



# Improving Air Quality Through PM<sub>2.5</sub> Control *The U.S. Experience*

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## *Key Messages*

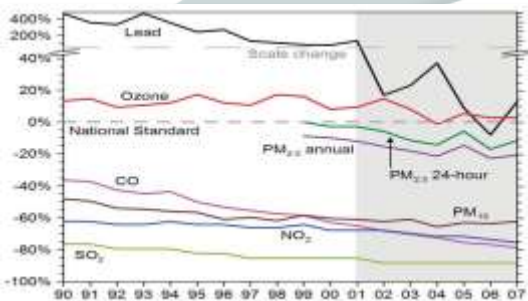
- Air quality management is a continuous cycle of development and improvement with a goal of improving public health and the environment
- PM<sub>2.5</sub> is a multi-pollutant mixture of primary and secondarily formed substances that can be systematically controlled
- National, regional and local regulations, along with voluntary and market-based programs, can be effective in achieving reductions
- Regional cooperation is critical for controlling air pollution that affects multiple cities and states/provinces
- Providing information to the public enables them to play a key role in achieving standards and improving public health



***Establish Goals***



***Determine Emission  
Reductions***



***On-going Evaluation***

***Scientific Research***



***Control Strategies***



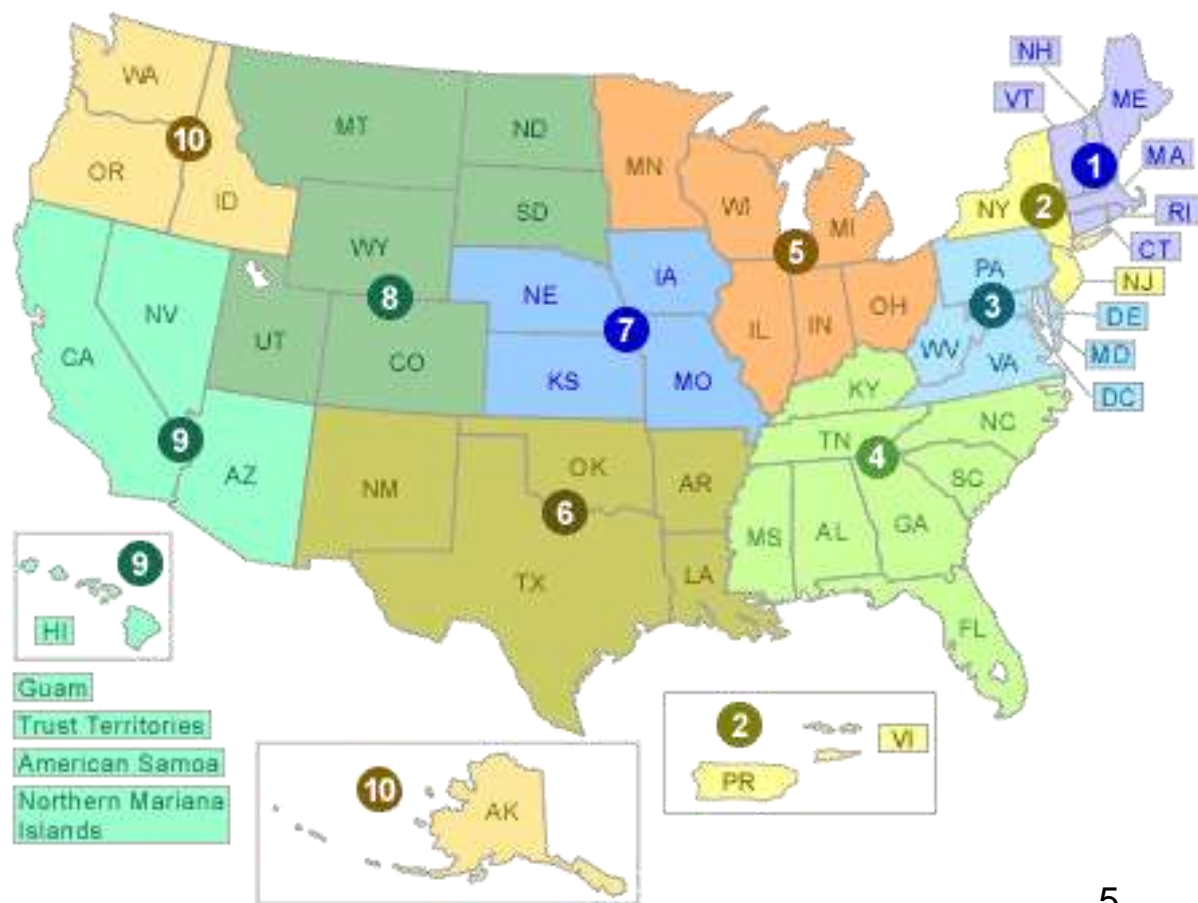
***Implementation Programs***

## *EPA Air Program Structure – National Level*

- Office of the Administrator
  - *Final authority for EPA actions*
- Office of Air and Radiation
  - *Responsible for national air quality programs*
- Office of General Counsel
  - *Legal support for air quality rules and policies, case-by-case decisions (e.g., permits and response actions), and legislation.*
- Office of Enforcement & Compliance Assurance
  - *Works in partnership with states, etc, to enforce laws*
- Office of Research and Development
  - *Provides scientific foundations for national policies*

