AAPCA

THE ASSOCIATION OF AIR POLLUTION CONTROL AGENCIES

State Air Trends & Successes

The StATS Report | 2024 Edition

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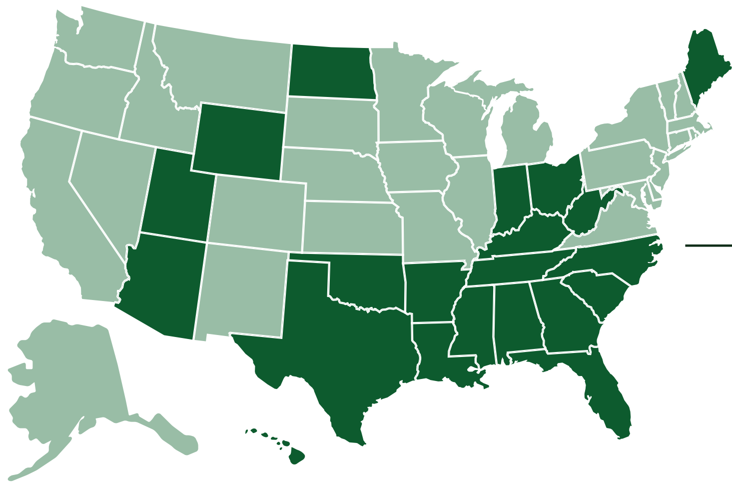
State Environmental Agencies Currently Represented on the AAPCA Board of Directors



Alabama	North Carolina
Arizona	North Dakota
Arkansas	Ohio
Florida	Oklahoma
Georgia	South Carolina
Hawaii	Tennessee
Indiana	Texas
Kentucky	Utah
Louisiana	West Virginia
Maine	Wyoming
Mississippi	

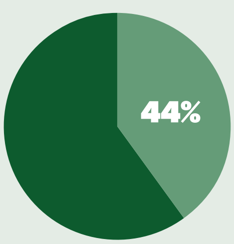
Association of Air Pollution Control Agencies (AAPCA)

AAPCA is a national, non-profit, consensus-driven organization focused on assisting state and local air quality agencies and personnel with implementation and technical issues associated with the federal Clean Air Act.

The Association represents 51 state and local air pollution control agencies, and senior officials from 21 state environmental agencies currently sit on the AAPCA Board of Directors. AAPCA is housed in Lexington, Kentucky as an affiliate of The Council of State Governments. More information about AAPCA can be found on the Association's website: www.cleanairact.org.

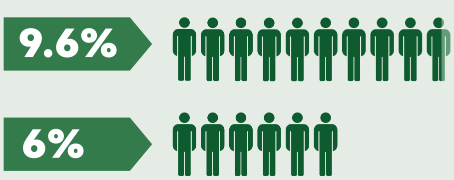
Footprint of AAPCA Member States

State members of the AAPCA Board of Directors have primary responsibility for protecting air quality for a significant portion of the country, as reflected in the following statistics:



An estimated **147.2 million** Americans, nearly **44%** of the total ***U.S. population*** in 2023.

A ***population growth*** of **9.6%** vs. a national population growth of **6%** from 2013 to 2023.



38% of ***U.S. Gross Domestic Product*** (GDP) in 2023.

42% of ***U.S. total manufacturing output*** and **5.5 million** manufacturing jobs in 2022.

1.6 trillion ***vehicle miles traveled*** in 2022.

67% of ***U.S. operable petroleum refining capacity*** in 2023.

Total ***energy production growth*** of **51%** vs. a national growth of **38%** since 2000.

60% of total ***U.S. energy production*** in 2021, as well as:

- **54%** of total ***net electricity generation*** in 2023.
- **43%** of ***solar generation*** in 2023.
- **47%** of ***wind generation*** in 2023.
- **67%** of ***natural gas production*** in 2022.
- **71%** of ***crude oil production*** in 2023.
- **76%** of ***coal production*** in 2022.

Foreword

Dear Readers,

It has been a busy year for those of us in the air quality world. As Air Directors, we have been navigating the many grant opportunities presented over the past few years while contending with a host of new or revised rules. Some of the most notable actions include the revision of the primary fine particulate matter ($PM_{2.5}$) national ambient air quality standard (NAAQS), the proposed and likely imminent changes to the Air Emissions Reporting Requirements (AERR), and most recently, the final rules for the Synthetic Organic Chemical Manufacturing Industry (SOCMI). In fact, U.S. EPA's regulatory agenda, released in December 2023, indicates there are 84 short- and long-term forthcoming regulatory actions from U.S. EPA's Office of Air and Radiation (OAR). Around 37 air-related rulemakings are to be completed by the end of the 2024 federal fiscal year, of which 10 actions are designated as major/economically significant regulations. Indeed, the past year has been a big challenge for us all.

The Association of Air Pollution Agencies (AAPCA) is a consensus-driven organization of 51 state and local air agencies focused on assisting members with implementation of technical issues associated with the federal Clean Air Act. Comprised of senior officials from 21 state environmental agencies, AAPCA's Board of Directors is geographically diverse, providing a unique forum of perspectives to engage as we work to improve air quality for the more than 147 million Americans we represent. AAPCA's Member States also guide the Association on a consensus basis, seeking to engage our federal co-regulator partners on common principles as we implement the federal Clean Air Act.

