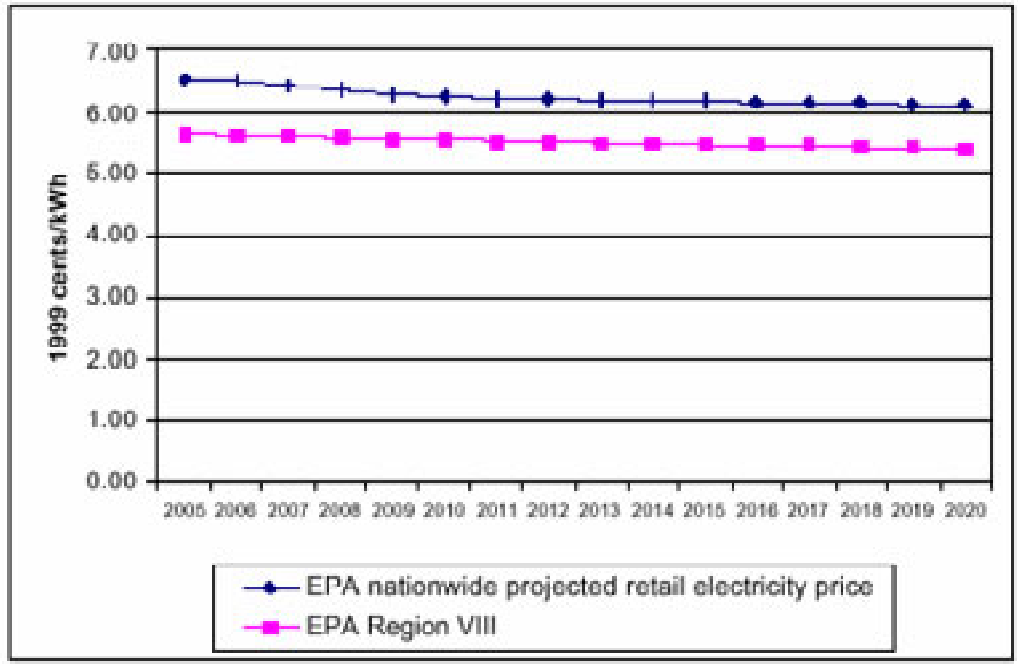
Electricity prices were calculated using the Retail Electricity Price Model (see Section G for a description of the Model).

Summary of Projected Impacts in EPA Region VIII

Current Generation Mix and Projected Mix Under Clear Skies



Projected Retail Electricity Prices under Clear Skies (2005 - 2020)



Projected Emissions Rates from Power Generators

Year		SO_2	NOx			Hg
		Coal	All	Coal	Gas	Coal
	Units	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/TBtu
2010	Base Case	0.38	0.45	0.46	0.11	3.19
	Clear Skies	0.30	0.33	0.34	0.09	2.38
2020	Base Case	0.31	0.43	0.46	0.08	3.15
	Clear Skies	0.30	0.32	0.34	0.06	2.04

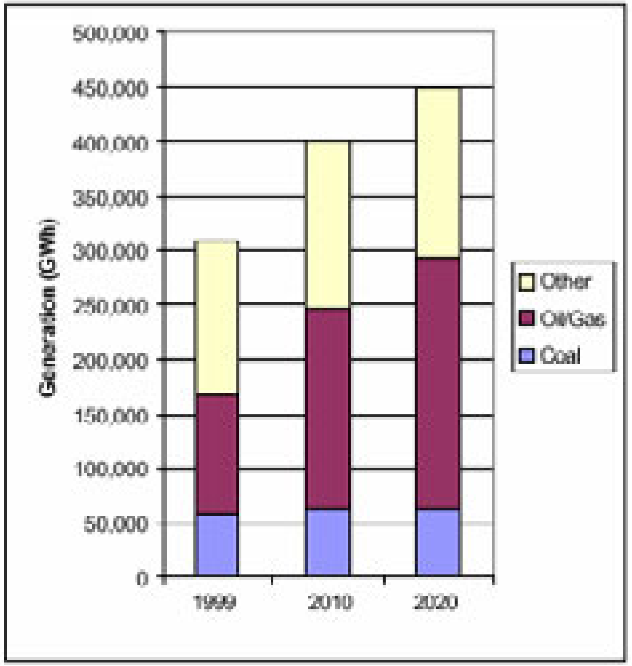
Note: Region VIII includes Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming.

2020 generation projections are EPA estimates using IPM. 1999 generation from EIA, aggregated from state-level data at: www.eia.doe.gov/cneaf/electricity/st_profiles/ (Table 5).

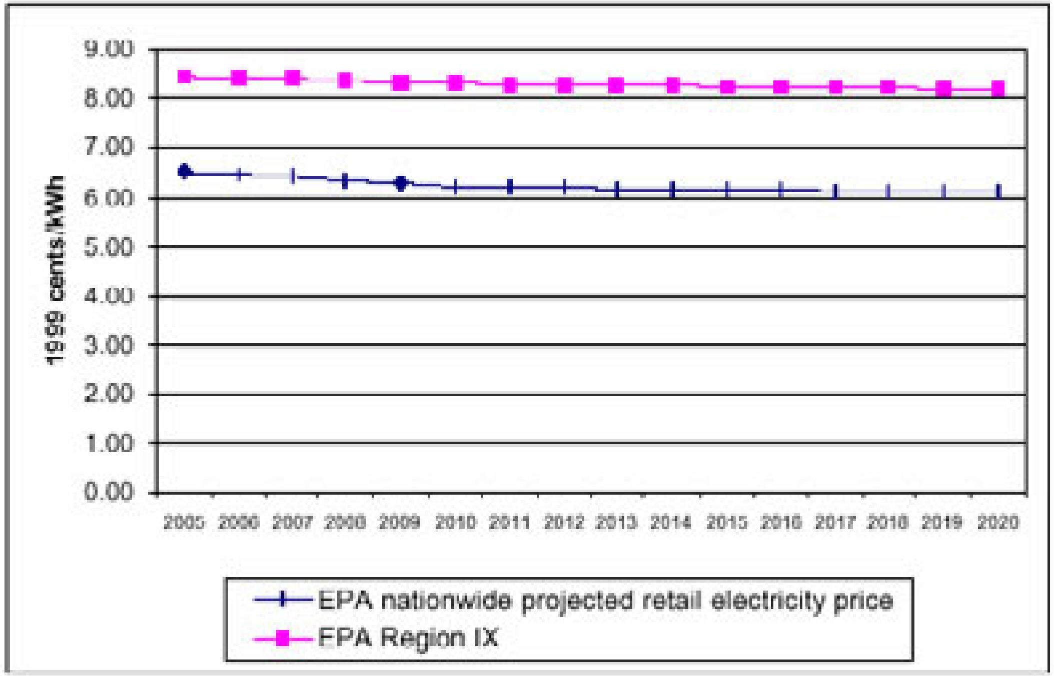
Electricity prices were calculated using the Retail Electricity Price Model (see Section G for a description of the Model).