# EPA Air Program Structure – Regional Level

- **Ten Regional Offices**
- **Work directly with State, local and tribal governments to implement national air quality programs**



# *AQM Responsibilities*

## The federal government:

- Sets air quality standards
- Designates areas as attainment, nonattainment, or unclassifiable
- Establishes national controls for certain source categories that states cannot regulate (e.g., mobile sources)
- Promulgates regulations to address interstate transport of pollution
- Develops guidance to interpret rules and Clean Air Act requirements
- Approves and enforces SIPs

## States:

- Recommend designation of areas
- Develop emission inventories
- Operate air quality monitoring networks
- Perform air quality modeling and identify emissions control strategies needed to attain standards
- Adopt the necessary measures into their State Implementation Plans
- Enforce regulations
- Issue pre-construction and operating permits

# Setting National Ambient Air Quality Standards

Under the Clean Air Act, the levels set for NAAQS are based on these considerations

- Reviewed every 5 yrs
- Scientific panel (CASAC) advises EPA



## PRIMARY STANDARDS

*The level required to protect public health, allowing for an adequate margin of safety*



## SECONDARY STANDARDS

*The level required to protect public welfare (visibility, crops, forests, etc.) from any known or anticipated adverse effects*

**NOTE: Costs and technology are not considered in setting the level of NAAQS, but later in the implementation phase.**



# Evolution of Ozone and PM Standards

## Ozone

Year	Averaging Time	Parts Per Million
1971	1 hour	0.08*
1979	1 hour	0.12
1993	unchanged	
1997	8 hour	0.08
2008	8 hour	0.075

## Particulate Matter

Year	Averaging Time	ug/m3	Pollutant
1971	24-hour	260/150	TSP*
1971	annual	75	TSP
1987	24-hour	150	PM-10
1987	annual	50	PM-10
1997	24-hour	65	PM-2.5
1997	annual	15	PM-2.5
2006	24-hour	35	PM-2.5
2006	annual	revoked	PM-10
2012	annual	12	PM-2.5

 = current standards

\* Total Photochemical Oxidants

\* Total Suspended Particles (25-45 um)



# ***Implementing the US NAAQS***

- Designating areas
- Developing state implementation plans (SIPs)
- Federal measures
- PM<sub>2.5</sub> controls
- Mobile source measures
- Regional control programs