As AAPCA's President, I am pleased to present the Association's 2024 edition of its annual publication, *State Air Trends & Successes: The StATS Report*. Highlights from this year's report include:

- From 2000 to 2023, AAPCA Member States significantly reduced the combined emissions of criteria air pollutants (or pollutant precursors) for which there are NAAQS by 52 percent.
- The United States has reduced aggregate emissions of the six criteria air pollutants by 78 percent, from 1970 to 2022.
- From 2000 to 2023, emissions of sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) from the electricity sector have decreased by 94 percent and 86 percent, respectively, in AAPCA Member States.
- In 2021, AAPCA Member States generated 60 percent of total energy production in the United States.
- AAPCA Member States were responsible for 66 percent of the national reduction in reported toxic air releases of more than 204 million pounds from 2013 to 2022.
- In 2023, AAPCA Member States were the permitting agencies for more than 21,000 facilities, or 47 percent of the state agency total, and the lead agencies for nearly 7,000 full compliance evaluations, approximately 51 percent of the state agency total.
- From 2000 to 2021, visibility in 156 national parks and wilderness areas across the U.S. improved by 32 percent on the clearest days and by 25 percent on the most impaired days.

As we move forward, we should be proud of all the accomplishments listed above and relish the fact that we are breathing "the cleanest air since the Industrial Revolution"—one of our revered AAPCA colleague Vivian Johnson's favorite quotes. These improvements in air quality benefit us all, however, as we are all aware, our work is not done. We will continue to engage federal partners and other stakeholders and continue to improve air quality across the nation.

Thank you for reading.

Jason Meyers

Administrator, Air Planning and Assessment Division

Louisiana Department of Environmental Quality

2024 President, AAPCA

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Introduction

Air Quality, Economic Growth, and International Leadership

State Air Trends & Successes: The StATS Report is an **annual report** from the Association of Air Pollution Control Agencies, or AAPCA, that showcases the central role of state and local air agencies in improving air quality in the United States. Under the Clean Air Act's framework of cooperative federalism, the U.S. Environmental Protection Agency (EPA) sets national standards while state, local, and tribal agencies work on the ground with businesses, communities, and other stakeholders to develop implementation strategies that meet unique economic and social factors. This approach has been remarkably successful: Since 1970, when the Clean Air Act was passed, air pollution control efforts have vastly improved air quality while the nation has experienced substantial economic and social growth.

As the title indicates, *The StATS Report* also provides key data and trends from federal, state, and local agencies that demonstrate this marked progress, including for criteria pollutant concentrations and emissions, hazardous air pollutants (or air toxics), greenhouse gases, and visibility in national parks (see page 6, "Types of Air Quality Data and Metrics"). Where applicable and to provide context, this report also presents the trend lines of important economic and social indicators, such as Gross Domestic Product (GDP), energy production, and population growth. These data and metrics are organized into three sections:

- "AAPCA Member State Air Trends & Successes," the opening section, highlights the efforts and leadership of AAPCA's state and local air agency members. Collectively, the 21 state members of AAPCA are responsible for protecting the air quality for more than 147 million Americans while being home to 5.5 million manufacturing jobs and 60 percent of U.S. energy production.
- The next section, "American Air Quality in an International Context," looks at United States air quality trends alongside those of other nations. Internationally, the United States ranks first in GDP, second in total energy supply, and third in population.
- Finally, "Air Quality Trends in the United States" provides a detailed look at decades of air quality progress under key Clean Air Act programs, including the cornerstone National Ambient Air Quality Standards (NAAQS) program.

Overall, these trends make clear that the Clean Air Act is a tremendously consequential piece of legislation that underscores the importance of state, local, tribal, and federal collaboration in making sure that efforts to protect the environment and public health can accommodate economic growth as well as meet present and future challenges.

Underpinning the Foundation

As primary implementers of the Clean Air Act, air agencies have delegated responsibility for a broad – and growing – range of core air pollution control efforts, including developing plans to meet air quality standards and improve visibility, monitoring, managing emissions inventories, modeling, implementing federal air toxics rules, permitting, and overseeing enforcement and compliance. Air agencies are also increasingly involved in air quality efforts resulting from exceptional events, such as wildfires and prescribed burning, as well as utilizing emerging technologies like sensors and satellites to meet demands for real-time data. And in an evolving capacity, state and local air agencies lead public outreach and information campaigns, such as forecasting air quality, responding to complaints, and conducting stakeholder engagement.

Succinctly put, state and local air agencies provide a critical nexus in air pollution control, bringing essential insight and knowledge that ensures national environmental policy melds with local priorities, economic strategies, and social needs.

Despite this vital role in protecting the nation's air quality, state and local agencies have been confronted in recent years by resource and staffing constraints, requiring strategic budgeting and efficient programming to meet new and existing federal regulations. Coupled with budget limitations are challenges to maintaining a qualified, technical, and experienced workforce. An AAPCA survey on "**Staffing at State and Local Air Pollution Control Agencies**" found on average that air agencies had, as of July 2023, a 12 percent vacancy rate, nearly 21 percent of staff with two or less years of experience with the agency, and nearly 30 percent of staff at or near retirement (20-plus years of experience).

Importantly, state and local air agencies are led by dedicated public servants determined to meet the challenges of administering progressively complicated and demanding operations. Supporting these agencies through the framework of cooperative federalism strengthens their position as co-regulators in improving air quality – and is necessary to continuing the success of the first half-century of the Clean Air Act.

Types of Air Quality Data and Metrics

This report primarily relies on data from the U.S. Environmental Protection Agency (EPA) and other federal agencies, such as the U.S. Energy Information Administration (EIA), to evaluate air quality trends. These trends include metrics for criteria air pollutants, air toxics or hazardous air pollutants (HAPs), visibility progress in National Parks and wilderness areas, and greenhouse gases, with sources provided below each chart or graph and in the reference notes. Also included in this report are case studies and short excerpts from other relevant analyses, which include links to sources and data.