Summary of Projected Impacts in EPA Region IX

Current Generation Mix and Projected Mix Under Clear Skies



Projected Retail Electricity Prices under Clear Skies (2005 - 2020)



Projected Emissions Rates from Power Generators

Year		SO_2	NOx			Hg
		Coal	All	Coal	Gas	Coal
	Units	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/TBtu
2010	Base Case	0.37	0.15	0.40	0.04	1.97
	Clear Skies	0.37	0.13	0.34	0.03	1.98
2020	Base Case	0.37	0.15	0.40	0.03	2.00
	Clear Skies	0.37	0.12	0.34	0.03	1.98

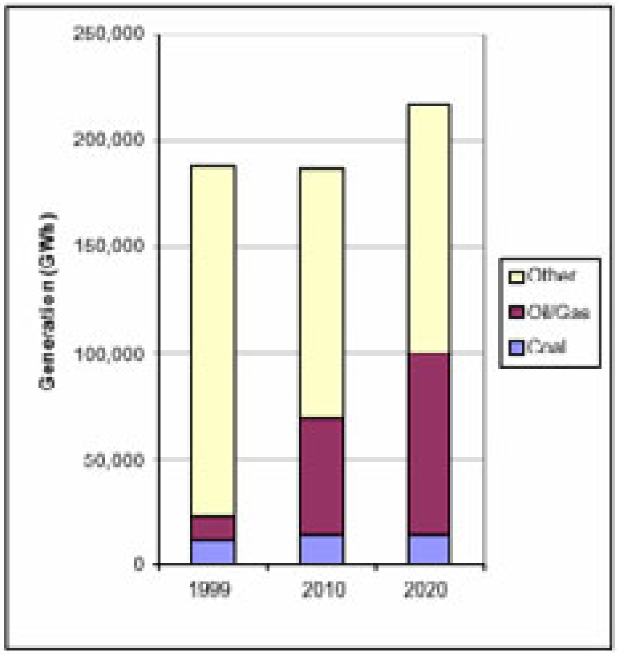
Note: Region IX includes Arizona, California and Nevada.

2020 generation projections are EPA estimates using IPM. 1999 generation from EIA, aggregated from state-level data at: www.eia.doe.gov/cneaf/electricity/st_profiles/ (Table 5).

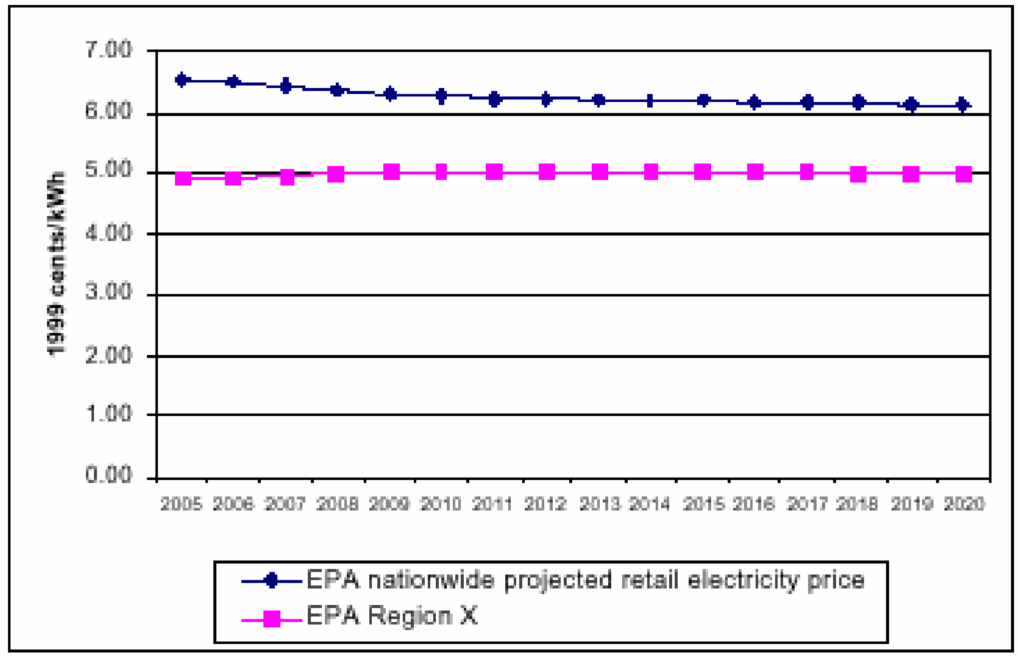
Electricity prices were calculated using the Retail Electricity Price Model (see Section G for a description of the Model).

Summary of Projected Impacts in EPA Region X

Current Generation Mix and Projected Mix Under Clear Skies



Projected Retail Electricity Prices under Clear Skies (2005 - 2020)



Projected Emissions Rates from Power Generators

Year		SO_2	NOx			Hg
		Coal	All	Coal	Gas	Coal
	Units	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/MMBtu	lbs/TBtu
2010	Base Case	1.71	0.16	0.41	0.07	4.46
	Clear Skies	0.36	0.13	0.33	0.06	4.46
2020	Base Case	1.71	0.11	0.41	0.04	4.46
	Clear Skies	0.36	0.10	0.33	0.04	4.46

Note: Region X includes Idaho, Oregon, Washington.

2020 generation projections are EPA estimates using IPM. 1999 generation from EIA, aggregated from state-level data at: www.eia.doe.gov/cneaf/electricity/st_profiles/ (Table 5).

Electricity prices were calculated using the Retail Electricity Price Model (see Section G for a description of the Model).

Subsequent to the development of the latest version of the model used to project power plant emissions, SO_2 control equipment has been installed at the Centralia Plant in Washington. Since emission reductions from the installation of these controls were not included in the **base case** modeling, the amount of reductions expected under Clear Skies, as well as the benefits associated with those reductions, will be lower in the state of Washington than projected.

Projected State Generation Mix in 2010

Note: "Other" includes generation from nuclear, hydroelectric, biomass, geothermal, landfill gas, wind, and solar sources.

	% Coal	% Natural Gas	% Other
Alabama	49%	26%	25%
Arizona	34%	33%	34%
Arkansas	47%	15%	38%
California	2%	54%	44%
Colorado	84%	12%	4%
Connecticut	10%	85%	6%
Delaware	42%	58%	0%
District of Columbia	0%	100%	0%
Florida	39%	45%	16%
Georgia	47%	33%	21%
Idaho	0%	37%	63%
Illinois	59%	11%	30%
Indiana	98%	2%	0%
Iowa	83%	6%	11%
Kansas	78%	1%	20%
Kentucky	91%	6%	3%
Louisiana	34%	41%	25%
Maine	5%	74%	21%
Maryland	58%	10%	32%
Massachusetts	23%	71%	6%
Michigan	69%	8%	24%
Minnesota	64%	6%	30%
Mississippi	30%	51%	19%
Missouri	79%	9%	12%
Montana	62%	5%	34%
Nebraska	73%	6%	21%
Nevada	57%	31%	12%
New Hampshire	12%	21%	67%
New Jersey	24%	55%	21%
New Mexico	74%	25%	1%
New York	18%	47%	36%
North Carolina	67%	3%	31%
North Dakota	90%	4%	6%
Ohio	89%	1%	10%
Oklahoma	54%	42%	4%
Oregon	6%	37%	57%
Pennsylvania	59%	7%	34%
Rhode Island	0%	100%	0%
South Carolina	39%	6%	55%
South Dakota	35%	8%	57%
Tennessee	47%	19%	35%
Texas	33%	56%	11%
Utah	97%	0%	3%
Vermont	0%	3%	97%
Virginia	48%	8%	43%
Washington	9%	26%	66%
West Virginia	99%	0%	1%
Wisconsin	78%	12%	11%
Wyoming	98%	0%	2%
National	50%	26%	24%