# ***Designating Nonattainment Areas***

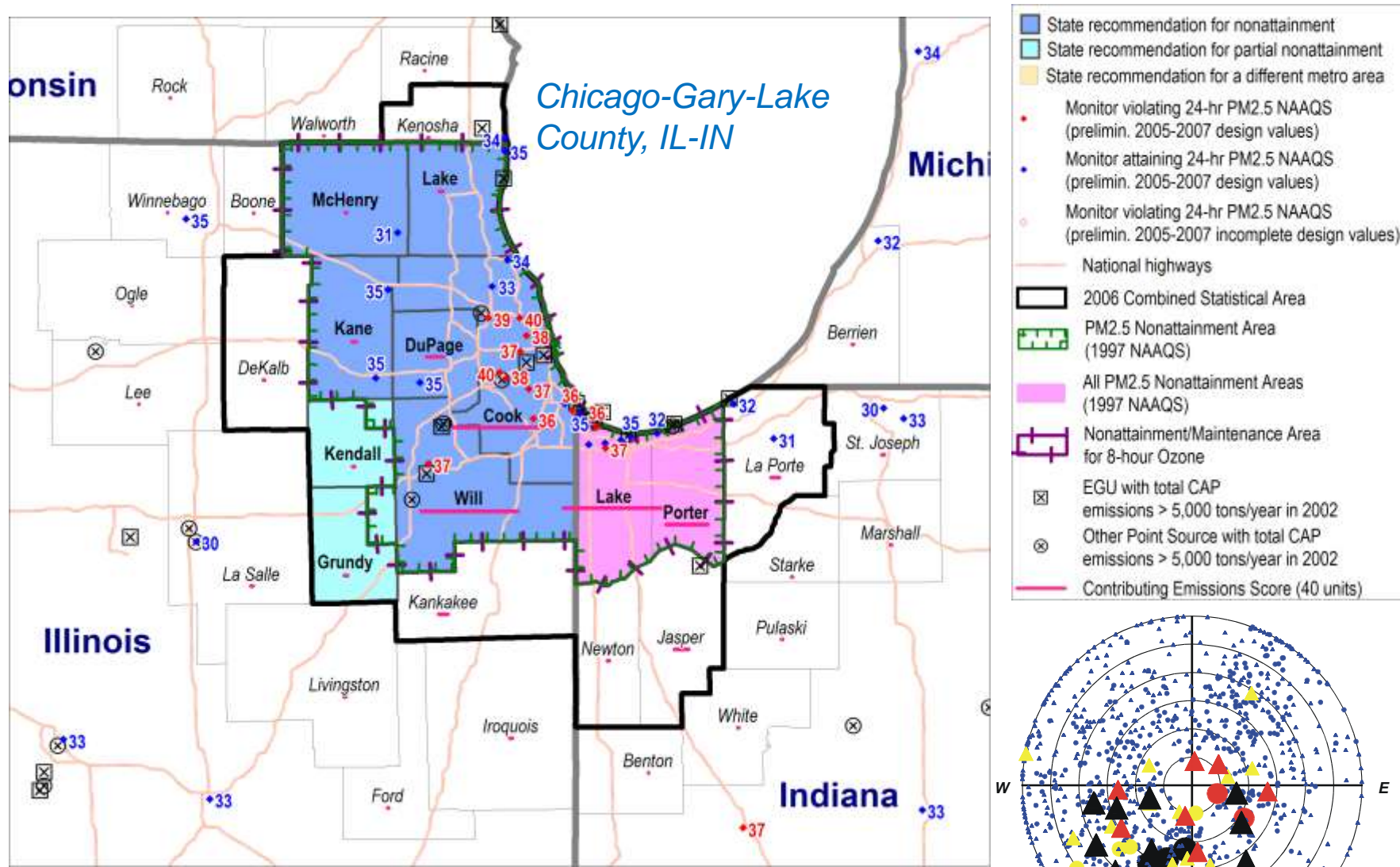
## **After Air Quality Standards are revised:**

- States submit recommendations to EPA regarding attainment, nonattainment or unclassifiable areas
  - EPA designates areas attainment or nonattainment for ozone and PM<sub>2.5</sub> based on the most recent 3 years of monitor data.
- Areas are to be designated nonattainment if they either violate the standard or contribute to a violation in a nearby area
  - Size of area varies by pollutant
- EPA makes the final decision on appropriate designation of areas

## ***Monitoring Requirements***

- Cities and States are required to locate at least one PM<sub>2.5</sub> monitor:
  - *In an area of “expected maximum concentration”; however,*
  - *We also require the site to be representative of “an area-wide location”*
    - *Not overly influenced by a single source, unless that source is persistent around the city*
- In most cases this means:
  - *Having a neighborhood scale of representation*
  - *Locating monitors in the urban core of a city and in a downwind location under light wind conditions as might be the case in an inversion or other episode*
- A site in the area of expected maximum concentration will likely be higher than other neighborhoods in the upwind part of the city, or sites that have a coastal sea breeze.

## Chicago Region Nonattainment Area



## ***State Implementation Plans (SIPs)***

### After nonattainment areas are designated:

- CAA requires States to submit an attainment plan **within 18-36 months** (varies by pollutant) of nonattainment area designation
- States must demonstrate attainment “as expeditiously as practicable”
  - Ozone (3-20 years); PM<sub>2.5</sub> (5-10 years)
- Take into account national and state emission reductions already in place
- Adopt regulations to require reasonable controls on sources in the state and to prevent significant contribution to other “downwind” states
- Provide public notice and opportunity for comment
- Submit to EPA for review and approval

## ***Elements of a Nonattainment Area Plan***

- Develop detailed emission inventory of sources
- Identify existing federal & state controls
- Evaluate (technically and economically) feasible new controls on sources in nonattainment area and state
- Conduct air quality modeling to evaluate air quality improvement from projected existing and new emission reductions
- Adopt enforceable regulations and control measures: emission limits, test methods, monitoring and reporting for specific sources
- Ensure reasonable progress toward attainment
- Adopt contingency measures to apply in the event the area fails to attain by its attainment date
- Include authority to stop air pollution that endangers public health (emergency powers)

## ***EPA Review and Approval***

- EPA works with states to develop plans for submittal by established deadlines
- EPA reviews and approves plans that meet applicable requirements. This makes state regulations **federally enforceable**.
- If states fail to submit timely SIPs or EPA disapproves plan, various **sanctions** apply.
  - In some cases, EPA may develop and implement a federal plan in the state.