Criteria Air Pollutant Data

Trends and indicators of air quality can be measured in a variety of ways, but an important group of data to analyze is that of the air pollutants that are regulated under the federal Clean Air Act. Section 109 of the Clean Air Act requires U.S. EPA to establish both primary and secondary national ambient air quality standards, or NAAQS. Primary NAAQS are "standards the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health," while secondary NAAQS "specify a level of air quality the attainment and maintenance of which… is requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air."[1]

NAAQS have been set for six "criteria" pollutants: carbon monoxide (CO), sulfur dioxide (SO_2), ground-level ozone (O_3), fine and course particulate matter ($PM_{2.5}$ and PM_{10}), lead (Pb), and nitrogen dioxide (NO_2). Individual NAAQS may differ in form (for example, annual fourth highest daily maximum 8-hour concentration average over three years, for ozone), level[2] (often measured in parts per billion or micrograms per cubic meter), and averaging time (from one hour up to one year).[3] U.S. EPA and the Clean Air Scientific Advisory Committee (CASAC) review the adequacy of the NAAQS according to the statute.[4]

Nationally, ambient air pollution data from thousands of monitors across the United States are collected by U.S. EPA and state, local, and tribal air pollution control agencies and provided to the Air Quality System, or AQS. These data are used to "assess air quality, assist in attainment/non-attainment designations, evaluate State Implementation Plans [SIPs] for non-attainment areas, perform modeling for permit review analysis, and prepare reports for Congress as mandated by the Clean Air Act."[5]

U.S. EPA reports on long-term air quality trends by preparing data analyses that show the overall trend lines for pollutant concentrations and emissions. Primary sources that inform this report include:

- Criteria air pollutant concentration data from U.S. EPA's analysis of AQS that looks at long-term trends in air quality.[6]
- Data showing emissions trends of the criteria pollutants from U.S. EPA's Air Pollutant Emissions Trends Data,[7] which relies on the National Emissions Inventory (NEI). The NEI is "a comprehensive and detailed estimate of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants from air emissions sources… released every three years based primarily upon data provided [to the Emissions Inventory System (EIS)] by State, Local, and Tribal air agencies for sources in their jurisdictions and supplemented by data developed by the U.S. EPA."[8]
- Design values that are computed and published annually by U.S. EPA and defined as "a statistic that describes the air quality status of a given location relative to the level of the NAAQS… typically used to designate and classify nonattainment areas, as well as to assess progress towards meeting the NAAQS."[9]

Other Air Quality Data

In addition to tracking criteria air pollutants, U.S. EPA also maintains data and develops analyses on multiple other federal air quality programs used to inform this report, including:

- The Toxic Release Inventory (TRI), which provides a consistent set of data over time for HAPs from source reporting.[10]
- Visibility progress tracked as part of the Regional Haze Program, with long-term trends available in U.S. EPA's annual air quality trends report.[11]
- In an annual progress report, the U.S. EPA publishes power sector emissions data for SO_2, nitrogen oxides (NO_x), and HAPs, as well as carbon dioxide (CO_2).[12]

Additionally, greenhouse gas data in this report are primarily from U.S. EPA's annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks*[13] and U.S. EIA reports, such as the *Annual Energy Outlook*, which includes CO_2 emissions data from energy sources.[14]

1 42 U.S.C. §7409(b).

2 U.S. EPA states: "Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (µg/m^3)."

3 A chart of the primary and secondary NAAQS by pollutant, which includes averaging time, level, and form, can be found here.

4 42 U.S.C. §7409(d).

5 U.S. EPA, Air Quality System. U.S. EPA notes that the AQS "also contains meteorological data, descriptive information about each monitoring station (including its geographic location and its operator), and data quality assurance/quality control information."

6 Links to data summary files for national criteria pollutant trends can be found here.

7 Data can be found here. U.S. EPA notes: "The latest version of the 1970–2023 data show the trends for Tier 1 categories which distinguish pollutant emission contributions among major source types… As inventory methods are improved over time, for some emission sources an improved estimation method may be applied 'backwards' to previous year trend estimates."

8 More information on the NEI can be found here. U.S. EPA states: "The NEI is built using the Emissions Inventory System (EIS) first to collect the data from State, Local, and Tribal air agencies and then to blend that data with other data sources."

9 U.S. EPA, Air Quality Design Values.

10 U.S. EPA, Toxics Release Inventory (TRI) Program. Annual TRI National Analysis here. U.S. EPA notes that the TRI "is a resource for learning about toxic chemical releases and pollution prevention activities reported by industrial and federal facilities. TRI data support informed decision-making by communities, government agencies, companies, and others. Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) created the TRI Program."

11 U.S. EPA, Air Quality—National Summary. See also: U.S. EPA, *Our Nation's Air: Trends Through 2022,* June 2023 (Section: "Visibility Improves in Scenic Areas").

12 U.S. EPA, Power Sector Programs—Progress Report.

13 U.S. EPA releases the ***Inventory of U.S. Greenhouse Gas Emissions and Sinks*** annually on April 15. See also: U.S. EPA, Greenhouse Gas Data Inventory Data Explorer.

14 U.S. EIA, ***Annual Energy Outlook 2023***, March 16, 2023.

AAPCA Member State Air Trends & Successes

"More than 50 years after the creation of EPA, states and local governments serve as primary implementers of many of the nation's environmental laws. Due to these unique relationships, the early, meaningful, and substantial involvement of EPA's co-regulator partners is critical to the development, implementation, and enforcement of the nation's environmental programs."