Projected Retrofits By State in 2010 and 2020

	Cumulative Coal-Capacity Retrofitted by 2010 (MW)			Cumulative Coal-Capacity Retrofitted by 2020 (MW)		
	SCR	Scrubber	ACI	SCR	Scrubber	ACI
Alabama	9,000	2,700	0	9,700	8,300	0
Arkansas	800	0	0	3,800	1,300	0
Connecticut	400	0	0	400	600	0
Delaware	0	0	0	0	400	0
Florida	6,900	2,700	0	7,500	4,200	0
Georgia	9,900	7,400	0	11,900	11,900	0
Illinois	6,500	5,400	0	8,600	6,800	0
Indiana	14,900	5,500	0	15,800	9,200	0
Iowa	2,300	0	0	3,400	1,300	0
Kansas	3,200	0	0	4,200	0	0
Kentucky	10,700	900	0	12,000	4,700	300
Louisiana	700	0	0	2,900	500	0
Maryland	2,500	2,900	0	3,000	4,400	0
Massachuse ts	0	0	0	1,200	1,200	0
Michigan	4,400	0	0	6,900	1,900	0
Minnesota	2,200	0	0	4,400	0	900
Mississippi	1,400	900	0	2,200	1,800	0
Missouri	4,100	0	0	4,600	600	0
New Hampshire	0	300	0	0	300	0
New Jersey	0	0	0	400	1,700	0
New Mexico	1,800	0	0	1,800	0	0
New York	700	400	0	1,400	800	0
North Caro ina	8,800	0	0	10,300	9,800	0
North Dakota	1,100	900	400	1,100	1,000	1,300
Ohio	15,600	7,900	0	18,500	12,700	0
Oklahoma	4,400	0	0	4,400	0	0
Pennsylvania	9,800	5,800	0	11,900	9,100	0
South Caro ina	3,900	0	0	4,100	1,900	0
South Dakota	400	400	0	400	400	0
Tennessee	3,800	0	0	4,700	2,300	0
Texas	9,300	2,000	0	13,900	2,200	0
Virginia	900	0	0	2,100	2,200	0
Washington	0	1,200	0	0	1,300	0
West Virginia	12,200	4,100	0	12,200	8,800	0
Wisconsin	300	0	0	3,800	800	0
Grand Total	152,900	51,400	400	193,5 0	114,400	2, 00

Note: Table includes retrofits in response to the NOx SIP call and Title IV, as well as Clear Skies.

SCR = Selective Catalytic Reduction

ACI = Activated Carbon Injection

Projected Retail Electricity Prices under Clear Skies

- In 1999, the national average retail electricity price was 6.66 cents/kWh.

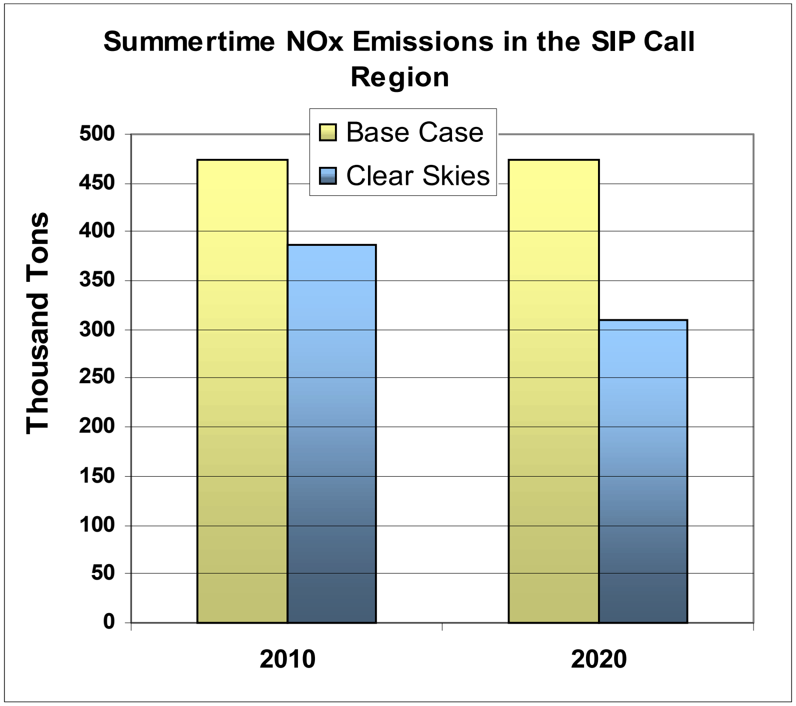
Projected Retail Electricity Prices (1999 cents per kilowatt hour)					
NERC Region*	**States Included**	**2005**	**2010**	**2015**	**2020**
ECAR	OH, MI, IN, KY, WV, PA	6.19	5.78	5.72	5.64
ERCOT	TX	4.95	5.36	5.52	5.47
MAAC	PA, NJ, MD, DC, DE	7.75	7.09	7.10	7.05
MAIN	IL, MR, WI	6.72	6.15	6.02	5.96
MAPP	MN, IA, SD, ND, NE	5.48	5.46	5.21	5.01
NY	NY	9.39	8.52	8.59	8.89
NE	VT, NH, ME, MA, CT, RI	9.24	8.18	8.48	8.43
FRCC	FL	7.04	6.94	6.83	6.69
STV	VA, NC, SC, GA, AL, MS, TN, AR, LA	5.79	5.65	5.53	5.52
SPP	KS, OK, MR	5.97	5.55	5.44	5.38
PNW	WA, OR, ID	4.90	5.02	5.01	4.98
RM	MT, WY, CO, UT, NM, AZ, NV, ID	6.79	6.32	6.27	6.25
CALI	CA	9.39	9.35	9.29	9.22
Lower 48 States		6.54	6.24	6.18	6.13

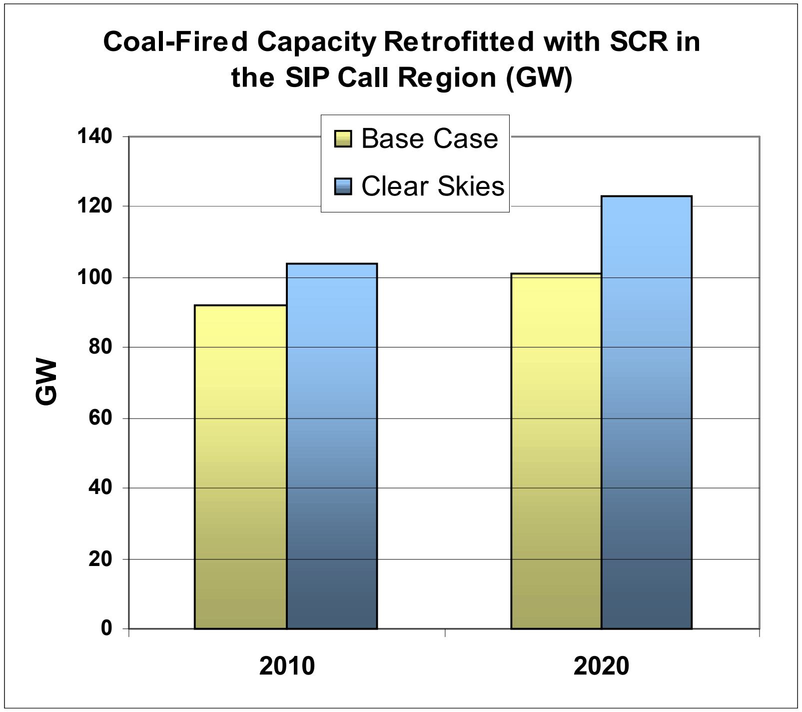
Note: Information on the North American Electric Reliability Council (NERC) is available at http:// www.nerc.com.

