1980 – The National Acid Precipitation Assessment Program (NAPAP), mandated by Congress, begins study on acid rain

Throughout the 1980s:
Lake acidification and fish loss in the Adirondacks and Appalachian mountains make national news

1990 – Congress strengthens the Clean Air Act and establishes the Acid Rain Program (Title IV) using a market-based approach to reduce sulfur dioxide from power plants by more than 50 percent as well as a rate-based nitrogen oxides reduction program

1995 – Phase I of the Acid Rain Program (ARP) begins

2000 – Phase II of the ARP begins

2010 – Full implementation of the ARP
How Acid Rain is Formed

• When certain pollutants – sulfur dioxide (SO₂) and nitrogen oxides (NOₓ) – are released into the air, they can mix and react with water, oxygen, and other chemicals to form acids.
  – Rainwater, snow, fog, and other forms of precipitation then mix with these acids in the air and fall to Earth as acid rain (wet deposition)
  – About half of the acidity in the atmosphere is deposited onto buildings, cars, homes, and trees as particles and gases (dry deposition)

• Power plants release the majority of the pollutants that form acid rain when they burn fossil fuels, such as coal, to produce electricity. In addition, the exhaust from cars, trucks, and buses releases nitrogen oxides into the air.

• Atmospheric transport (i.e., wind) can carry these pollutants long distances, affecting ecosystems and communities hundreds of miles from the source of pollution.
Acid Rain Effects

• Lakes/Streams
  – Acid deposition increases acidity in freshwater environments and has impacts on fish and ecosystems

• Forests
  – Causes leaching of essential nutrients from soils: trees more susceptible to disease, insects, and cold weather
  – Increases aluminum in soil: nutrient uptake more difficult

• Buildings and Materials
  – Can cause deterioration of stone and metal structures, including historically important monuments

• Human Health
  – Significant impacts from pollutants that cause acid rain
    • Respiratory – asthma, bronchitis,
    • Heart attacks
    • Premature death

• Visibility Reduction
  – Pollutants that cause acid rain also limit how far we can see through the air, affecting our enjoyment of national parks
Key Components of the ARP

- **SO₂ Program Phases and Reductions:** Title IV of the 1990 CAA Amendments set a goal of reducing annual SO₂ emissions by 10 million tons from all sources (8.4 million tons from power plants) below 1980 levels. To achieve these reductions, the law required a two-phase tightening of the restrictions placed on fossil fuel-fired power plants. Phase I began in 1995 and Phase II began in the year 2000.

- **Emissions Cap:** A fixed quantity of SO₂ allowances was established to achieve and maintain the environmental goal.

- **Limited Allowances:** Authorizations to emit, known as allowances, are allocated to power plants based on their historic fuel consumption and a specific emissions rate. Each allowance represents one ton of SO₂ emissions. The SO₂ allowance market enables sources to trade (buy and sell) allowances throughout the year.

- **Flexible Compliance:** Each source can choose the most efficient way to reduce its SO₂ emissions. Installing new control technology, switching to lower-sulfur fuel, or optimizing existing controls are all options.

- **Stringent Monitoring:** Each source must continuously measure and record its emissions of SO₂, NOₓ, and CO₂, as well as other information. Most emissions are measured using a continuous emission monitoring system (CEMS). Accurate and verifiable data assures accountability, provides public access to data, and leads to program integrity and confidence.
Key Components of the ARP

• **Compliance Determination**: At the end of each year, sources are granted a 60-day grace period to ensure that they have sufficient allowances to match their SO$_2$ emissions during the previous year. If they need to, they may buy allowances during the grace period.

• **Allowance Trading**: If a source had excess allowances because it reduced emissions beyond required levels, it could sell the unused allowances or bank (save) them for use in a future year. SO$_2$ allowance trading minimizes compliance costs and encourages units to reduce emissions beyond required levels.