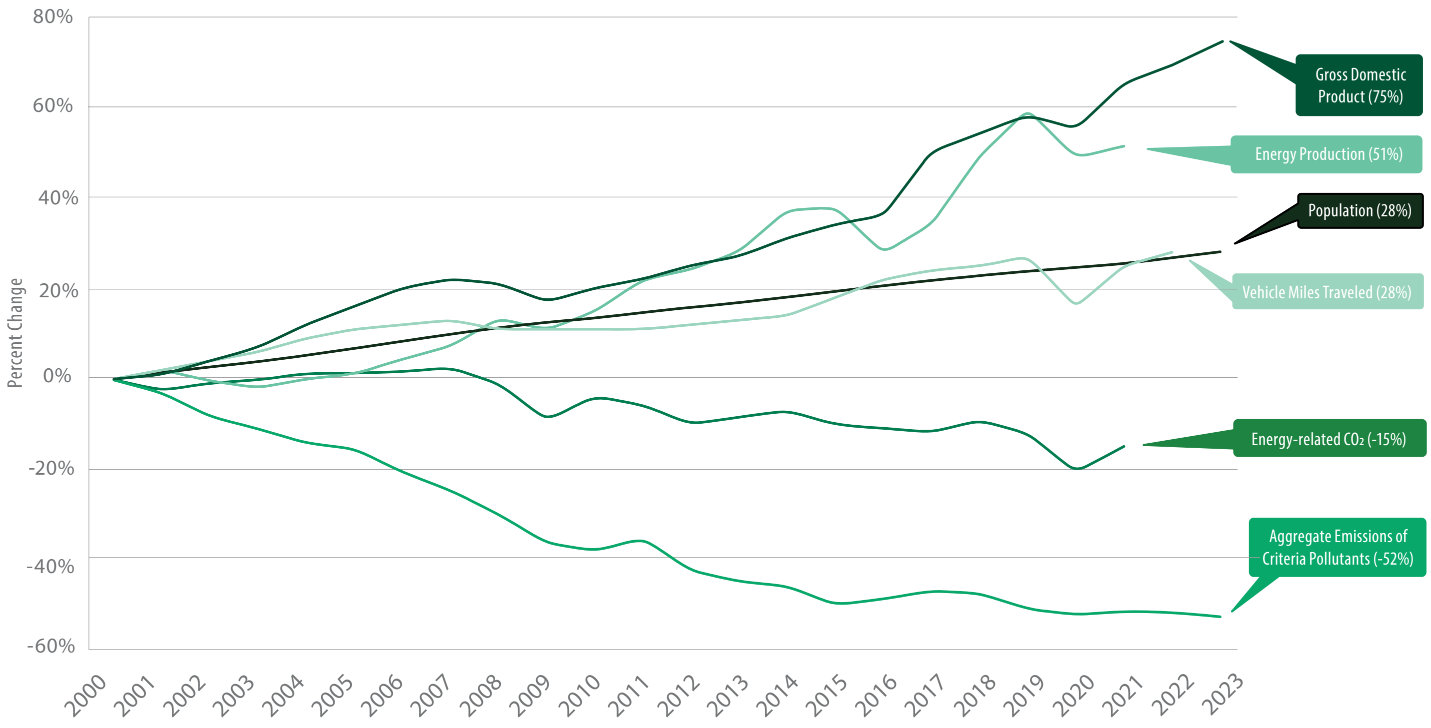
Source: U.S. EPA, ***FY 2022–2026 EPA Strategic Plan***, March 2022.

Economic Growth and Air Quality in AAPCA Member States

Since the turn of the century, AAPCA Member States have overseen significant improvements in air quality from emissions reductions, decreasing the combined emissions of the pollutants (or pollutant precursors) for which there are national ambient air quality standards, or NAAQS,[1] by 52 percent from 2000 to 2023. Simultaneously, AAPCA Member States have experienced major economic and social growth:

- A 75 percent increase in Gross Domestic Product (GDP) from 2000 to 2023, including accounting for nearly 38 percent of the total U.S. GDP in 2023.[2]
- A 28 percent increase in population from 2000 to 2023, representing over 147 million people, nearly 44 percent of the total U.S. population.[3]
- A 28 percent increase in vehicle miles traveled from 2000 to 2022.[4]
- A 51 percent increase in energy production from 2000 to 2021, contributing 60 percent of total U.S. energy production in 2021.[5]
- A 15 percent decrease in energy-related carbon dioxide (CO_2) emissions from 2000 to 2021.[6]

Figure 1. AAPCA Member States | Comparison of Growth Indicators and Emissions Since 2000



Sources: U.S. Bureau of Economic Analysis, data available **here**; U.S. Energy Information Administration, **State Energy Data System (SEDS): 1960–2021**; U.S. Federal Highway Administration Office of Highway Policy Information, data available **here**; U.S. Census Bureau, data available **here**; U.S. EIA, **Energy-Related CO_2 Emission Data Tables**, Table 1. State energy-related carbon dioxide emissions by year (1970–2021); U.S. EPA, **Air Pollutant Emissions Trends Data**, State Tier 1 CAPS Trends, Criteria pollutants State Tier 1 for 1990–2023.

State Clean Air Act Deadlines

The timeline below lays out important dates for developing State Implementation Plans (SIPs)[1] for several recent U.S. EPA Office of Air & Radiation rulemakings, including National Ambient Air Quality Standards (NAAQS).

2024

February 2024
U.S. EPA Promulgates Final 2024 $PM_{2.5}$ NAAQS at 9.0 µg/m^3

March 2024
U.S. EPA Promulgates Final NSPS and EG for the Oil & Natural Gas Sector

April 2024
U.S. EPA Promulgates Final NSPS and EG for Existing Coal-Fired and New Gas-Fired Power Plants

June 2024
SIP Option State Allocations for the 2025 Control Period Due

August 2024
Moderate Area Attainment Date

December 2024
Deadline to Submit Revisions for SIP Options Effective Beginning with the 2026 Control Period

2025

January 2025
Second Planning Period Progress Reports Due

February 2025
States Submit Recommendations for $PM_{2.5}$ Designations to U.S. EPA