1999 national average electricity retail price: EIA at http://www.eia.doe.gov/cneaf/electricity/page/fact_sheets/retailprice.html.
2005 - 2020 projections: from the “Retail Electricity Price Model” (see section G for a description of the Model.)

Impact of Clear Skies on the NOx SIP Call Region

- Summertime NOx emissions in the SIP Call region under Clear Skies are significantly lower than the emissions projected under the NOx SIP Call. The additional reductions under Clear Skies come from the approximately 23 GW of additional SCR retrofits by 2020.





Note: The NOx SIP call region includes nineteen Eastern states and DC. Summertime emissions occur between May 1 and September 30.

Section F:

Engineering and Economic Factors Affecting the Installation of Control Technologies

Engineering and Economic Analysis Introduction

- **Estimates were made for the resources required for the construction and operation of control technologies for the Clear Skies Act based on the projected number of retrofits from IPM modeling analyses. The demand for resources due to the Clear Skies Act was compared to the current supply in today's market.**

- **It is expected that there will be a market response, however not instantaneous, to the demand for engineering, labor, construction equipment and materials for the installation and operation of a significant number of control technologies.**

  – It is projected that there are sufficient resources to meet the phase I caps in 2010 although some resources may be put under more pressure than others. Boilermaker labor is one of the resources that may be under pressure in the early part of phase I due to the simultaneous installation of NOx controls for the NOx SIP call.
  – It is difficult to predict the market supply of resources beyond phase 1, however, if the current availability of resources is sustained, it is expected that the supply will meet the demand beyond 2010. Sufficient planning time for the 2018 phase II caps should allow ample time for the market to meet the resource demands.

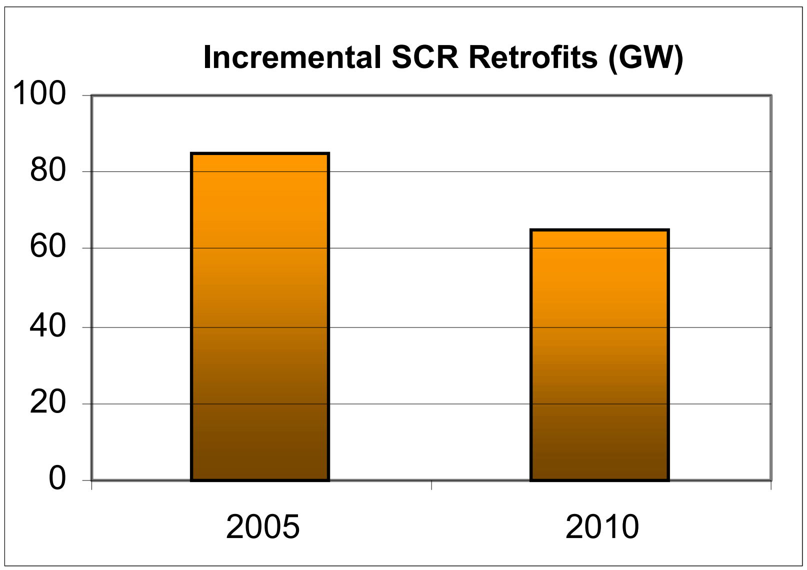
- **Alternative approaches to meeting the emission targets are likely to produce technologies and means of meeting the caps with less resources than what was projected.**

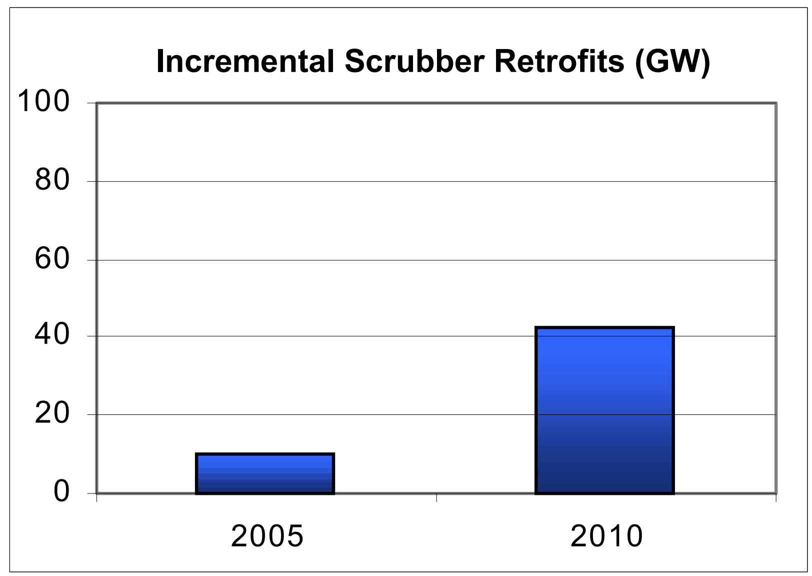
  – Scrubber technology improvements and switching to lower sulfur coal under the Acid Rain Program are examples of how alternative approaches required less resources than projected.
  – The development of control technology alternatives to SCR under the NOx SIP call is another example of innovations which may reduce the resource requirement of a given program.
  – Multi-pollutant control technologies are being developed which may provide integrated treatment of multiple pollutants as opposed to the standard approach of add-on technologies for each pollutant.

- **Resource requirements for coal-fired installations of selective catalytic reduction (SCR) for NOx control and flue gas desulfurization (FGD) for SO2 control were considered. Conservatively high assumptions for the resource requirements for these single pollutant control technologies were used.**

Capacity Projected to Install Control Technologies

- **The incremental number of SCR and FGD control technology retrofits, beyond what was in place by 2000, projected under the Clear Skies Act for 2005 and 2010 are provided below.**
  - The 2005 projected SCR retrofits include about 72 GW of SCR needed to meet the NOx SIP call with an additional 13 GW for state multi-pollutant rules. None of the SCR retrofits for 2005 are in response to the Clear Skies Act. It was projected that 6 GW of FGD, more commonly called scrubbers, would be installed by 2005 and a total of 9 GW by 2010 due to existing regulatory programs.
  - IPM modeling projected that 32 GW of scrubbers would be cost effective to install by 2005 during the simultaneous installation of SCR for the NOx SIP call. However, a scrubber sensitivity analysis projected that up to 10 GW of scrubbers could be installed before 2005 as resources such as boilermaker labor may be limiting.