• **Automatic Penalties and Enforcement**: Any source that fails to hold enough allowances to match its SO$_2$ emissions for the previous year must pay to EPA an automatic penalty of $2,000 (inflation-adjusted to $3,517 for 2009) per ton of emissions in excess of allowances held. The source must also immediately surrender to EPA an amount (referred to as an “offset”) of allowances, issued for the year the payment is due, equaling the tons of excess emissions.

• **NO$_x$ Program**: Title IV requires NO$_x$ emission reductions for certain coal-fired power plants by limiting the NO$_x$ emission rate (the measure of how much pollutant is emitted compared to the amount of energy used – expressed in lb/mmBtu). The goal of the NO$_x$ program is to limit NO$_x$ emission levels from the affected coal-fired boilers so that their emissions are at least 2 million tons less than the projected level for the year 2000 without implementation of Title IV. EPA estimated this projected number to be 8.1 million tons.
Cap and Trade

- Initial Emissions Total = 30 tons
- Allowable Limit (Cap) Cap Total = 15 tons

<table>
<thead>
<tr>
<th>Plant A</th>
<th>Plant B</th>
<th>Plant C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction: 5 tons</td>
<td>Reduction: 7 tons</td>
<td>Reduction: 3 tons</td>
</tr>
</tbody>
</table>

2 Allowances
Covers about 1,200 power plants with 3,600 units in the lower 48 states.

From 1990 to 2010, annual SO\(_2\) emissions from ARP sources decreased by 67%.

From 1990 to 2010, annual NO\(_x\) emissions from ARP sources decreased by 68%.

Sources were 100% in compliance with both programs.
The Biggest Emitters Achieved the Steepest Reductions

• The states with the highest emitting sources in 1990 have generally seen the greatest SO$_2$ reductions under the ARP.
  – Most of these states are upwind of the areas the ARP was designed to protect.

• These reductions have had tremendous environmental and health benefits
  – Over $120 billion annually in health benefits

• Future reductions under the ARP and other programs – the NO$_x$ Budget Trading Program, the Clean Air Interstate Rule and the newly finalized Cross-State Air Pollution Rule – are a key component in the attainment of ozone and PM NAAQS

[Map showing emissions trends from 1990 to 2010 with color bars representing different years]

Scale: Largest bar equals 2.21 million tons of SO$_2$ emissions in Ohio, 1990
Source: EPA, 2011
Environmental Results

Substantial Gains:
- Reduced “Acid Rain”
- Improved air and water quality
- Reduced Regional Haze
- Improved health (lives extended and ailments reduced)
- Other Benefits

Water Quality Improvements, 1990-2008

<table>
<thead>
<tr>
<th>Region</th>
<th>Waterbodies Covered</th>
<th>% of Sites with Improving Sulfate Trend</th>
<th>% of Sites with Improving Nitrate Trend</th>
<th>% of Sites with Improving ANC Trend</th>
<th>% of Sites with Improving DOC Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adirondack Mountains</td>
<td>50 lakes in NY</td>
<td>90%</td>
<td>32%</td>
<td>58%</td>
<td>42% (26 sites)</td>
</tr>
<tr>
<td>Catskills / N. Appalachian Plateau</td>
<td>9 streams in NY and PA</td>
<td>78%</td>
<td>33%</td>
<td>56%</td>
<td>29% (7 sites)</td>
</tr>
<tr>
<td>New England</td>
<td>26 lakes in ME and VT</td>
<td>96%</td>
<td>31%</td>
<td>12%</td>
<td>20% (10 sites)</td>
</tr>
<tr>
<td>Central Appalachians</td>
<td>66 streams in VA</td>
<td>12%</td>
<td>45%</td>
<td>12%</td>
<td>NA</td>
</tr>
</tbody>
</table>

Source: NADP, 2010

Annual Wet Sulfate Deposition (“acid rain”)
Public Access to Data

- Annual progress reports
- Detailed, searchable emissions and allowance data
- Monitoring network data
- Interactive 3-D mapping

www.epa.gov/cleanairmarkets