## ***Failing to Comply with Requirements vs. Failing to Attain the Standard:***

- States that fail to comply with planning or implementation requirements may be subject to sanctions
  - New source emissions offset ratio of 2 to 1
  - Restricted highway funding
- States that fail to attain by the attainment date, no sanctions apply, but...
  - States must undertake a **new round of planning** and control measure development
  - EPA can require **additional measures** to ensure attainment by a new attainment date
  - Ozone areas are **automatically reclassified** to higher classification and must meet additional requirements

## ***Stationary source controls***

- SIPs must include a set of **rules that require permits** for the construction and operation of new or modified stationary sources.
- These sources must install technology that meets the lowest achievable emission rate and secure additional emission reductions to offset any increases in emissions



## ***Transportation Conformity***

- Ensure that federal funding and approval are given to highway and transit projects that are consistent with ("conform to") the air quality goals established by a state air quality implementation plan (SIP)
- Conformity, for the purpose of the SIP, means that transportation activities will not cause new air quality violations, worsen existing violations, or delay timely attainment of the national ambient air quality standards

## ***Federal Measures***

- Federal programs provide for nationwide reductions in emissions ozone through:
  - **Federal Mobile Source Control Program** including controls for automobile, truck, bus, motorcycle, and nonroad emissions
  - **New source performance standards**
  - **Emission standards for hazardous air pollutants**
  - **Regional trading programs** (e.g., NO<sub>x</sub> Budget Trading Rule)

## ***Ozone nonattainment requirements***

- Persistent difficulties attaining the ozone standard have led to further requirements specific to ozone
- Ozone nonattainment areas are **classified** from marginal to extreme according to the degree of nonattainment, with increasingly more stringent control obligations in more heavily polluted areas
  - Higher classifications have **more time** to attain, from three to twenty years respectively
  - Higher classifications must include **all controls** required for lower classifications as well

## ***Point sources controls for PM<sub>2.5</sub>***

- Direct PM has been regulated in some form in the US since 1970s
  - *Controlling total suspended particles and PM-10 has resulted in significant overall reductions in direct PM<sub>2.5</sub>*
  - *Completely uncontrolled stack sources of PM are relatively rare*
- Methods to achieve further reductions in PM<sub>2.5</sub> include:
  - *Capture and send to control device (baghouse, ESP, etc; as noted most PM sources already controlled)*
  - *Improve performance of existing controls*
  - *Improve capture of particles*
  - *Identify and mitigate malfunctions*
  - *Upgrade control devices*

## ***Resources for Control Information***

- EPA website:
  - <http://epa.gov/airquality/particlepollution/measures.html>
- EPA summary tables:
  - [http://epa.gov/airquality/particlepollution/measures/pm\\_control\\_measures\\_tables\\_ver1.pdf](http://epa.gov/airquality/particlepollution/measures/pm_control_measures_tables_ver1.pdf)
- STAPPA/ALAPCO menu of options:
  - <http://www.4cleanair.org/PM25Menu-Final.pdf>