June 2025
SIP Option State Allocations for the 2026 Control Period Due

July 2025
Ambient Air Monitoring 5-Year Network Assessments Due

December 2025
Serious Area Outermost Attainment Date

2026

January 2026
Serious Nonattainment Area SIPs Due

February 2026
U.S. EPA Promulgates Final Area Designations

March 2026
SIPs for EG OOOOc Due

2027

February 2027
"Infrastructure" SIPs Due

August 2027
Moderate Area Attainment SIPs Due

August 2027
Serious Nonattainment Area Attainment Date

2028

Summer 2028
Third Implementation Period SIPs Due

2029

March 2029
State Plan Compliance Deadline for EG OOOOc

2030

July 2030
Ambient Air Monitoring 5-Year Network Assessments Due

2032

December 2032
Moderate Area Attainment Date

2036

December 2036
Serious Area Attainment Date

Legend

- 2024 Fine Particulate Matter ($PM_{2.5}$) NAAQS (89 FR 16202)
- 2012 Fine Particulate Matter ($PM_{2.5}$) NAAQS (78 FR 3086, See also: 81 FR 58009)
- 2015 Ozone NAAQS (80 FR 65292)
- Monitoring Network
- Good Neighbor Plan SIP Revisions (88 FR 36654)[2]
- NSPS and EG for the Oil & Natural Gas Sector / Methane Rule (89 FR 16820)
- Power Plant Rules
- Regional Haze

[1] A State Implementation Plan (SIP) is a collection of regulations and documents used by a state, territory, or local air district to implement, maintain, and enforce the NAAQS, and to fulfill other requirements of the Clean Air Act. More information from U.S. EPA is available here.

[2] Since publication of the final Good Neighbor Plan, U.S. EPA has taken several supplemental actions, including: July 2023 interim final rule, "Federal "Good Neighbor Plan" for the 2015 Ozone National Ambient Air Quality Standards; Response to Judicial Stays of SIP Disapproval Action for Certain States"; August 2023 memorandum, "Notice of Forthcoming EPA Action to Address Additional Judicial Stay Orders"; and February 2024 proposed rule, "Supplemental Air Plan Actions: Interstate Transport of Air Pollution for the 2015 8-Hour Ozone National Ambient Air Quality Standards and Supplemental Federal 'Good Neighbor Plan' Requirements for the 2015 8-Hour Ozone National Ambient Air Quality Standards."

Air Quality | Fine Particulate Matter

U.S. EPA's online Green Book "provides detailed information about area National Ambient Air Quality Standards (NAAQS) designations, classifications, and nonattainment status."[7] According to the online database, a total of 39 areas were initially designated nonattainment for the 1997 fine particulate matter ($PM_{2.5}$) annual NAAQS of 15.0 micrograms per cubic meter (µg/m^3), measured by the three-year average annual mean concentration.[8]

U.S. EPA develops design values[9] based on monitoring data from the Agency's Air Quality System (AQS).[10] Of the previously designated nonattainment areas for the 1997 annual $PM_{2.5}$ NAAQS, 23 are located partially or completely within AAPCA Member States. The table below lists the percent change in design values from 2002 to 2022, a period in which AAPCA Member States averaged a 48.5 percent reduction in $PM_{2.5}$ ambient air concentrations.[11] Furthermore, all the designated areas within AAPCA Member States have since been classified as in attainment or maintenance for the 2012 $PM_{2.5}$ NAAQS of 12.0 µg/m^3.[12]

Table 1

Designated Area	2000–2002 Design Value (µg/m^3)	2020–2022 Design Value (µg/m^3)	Percent Change in $PM_{2.5}$ Concentrations
Atlanta, GA	19.3	9.4	-51%
Birmingham, AL	19.6	8.4	-57%
Canton-Massillon, OH	17.9	9.2	-49%
Charleston, WV	17.8	7.5	-58%
Chattanooga, TN-GA-AL	16.9	7.7	-54%
Chicago-Gary-Lake County, IL-IN	19.6	10.5	-46%
Cincinnati-Hamilton, OH-KY-IN	18.6	10.5	-44%
Cleveland-Akron-Lorain, OH	19.2	9.3	-52%
Columbus, OH	17.1	8.8	-49%
Dayton-Springfield, OH	16.0	9.4	-41%
Evansville, IN	16.7	9.2	-45%
Greensboro-Winston Salem-High Point, NC	16.7	8.8	-47%
Hickory-Morganton-Lenoir, NC	16.2	8.2	-49%
Huntington-Ashland, WV-KY-OH	19.4	8.1	-58%
Indianapolis, IN	18.6	11.9	-36%
Knoxville, TN	17.9	9.4	-47%
Louisville, KY-IN	17.3	10.2	-41%
Macon, GA	16.4	8.8	-46%
Martinsburg-Hagerstown, WV-MD	16.2	8.2	-49%
Parkersburg-Marietta, WV-OH	17.0	7.5	-56%
Rome, GA*	16.1	9.9*	-39%
Steubenville-Weirton, OH-WV	17.8	8.5	-52%
Wheeling, WV-OH	16.0	8.4	-48%

*Rome, GA is calculated to the last year that data was available, design value year 2014–2016.
Source: U.S. EPA, **Air Quality Design Values**, $PM_{2.5}$ Design Values, 2022.