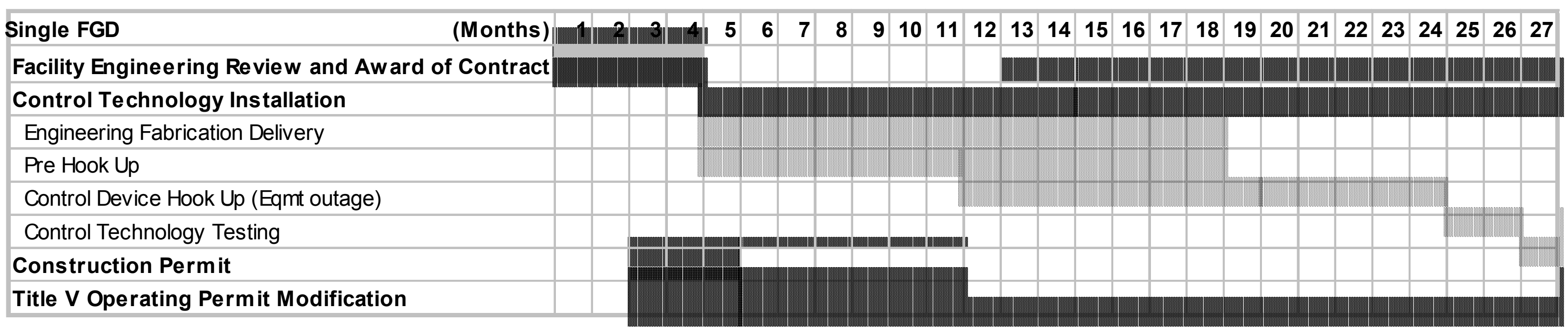


- **Through 2010, 0.4 GW of activated carbon injection (ACI) controls for mercury are projected to be installed and therefore are expected to have a negligible affect on the availability of resources in phase I of the program.**

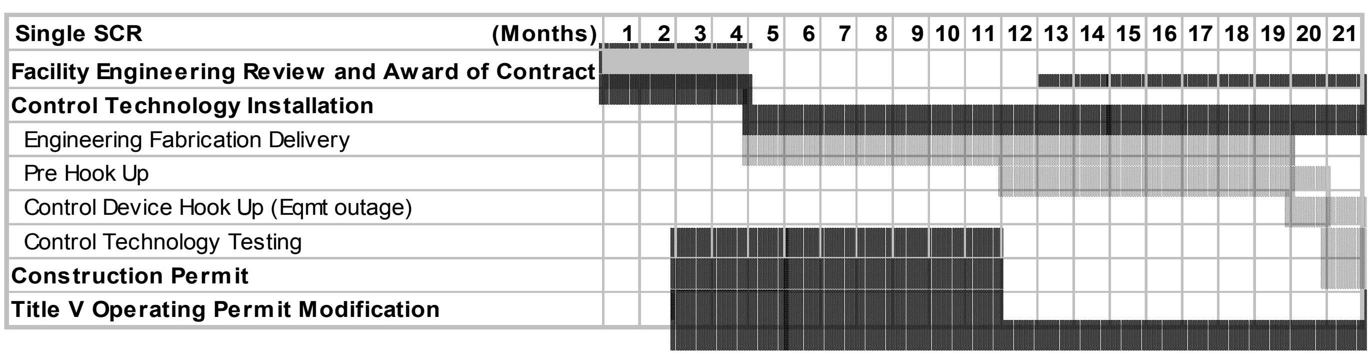
Control Technology Installation Times

- **Based on engineering analyses, EPA estimated the time it takes for a typical 500 MW unit to install control technology, including the time required for engineering review, construction permitting, control installation, and obtaining an operating permit:**

- **27 months for typical wet limestone scrubber installation**
  - Examples of installation times: 27 months for 890 MW retrofit of two units at Big Bend Station, 24 months for each 730 MW unit at Centralia from contract award to commissioning



- **21 months for typical SCR installation**
  - Examples of installation times: 13 months for 675 MW Somerset Station, 19 months for two 900 MW units at Keystone



Note: May find examples of longer installation times, depending on the regulatory driver

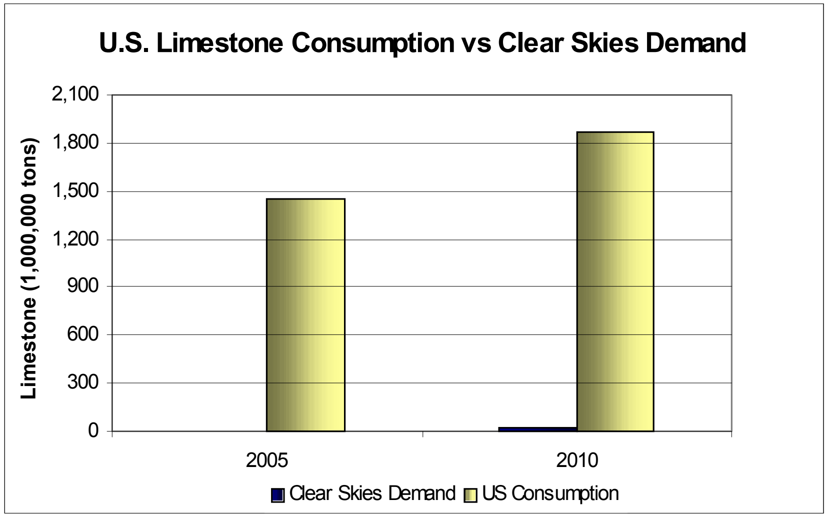
Control Technology Installation Times

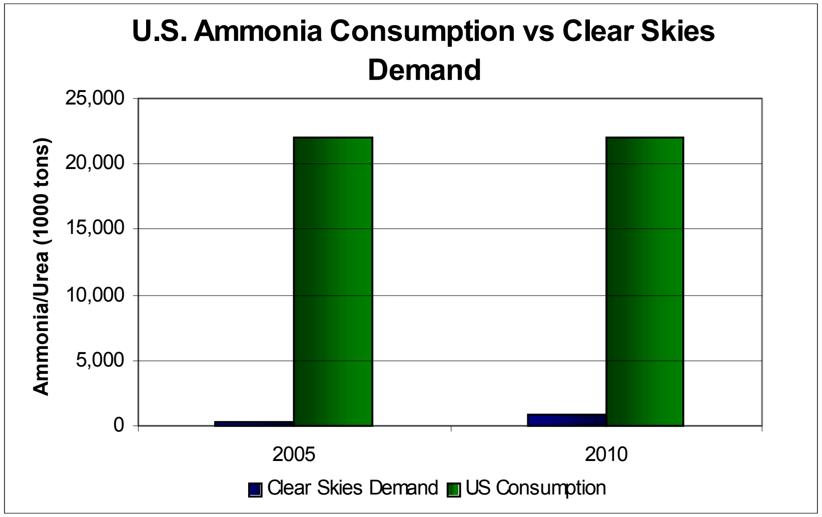
- Control device hookup to the boiler is typically scheduled during unit shutdowns which occur outside of the peak load summer months.
  - Typically takes 4-7 weeks for FGD hookup
  - Typically takes 3-5 weeks for SCR hookup
  - Other activities may be scheduled during shutdown which may prolong outage

- Control installation times for multiple retrofits of the same technology (e.g. 2 SCRs) at the same plant typically add 2 to 3 months to the single unit installation time for each unit, since much of the work involved in multiple retrofits can be done simultaneously.
  - Six units were the maximum number of units at one plant projected to be retrofitted with SCR by 2010. It may take from 33-37 months to complete the installation considering no hookup during the peak summer months.
  - Five units were the maximum number of units at one plant projected to be retrofit with FGD by 2010. It may take up to 36-40 months to complete the installation considering no hookup during the peak summer months.

- Scrubbers and SCRs may be simultaneously installed on the same unit as their locations do not usually cause much construction interference. In addition, simultaneous installations more efficiently use labor, construction equipment, and outages for hookup to the boiler.