# EPA's Mobile Source Roadmap

## Tier 2 Light-Duty

final rule 1999

fully phased in 2009

Diesels held to same stringent  
standards as gasoline vehicles

GAS 30 PPM; DIESEL 15 PPM



2009



2010

## Heavy-Duty Highway

sales 800,000 / yr

40B gallons / yr

final rule 2000

fully phased in 2010

DIESEL 15 PPM



2015-2016



2015

## Nonroad Diesel

sales over 650,000 / yr

12B gallons / yr

final rule 2004

fully phased in 2015

DIESEL 15 PPM



2017

## Locomotive/Marine

sales 40,000 marine engines,

1,000 locomotives / yr

final rule 2008

fully phased in 2017

DIESEL 15 PPM



## Ocean Going Vessels

Clean Air Act Rule December 2009

International Maritime Organization

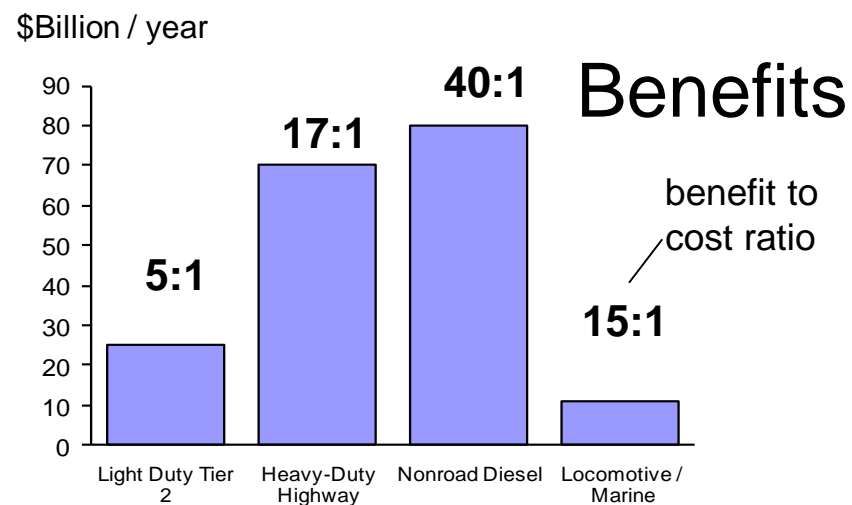
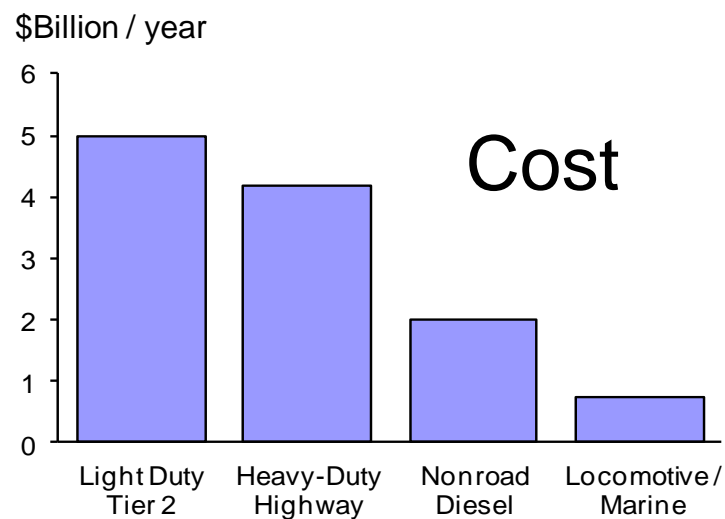
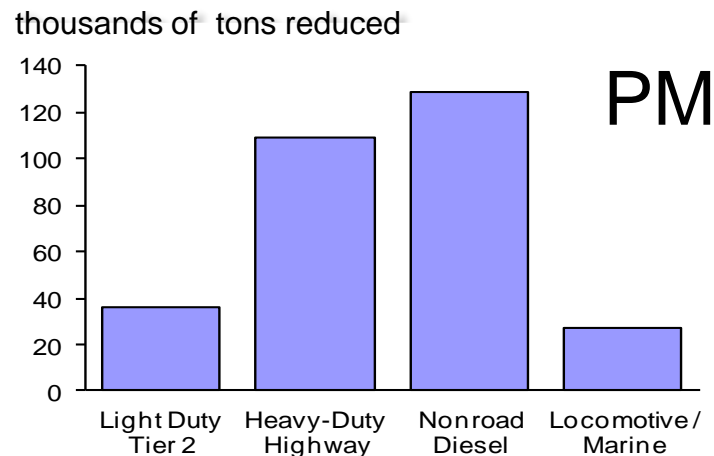
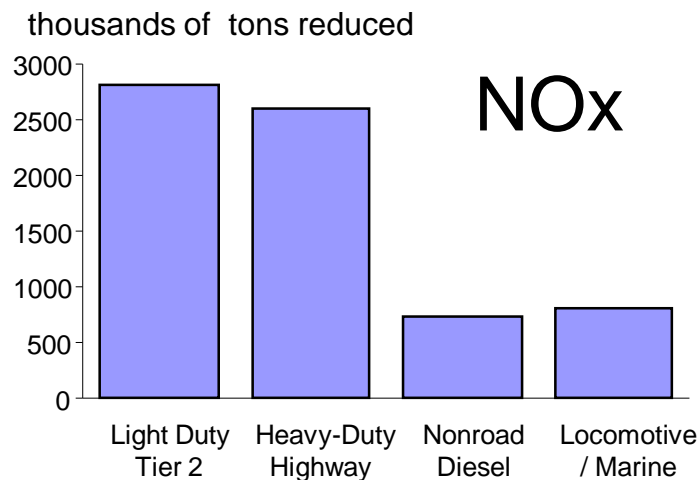
(IMO) MARPOL Annex VI

Emission Control Area Controls:

- Fuel Based 2015 - 1000 PPM sulfur
- SCR Catalyst Based 2016

Note: sales and diesel fuel  
usage vary year-to-year;  
these figures are for  
comparison purposes only

# Mobile Source Program Impacts in 2030: Examples



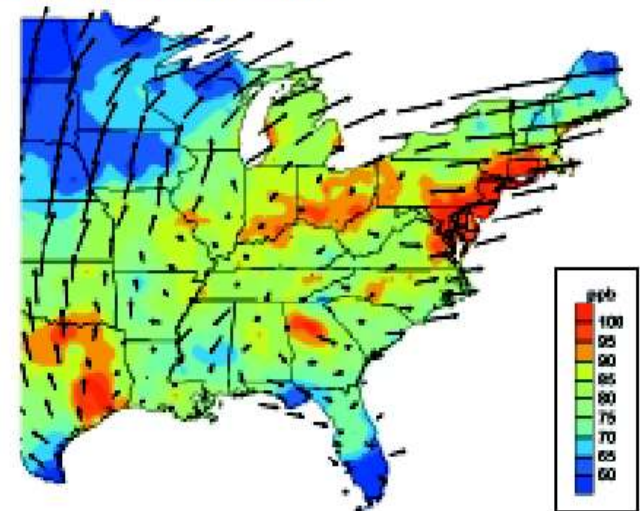
## *Requirements for Regional Pollution*