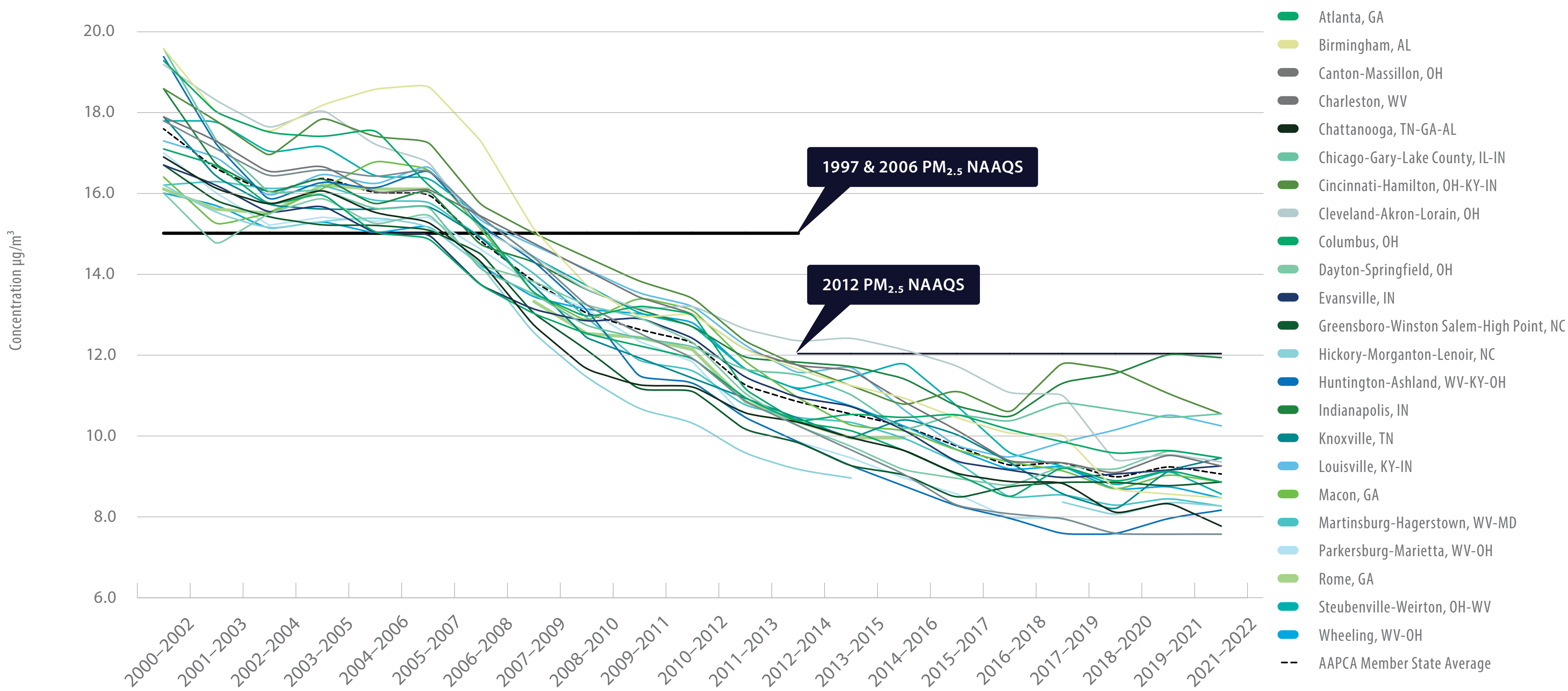
As directed by the federal Clean Air Act (CAA), U.S. EPA and delegated programs at state, local, and tribal air agencies work together to implement the NAAQS. On February 7, 2024, U.S. EPA promulgated a final rule to tighten the annual $PM_{2.5}$ NAAQS to 9.0 µg/m^3, based on an annual arithmetic mean averaged over three years.[13] As a result of this revision to the NAAQS, the CAA requires that U.S. EPA designate all parts of the country with respect to the revised annual, or primary, standard. U.S. EPA provides the below timeline for state designations and implementation[14] of the 2024 annual $PM_{2.5}$ NAAQS:

Table 2

State deadline to submit recommendations for designations to U.S. EPA	February 7, 2025
U.S. EPA promulgates final area designations	February 6, 2026
State deadline to submit "infrastructure" state implementation plans (SIP)	February 7, 2027
State deadline to submit SIPs for nonattainment areas	August 6, 2027

Air Quality | Fine Particulate Matter

Figure 2. AAPCA Member States | Design Value History for Areas Previously Designated Nonattainment or Maintenance for the 1997 $PM_{2.5}$ Annual NAAQS, 2002–2022



Source: U.S. EPA, **Air Quality Design Values**, $PM_{2.5}$ Design Values, 2022.

Air Quality | Ozone

According to U.S. EPA's Green Book, 47 areas in the United States were previously designated as nonattainment for the 2008 ozone annual National Ambient Air Quality Standards (NAAQS) of 0.075 parts per million (ppm), determined using the annual fourth-highest daily maximum 8-hour concentration, averaged over three years.[15]

Table 3 below lists the percent change in design values from 2002 to 2022 for the 13 previously designated nonattainment areas for the 2008 ozone annual NAAQS that are partially or fully within AAPCA Member States, which averaged a 26 percent reduction in ambient concentrations of ozone.[16]

Table 3

Designated Area	2000–2002 Design Value (ppm)	2020–2022 Design Value (ppm)	Percent Change in Ozone Concentrations
Atlanta, GA	0.099	0.065	-34%
Baton Rouge, LA	0.086	0.069	-20%
Charlotte-Rock Hill, NC-SC	0.102	0.064	-37%
Chicago-Naperville, IL-IN-WI	0.100	0.075	-25%
Cincinnati, OH-KY-IN	0.096	0.069	-28%
Cleveland-Akron-Lorain, OH	0.099	0.074	-25%
Columbus, OH	0.090	0.066	-27%
Dallas-Fort Worth, TX	0.099	0.077	-22%
Houston-Galveston-Brazoria, TX	0.107	0.078	-27%
Knoxville, TN	0.098	0.063	-36%
Memphis, TN-MS-AR	0.094	0.070	-26%
Phoenix-Mesa, AZ	0.085	0.081	-5%
Upper Green River Basin, WY*	0.072*	0.067	-7%

*Upper Green River Basin, WY is calculated from the first year that data was available, design value year 2005–2007. This area is excluded from average calculations.
Source: U.S. EPA, **Air Quality Design Values**, Ozone Design Values, 2022.