Resources for Operation of Control Technologies





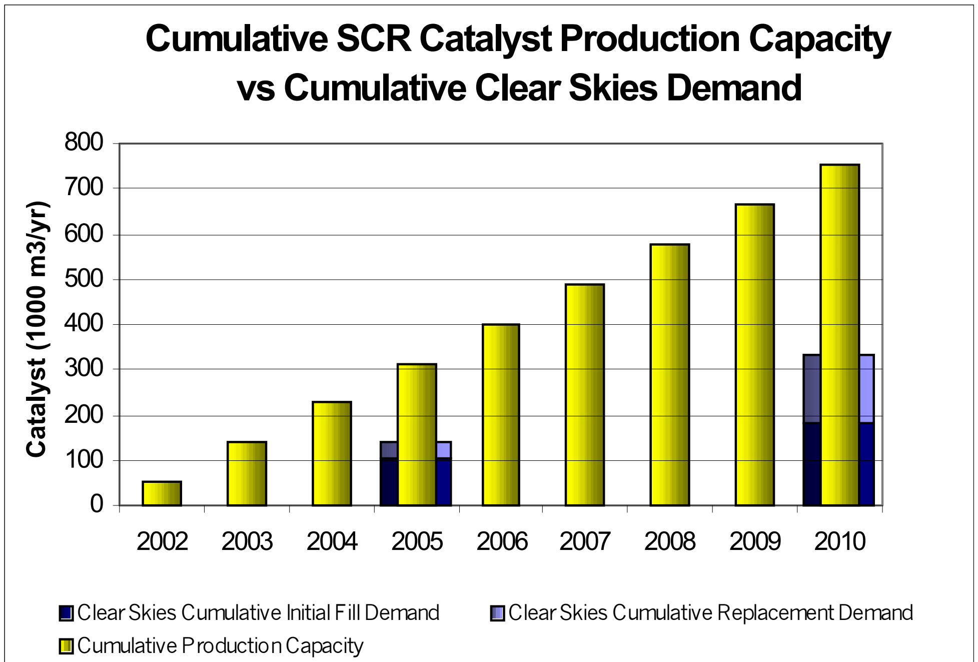
- The amount of reagent required to operate air pollution control technologies (e.g. limestone for scrubbers and ammonia for SCR) is very small relative to the US and world supply of these commodities.

- Limestone consumption in scrubbers for SO_2 reduction is projected to require less than 2% of the total U.S. consumption out to 2010. This estimate was conservatively high as it assumed only wet limestone scrubbers will be installed on units burning 4% sulfur coal, achieving a 95% SO2 removal efficiency, and having a capacity factor of 85%. The US consumption includes a 5.1% annual growth of limestone production based on recent market trends reported in the Minerals Yearbook by U.S. Geological Survey.

- Ammonia consumption in SCR for NOx reduction is projected to consume approximately 3% of the total U.S. consumption out to 2010. Recently, there was significant production capacity built in the US, Algeria and the former Soviet Union, along with 1.2 million tons of capacity built in Trinidad and Venezuela which could accommodate this increase in demand.

SCR Catalyst Availability

- SCR catalyst is one of the material resources which is unique to the air pollution control technology industry. Estimates of demand for SCR catalyst were based on both initial installed capacity and the annual replacement capacity requirements for the projected retrofits and also includes the replacement demand from all current world SCR installations.



Note: Additional catalyst supply from regeneration processes and production capacity for gas/oil fired SCR applications were not considered in this estimate.

- Current worldwide SCR catalyst production capacity for coal-fired SCR applications reported by the major manufacturers is estimated at almost 90,000 m^3/yr.

- Catalyst demand is expected to increase significantly as it is estimated that about 150 GW of SCR will be installed in the US by 2010, with 85 GW due to the NOx SIP call and state rules by 2005.

- The sum of the production capacity for each year starting in 2002 was compared to the cumulative Clear Skies demand from each 5 year increment. The percent of current cumulative production needed for Clear Skies is 45 % in 2005 decreasing to 44 % in 2010.

- Early in phase I, the majority of the catalyst demand is due to the initial fill of the catalyst reactor at new installations but the demand begins to shift over time to replacement demand.

Resources for Construction of Control Technologies

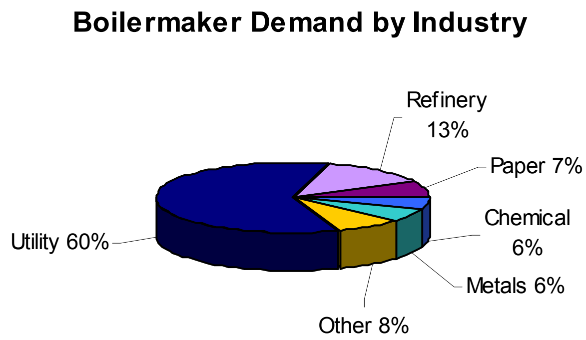
Steel, Hardware and Construction Equipment Requirements:

- Estimates of the cumulative steel demand needed to construct the control technologies (e.g. scrubber and SCR) yields less than 0.1% demand of the total US consumption per year reported in the Census Bureau's Current Industrial Reports.
- Steel is primarily needed for ductwork, support steel, storage silos, and reactor vessels for the control technologies. Some corrosive resistant steel alloys, rubber-lined steel or other materials may be used in the corrosive regions of scrubbers.
- Other hardware items such as piping, nozzles, pumps, fans, soot blowers and related equipment required for typical control technology installations are used in large industries such as construction, chemical production, and auto production and should be readily available.
- The availability of cranes, used to lift heavy pieces of equipment, are not expected to be a problem due to the extended time provided for planning installations. In addition to the cranes currently available, it is estimated that 12 new cranes can be supplied every six months if needed.

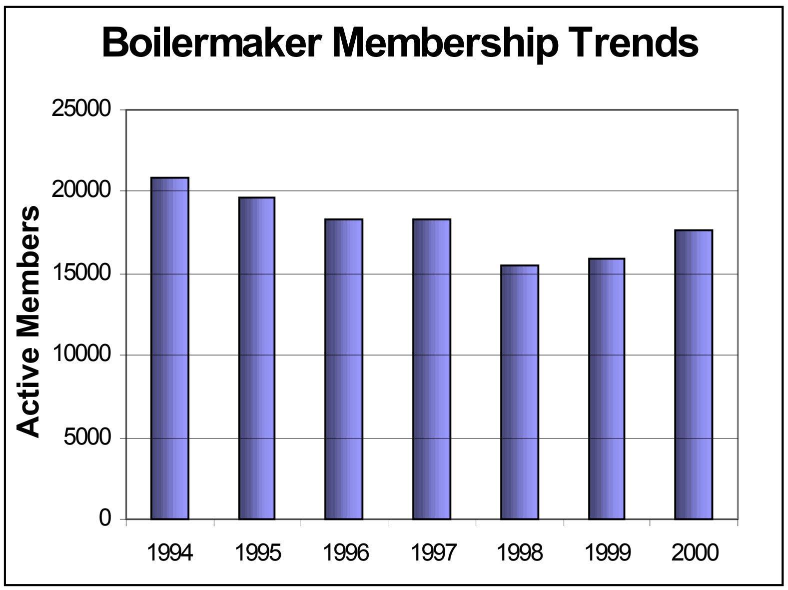
General Construction Labor Requirements:

- Labor requirements are generally split between two categories, one for general construction labor and another for skilled labor (e.g. boilermakers, pipe fitters, electricians).
- General construction labor requirements for control technology installations are expected to be less than 0.3% of the current national labor pool of 6.7 million workers as reported by the Bureau of Labor Statistics.