- State plans must address contributions of their sources to air quality problems in other states.
- State plans must provide controls necessary to prevent any **significant interference** with attainment or maintenance in downwind states
- For the Eastern US, this provided EPA with authority for:
  - Regional NO<sub>x</sub> Budget Trading Program Rule (1998)
  - Clean Air Interstate Rule (2005)
  - Cross-State Air Pollution Rule (2011)
  - Possible future rules related to transboundary air pollution

## *Regional emissions within the U.S.*

- Air pollution can travel hundreds of miles and cause multiple health and environmental problems on regional or national scales.
- EPA has rules that result in reducing emissions contributing to PM<sub>2.5</sub> and ozone nonattainment that often travel across state lines:
  - SO<sub>2</sub> and NO<sub>x</sub> contribute to PM<sub>2.5</sub> transport
  - NO<sub>x</sub> contributes to ozone transport
- Attaining national ambient air quality standards requires emission reductions from:
  - Sources located in or near nonattainment areas (local pollution).
  - Sources located further from the nonattainment area (transported pollution), and
  - Pollution emitted by power plants, cars, trucks, and other industrial facilities.

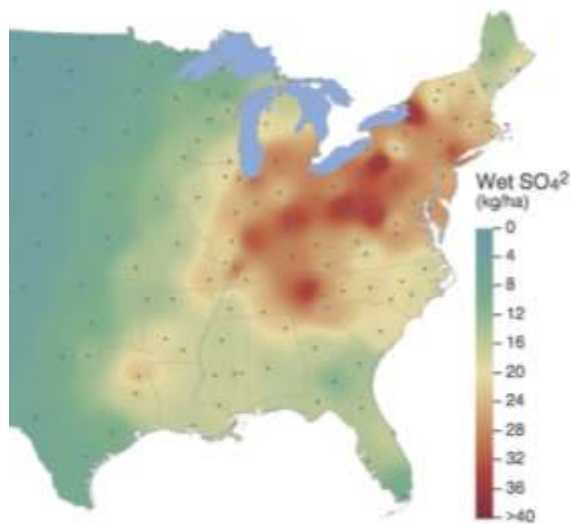
Transport Winds and Ozone Patterns on High Ozone Days



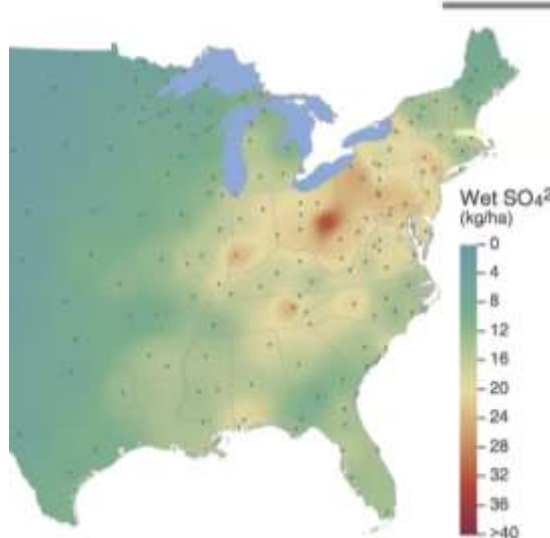
# ***Acid Rain Program: Major Reductions in SO<sub>2</sub> Emissions and Acid Rain***

## **Annual Mean Wet Sulfate Deposition**

**1989-91**

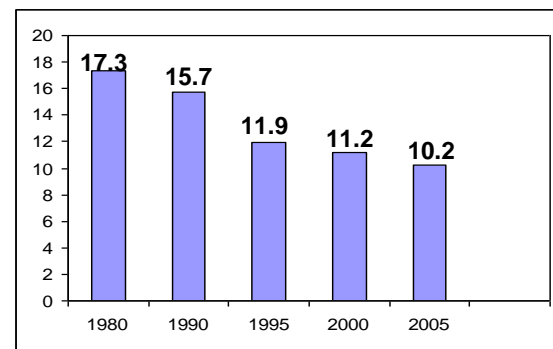


**2003-05**



**Substantial health, visibility, and other benefits provided**

## **Power Plant SO<sub>2</sub> Emissions**



**Million Tons of SO<sub>2</sub>**

**SO<sub>2</sub> emissions down by  
5.5 million tons since 1990**



**Acid rain cut by 25 –40%**

## *Voluntary Programs*

- Education Programs
  - AIRNow/Air Awareness Campaigns/Ozone Action Days/
  - Forecasting/reporting by states/localities
- Mobile Source Programs
  - Private Vehicle Programs
  - Smart Growth Land Use/Transportation Energy Efficiency Programs
  - Non-road Programs (Engines, Equipment, Vehicles)
  - Diesel emission reduction programs
- Industrial/Commercial Actions
  - Energy STAR Buildings
  - Leadership in Energy and Environmental Design (LEED) Green Building Rating System
- Energy Efficiency Measures/Programs