Articles from the Association of Air Pollution Control Agencies (AAPCA)

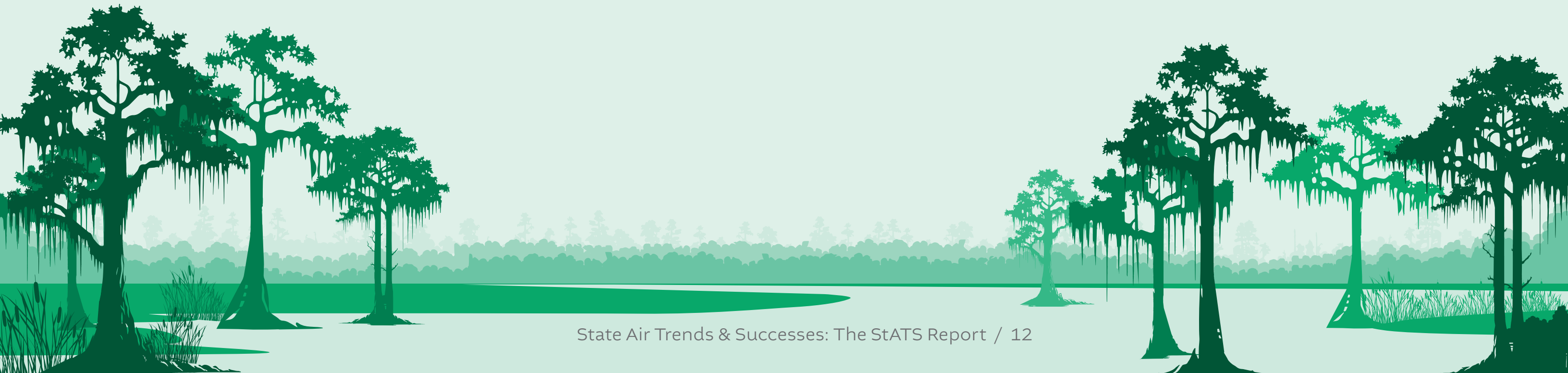
Understanding the Impact of a Lower Fine Particulate Matter National Ambient Air Quality Standard | *EM* magazine, May 2023

The National Ambient Air Quality Standards at 50 | *EM* magazine, January 2022 and December 2020

State Perspectives on Planning for Continue Regional Haze Progress | *EM* magazine, October 2019

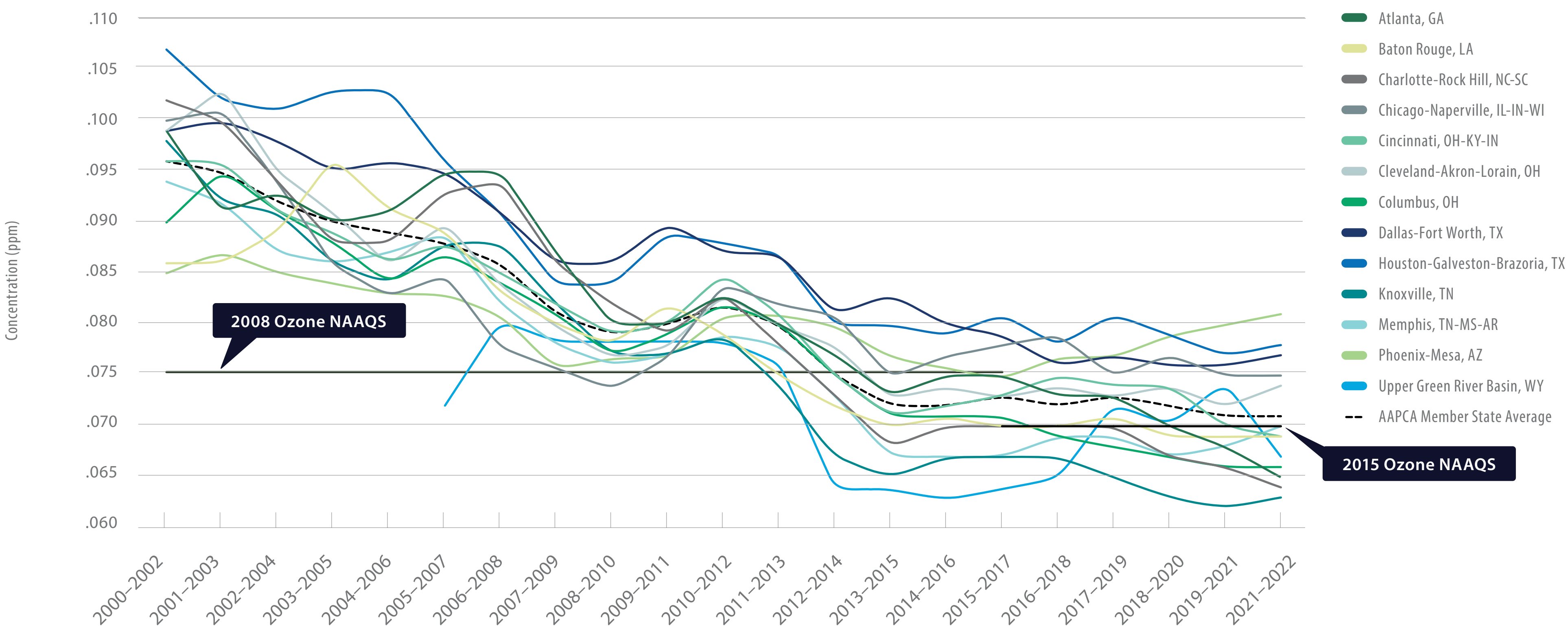
A Story Seldom Told: National Ambient Air Quality Standards and Successes in Air Pollution Control | *EM* magazine, September 2018