Labor for Construction of Control Technologies

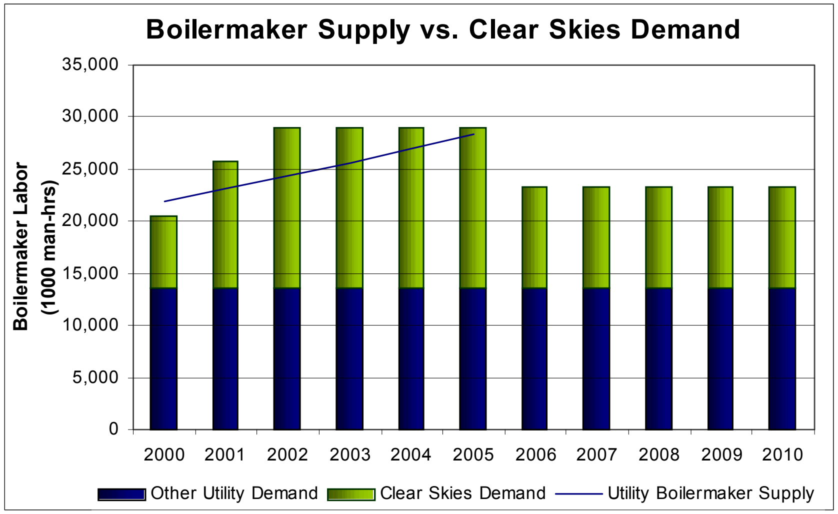


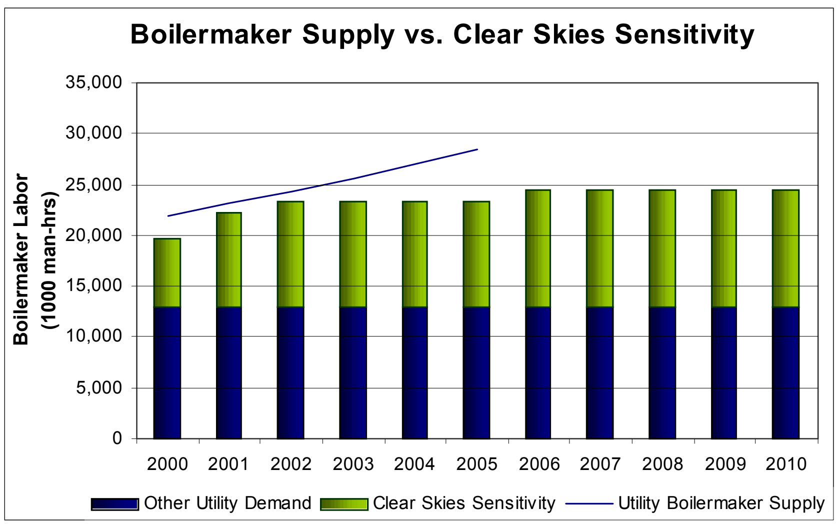
- Boilermakers are a skilled labor force used in the construction of high-energy vessels. Boilermaker apprenticeship takes up to 4 years but may require less time depending on the prior work experience and skill level of the individual.
- In 2000, 60% of the boilermaker journeymen were working in the electric utility sector. The remainder of the boilermakers were used in the refinery, chemical, metals, or other industries.



- Boilermaker numbers decreased from over 20,000 members in 1994 to just over 15,000 members in 1998.
- Boilermaker membership grew 6.7% from 1998-2000 and is projected to grow at a rate of at least 5.3% out to 2005 according to the International Brotherhood of Boilermakers.
- Their numbers have begun to rebound in recent years due to the construction of NOx controls for the NOx SIP call and new combustion turbine projects.

Labor for Construction of Control Technologies





Note: The boilermaker labor considered to be available for the Clear Skies control technology installations were from the portion of boilermakers employed in the electric utility industry.

- Boilermaker labor requirements based on control technology vendor experience were assumed to be approximately 40% and 50% of the total FGD and SCR labor requirement respectively.
- Economic modeling projects that 32 GW of FGD is cost effective to build by 2005. However, it is estimated that constructing 32 GW of FGD along with 85 GW of SCR for the NOx SIP call and state regulations by 2005 would exceed the current market availability of boilermaker labor.
- It is estimated that there is enough boilermaker labor to complete 85 GW of SCR and up to 10 GW of scrubber retrofits out to 2005.
- More control installations could potentially be constructed by 2005 but it may affect the cost of compliance.

Electric System Reliability and Installation Experience

- **Reliability:**
  - Because most control installations are expected to be hooked-up during regularly scheduled outages, there should be no changes in system reliability.
  - A 5-20 year implementation time-frame should allow companies to schedule the hook-up of difficult retrofits over multiple outages.
  - The cap-and-trade aspect of the program allows emissions banking which will encourage a more smooth compliance schedule by providing incentives for early installations spreading out the hook-ups.
- **Clear Skies Builds on NOx SIP call Experience:**
  - Lessons learned as part of installation of SCRs for the NOx SIP call will make installations more efficient.
  - More boilermaker labor and engineering resources have been developed to install emission controls in response to the NOx SIP call. The retrofits required under this program will provide incentives to continue the use of these resources and possibly expand them.
  - Emerging multi-pollutant control technologies could provide more flexibility for installations. Some of these new technologies are expected to be available within the required retrofit period.

Section G:

Summary of the Models used for the Analysis

Description of the Integrated Planning Model (IPM)

Analytical Framework of IPM

- EPA uses the Integrated Planning Model (IPM) to analyze the projected impact of environmental policies on the electric power sector in the 48 contiguous states and the District of Columbia. Developed by ICF Resources Incorporated and used to support public and private sector clients, IPM is a multi-regional, dynamic, deterministic linear programming model of the U.S. electric power sector.
- The model provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints. IPM can be used to evaluate the cost and emissions impacts of proposed policies to limit emissions of sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon dioxide (CO_2), and mercury (Hg) from the electric power sector.
- IPM was a key analytical tool in developing the President's Clear Skies proposal.

IPM Is Well Suited to Model Multi-Emission Control Programs

- Among the factors that make IPM particularly well suited to model multi-emissions control programs are (1) its ability to capture complex interactions among the electric power, fuel, and environmental markets, (2) its detail-rich representation of emission control options encompassing a broad array of retrofit technologies along with emission reductions through fuel switching, changes in capacity mix, and electricity dispatch strategies, and (3) its capability to model a variety of environmental market mechanisms, such as emissions caps, allowances, trading, and banking.
- IPM is particularly well suited for modeling Clear Skies because the program relies on the operation of an allowance market, the availability of a broad range of emissions reduction options, and empowerment of economic actors to achieve emission limits.

Extensive documentation of the IPM is available at http://www.epa.gov/airmarkets/epa-ipm/index.html.

Description of Air Quality Modeling

- The results for fine particle concentrations, visibility, sulfur deposition, and nitrogen deposition are based on the Regional Modeling System for Aerosols and Deposition (REMSAD).
- REMSAD is an Eulerian air quality model developed to simulate regional-scale distributions, sources, formation, transport, and removal processes for fine particles and other airborne pollutants. This analysis used REMSAD version 6.4 with meteorological inputs previously developed for 1996 using the Mesoscale Meteorological Model (MM-5).
- The results for ozone concentrations are based on the Comprehensive Air Quality Model with Extensions (CAMx).
- CAMx is an Eulerian air quality model developed to simulate local and regional-scale distributions, sources, formation transport, and removal processes for ozone and other photochemical pollutants. This analysis used CAMx version 3.1 with meteorological inputs previously developed using the Regional Atmospheric Modeling System (RAMS) for episodes in June, July, and August 1995.
- The Integrated Planning Model (IPM) was used to derive all future projections of electricity generation source emissions.
- Emissions inputs for non-electric generating facilities for REMSAD and CAMx were derived from the 1996 National Emissions Inventory (NEI). In addition, inventories prepared for the Heavy Duty Diesel Engine rulemaking were the basis for future year emissions projections.
- For the most part, the modeling results are analyzed in terms of the change in future year air quality relative to predictions under baseline conditions. In this way, effects of any uncertainties in emissions forecasts and air quality modeling are minimized.
- Results for projected annual PM2.5 and 8-hour ozone nonattainment were determined by “rolling back” current air quality levels. This was based on the change in air quality between the 1996 Base Year and each future year scenario. Since no ozone modeling was performed for the Western U.S., future ozone nonattainment in the West was determined through an emissions scaling analysis that used forecast changes in NOx emissions in the West coupled with the response of ozone to emissions changes, as modeled in the East.
- Maps which display the impacts on PM2.5 concentrations and deposition are reported as a percent reduction. A positive percent reduction (e.g. 30%) is a decrease in concentration or deposition compared to current conditions (an improvement); a negative percent reduction (e.g. -30%) is an increase in concentration or deposition compared to current conditions.
- Visibility results are reported as a change in deciviews. “Perfect” visibility is represented by a deciview of zero, so a decrease in deciview is an increase or improvement in visibility. An increase in deciview is a decrease in visibility.