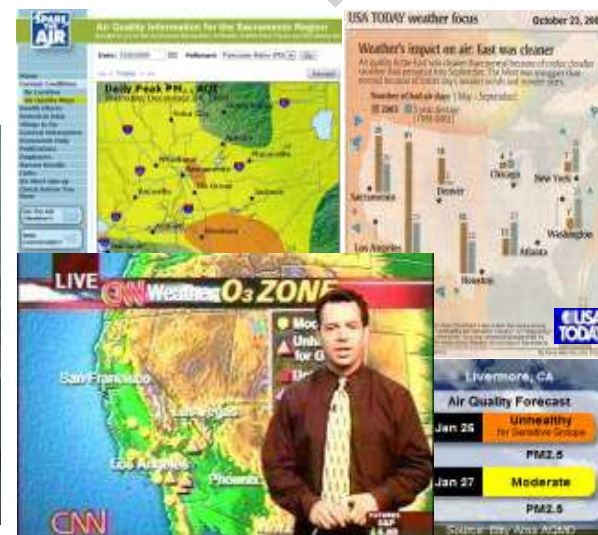
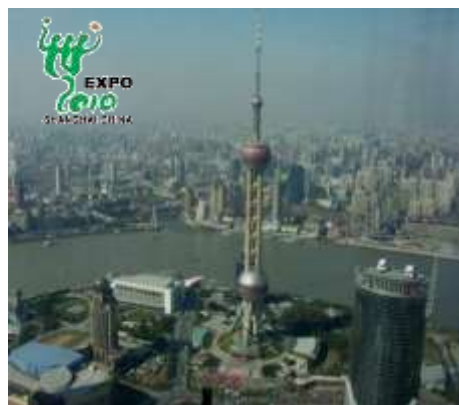
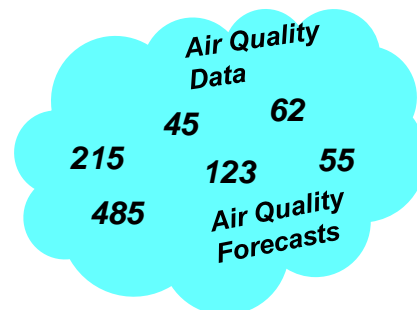




# AIRNow &



- AIRNow is EPA's national system for acquiring and distributing air quality information to the public
- Provides current and forecasted air quality information for most of North America
- Builds support for air quality improvement programs
- AIRNow-International successfully piloted at Shanghai 2010 World Expo
- New system is identical to AIRNow in U.S.
- Is adaptable to other cities and countries
- Builds a community of people and organizations dedicated to air quality information exchange





# Real-time reporting of Air Quality

- Purpose
  - Communicate air quality to the public
  - Protect people's health
  - Reduce people's exposure to poor air quality, especially sensitive groups (people with heart or lung disease, older adults, and children)
- Same Air Quality Index (AQI) scale and color are used for all pollutants and across the U.S.



Air Quality Index (AQI) Values	Levels of Health Concern	Colors
<i>When the AQI is in this range:</i>	<i>...air quality conditions are:</i>	<i>...as symbolized by this color:</i>
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