Description of Benefits Modeling

- The Criteria Air Pollutant Modeling System (CAPMS) is used to quantify human health benefits due to the changes in a population's exposure to fine particulate matter and ozone.
- Using the air quality modeling results, the change in pollutant concentration based on modeling for each CAPMS grid cell is determined. This is the level at which the population living in that grid cell is assumed to be exposed.
- Concentration-response functions from epidemiological studies are applied to each grid cell to predict the changes in incidences of health outcomes (e.g. asthma attacks) that would occur with the projected changes in air quality.
- The grid cells are aggregated to estimate the health impact of the change in air quality across the study region.
- The estimated economic value of an avoided health outcome (e.g. $41 per asthma attack day) is multiplied by total change in events to determine the health benefits of air quality improvements for the entire region.
- For visibility, benefits were calculated based on changes in fine particle concentrations, presented as deciviews, which are provided by the REMSAD air quality model.
- Individuals place a value on visibility improvements in recreational areas, such as National Parks and wilderness areas
- The economic value that people place on improved visibility on a day that they visit a Class I area is applied to the predicted deciview changes and projected number of park visitors affected to attain recreational visibility monetary benefits.

Description of Freshwater Modeling

- The Model of Acidification of Groundwater in Catchments (MAGIC) is used to examine changes in surface freshwater chemistry as indicated by changes in acid neutralizing capacity (ANC) in the waterbody.
- ANC represents the ability of a lake or stream to neutralize, or buffer, acid. The condition of a lake or stream improves as the the ANC increases, moving from chronically acidic ➔ episodically acidic ➔ not acidic.
- Episodically acidic lakes (ANC of 0-50 μeq/l) have a greater capacity to neutralize acid deposition than chronically acidic ones. However, these lakes remain susceptible to becoming chronically acidic if acid deposition increases.
- Watershed characteristics (e.g., soils, bedrock type, geologic history) affect the rate of water chemistry response to acid deposition.
- “Direct response” lakes or streams manifest changes more quickly, whereas “delayed response” lakes or streams manifest changes over a longer period of time.
- MAGIC results show the distribution of lakes and streams (by percentage) over the three ANC classes
- Three regions were modeled (the Adirondacks, the Northeast (including the Adirondacks), and the Southeast).
- Results are reported for current conditions (2000) and in 2030 under the Base Case and the Clear Skies Act.

Results are based on a model called the “Model of Acidification of Groundwater in Catchments” (MAGIC) used by the National Acid Precipitation Assessment Program (NAPAP) to estimate the long-term effects of acidic deposition (sulfur) on lakes and streams. The model simulates the size of the pool of exchangeable base cations in the soil. As the fluxes to and from the pool change over time due to changes in atmospheric deposition, the chemical equilibria between soil and soil solution shift to give changes in surface water chemistry. Changes in surface water chemistry are characterized by changes in Acid Neutralizing Capacity (ANC) – the ability of a waterbody to neutralize strong acids added from atmospheric deposition.

Description of the Technology Retrofit and Updating Model

Uses of the Technology Retrofit and Updating Model

- At this time, IPM does not model price elasticity of demand and the effect of multiple allowance allocation mechanisms. To study the effect of these variables on electricity prices and markets, ICF developed a macro-driven spreadsheet program termed the “technology retrofit and updating model.”
- The model is used to discern trends in marginal costs and retrofits, the approximate magnitudes of those trends, and the reasons for those trends.

Modeling Approach

- The technology retrofit and updating model consists of a set of approximately six hundred “sample” generating units with varying characteristics. The mix of generation types and sizes was chosen to mirror, in general terms, the nationwide mix of capacities. Each unit is assumed to choose emission control retrofit options, fuels, and generation levels so as to maximize its own net profit in response to fuel prices, emission allowance prices, and prices of electricity for various demand segments. Prices of fuels can be adjusted in the model in response to demand; prices of electricity by demand segment is set in the model so as to meet demand; and allowance prices can be adjusted to cause the industry to meet given caps.
- To simulate the effects of demand elasticity, the quantity of electricity demanded in each segment can be set as a function of electricity prices using an elasticity value that is entered as an input to the model. Finally, to simulate the effects of allowance updating, the value of reallocated allowances can be calculated and subtracted from each unit’s cost of generation – thereby inducing each unit to change its profit-maximizing level of generation in response to a given set of fuel, allowance, and electricity prices. Readjusting the allowance prices to meet the same emission caps then generates results showing the costs of meeting given caps with and without updating.
- An important limitation of this model is that it does not simulate changes over time in the demand for electricity, prices, technology, or other factors considered within IPM. Instead, it is run as though every year is the same as every other year and is therefore static in its outlook. In addition, it does not recognize the distinctions among electricity demand regions and the transmission constraints that can keep them separate. Thus, only one price of electricity is determined for each demand segment for the entire set of sample plants.

Description of the Retail Electricity Price Model

Primary Attributes of the Model

- The Model provides a forecast of average retail electricity prices from 2005 to 2020 for 13 regions and the contiguous U.S., and considers areas of the country that (1) will have competitive pricing of power generation and, (2) are likely to price retail power based on a cost-of-service basis.
- Combines IPM and EIA information with data from the National Regulatory Research Institute and Center for Advanced Energy Markets regarding the restructuring of the power industry.
- “Main Case” is EPA’s forecast of “likely deregulation” considering areas of the country that should price generation services for retail customers competitively and those that most likely to use cost-of-service pricing principles.
- The Model readily analyzes alternative multi-pollutant and base case scenarios modeled with IPM, alternative assumptions on deregulation and future savings/costs, and the implications of different allowance allocation approaches. The strongest application of the Calculator occurs from examining the relative price differences between two or more scenarios.

The Limitations of the Model Include

- The Model combines IPM and EIA cost elements that use similar -- but not identical -- assumptions on capital recovery and aggregate cost data in a similar -- but not identical -- regional manner that needs adjustment.
- The Model assumes public and private companies seek the same return and have the same tax treatment, which overstates prices in areas where there are large amounts of public power.
- The Model focuses on major costs. It assumes for cost-of-service areas (where most of power sales are likely to occur) that allowance allocations will not alter pricing of electricity.
- Uses EIA’s limited (but best available) data in some areas (e.g. rate base with stranded assets).
- The Model cannot address the uncertainty of deregulation created by California’s experience -- where competition may increase or decrease in the future. With the phasing in of competition and limited experience, the full benefits and costs of deregulation still remain unknown.