# 谢谢！

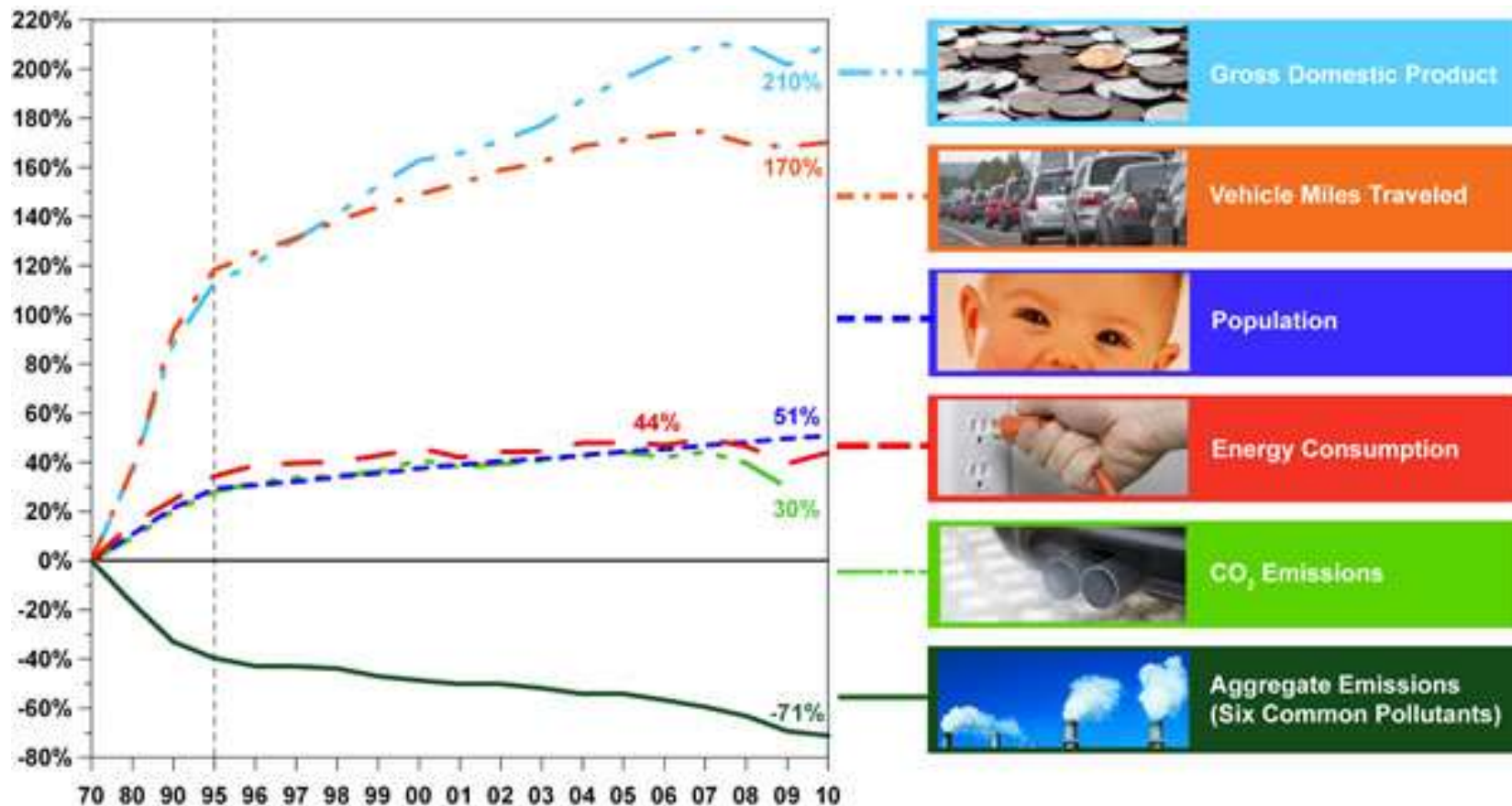
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# Progress Toward Clean Air 1970-2010

*Pollution Down While Growth Continues*





# Health/Economic Benefits of U.S. Clean Air Act

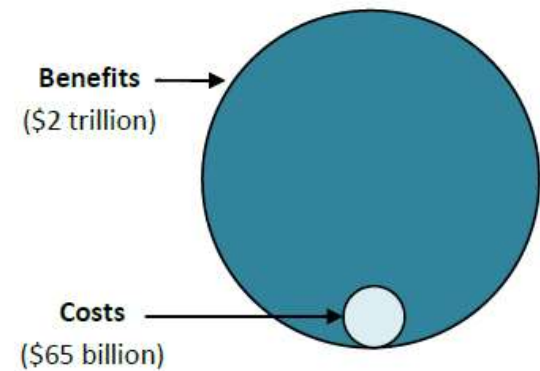
- **Clean Air Act Benefits 1970-1990**

- 205,000 premature deaths avoided
- 40:1 ratio of benefits/costs

- **Clean Air Act Benefits 1990-2010**

- 160,000 premature deaths avoided, as well as
  - Millions of cases of heart disease, bronchitis, asthma and other illnesses
- 25:1 ratio of benefits/costs

(Full report available at  
<http://www.epa.gov/air/sect812/prospective2.html>)



The 1990 Clean Air Act Amendments prevent:

	Year 2010 (cases)	Year 2020 (cases)
Adult Mortality - particles	160,000	230,000
Infant Mortality - particles	230	280
Mortality - ozone	4,300	7,100
Chronic Bronchitis	54,000	75,000
Acute Myocardial Infarction	130,000	200,000
Asthma Exacerbation	1,700,000	2,400,000
Emergency Room Visits	86,000	120,000
School Loss Days	3,200,000	5,400,000
Lost Work Days	13,000,000	17,000,000