Preparing for Personal Air Sensors: State and Local Air Quality Agencies on the Frontlines of Citizen Science | *EM* magazine, November 2017

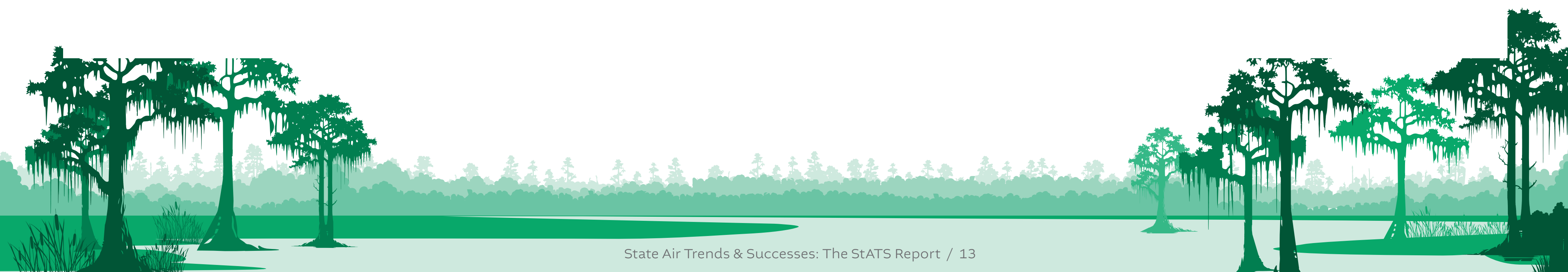


Air Quality | Ozone

Figure 3. AAPCA Member States | Design Value History for Areas Previously Designated Nonattainment or Maintenance for the 2008 Ozone Annual NAAQS, 2002–2022



Source: U.S. EPA, **Air Quality Design Values**, Ozone Design Values, 2022.



Regional Haze | Visibility Improvements in Dolly Sods and Otter Creek Wilderness Areas | West Virginia

High atop the Monongahela National Forest along the eastern continental divide in West Virginia hides the Dolly Sods Wilderness Area, a breathtaking expanse unlike any other in the southern United States. Encompassing 17,371 acres and ranging in elevation from 2,500 feet to more than 4,700 feet above sea level, this Class 1 federal wilderness area is also the highest plateau east of the Mississippi River, boasting a unique ecosystem characterized by rolling meadows, stunted spruce krummholz sculpted by harsh winds, and vibrant displays of wildflowers. Established as a Class 1 federal wilderness area in 1974 and managed by the United States Forest Service (USFS), Dolly Sods receives the highest level of protection under the Wilderness Act, ensuring its pristine beauty remains unspoiled for generations to come. Nearby Otter Creek – also a USFS Class 1 wilderness area – lies less than 10 miles west of Dolly Sods, and its 20,698 acres are as equally stunning.

Dolly Sods' unique geography and elevation foster an unexpected diversity of flora and fauna typically associated with climes much further north. The iconic krummholz, a testament to the area's harsh winds, stand in stark contrast to the vibrant wildflower displays which paint the landscape in summer. Shooting stars, fringed gentian, and other wildflowers add a splash of color, while sphagnum bogs, teeming with unique plant and animal life, whisper of a hidden world beneath the surface. This unexpected ecological tapestry makes Dolly Sods a haven for researchers, nature enthusiasts, and anyone seeking a truly unique wilderness experience. The area also offers camping, hiking, and backpacking to recreational visitors; travelers to Otter Creek may enjoy these activities in addition to whitewater rafting.

However, the story of Dolly Sods and Otter Creek was not always one of pristine skies. Regional haze, a consequence of air pollution, once shrouded the area. Haze is primarily caused by sulfur dioxide (SO_2) and nitrogen oxides (NO_x) emissions transported by winds from large distant up-wind pollution sources, including coal-fired power plants, and which once significantly reduced visibility. SO_2 and NO_x react with atmospheric ammonia and moisture to respectively form ammonium sulfate and ammonium nitrate aerosols – aloft wind-blown microscopic particulate matter that scatter light, contributing to the hazy effect.

Thankfully, the story of Dolly Sods and Otter Creek is one of environmental recovery, as tireless efforts to combat air pollution have yielded incredibly positive results. The IMPROVE (Interagency Monitoring of Protected Visual Environments) haze monitor stationed at Dolly Sods and shared with Otter Creek has documented a significant decline in regional haze over the past several decades. This improvement can be directly attributed to stricter air quality regulations and impactful programs implemented by the Environmental Protection Agency (EPA) under the Clean Air Act (CAA).

Several key EPA Power Sector programs established under the CAA played a pivotal role in reducing transported SO_2 and NO_x emissions throughout the country and consequently improving visibility at Class 1 areas, including:

- Acid Rain Program (1990–present): This landmark program implemented a market-based cap and trade system to reduce SO_2 and NO_x emissions from power plants, major contributors to acid rain, by encouraging the addition of controls. The program significantly lowered SO_2 and NO_x emissions, leading to a substantial decrease in regional haze across the country.
- Ozone Transport Commission (OTC) NO_x Budget Program (1999–2002): This capped ozone season (OS) NO_x trading program applied to electric utilities and industrial boilers in the northeastern U.S. in all or parts of 12 states and the District of Columbia. Capped OS NO_x emissions decreased via a timeline to less than half the 1990 baseline emissions rate. The NO_x Budget Trading Program replaced the OTC; however, in its brief life the OTC contributed to improved visibility.
- NO_x Budget Trading Program (2003–2009): Replacing the OTC, this capped NO_x trading program included large major stationary sources in the northeastern U.S. via a NO_x State Implementation Plan (SIP) Call. CAIR eventually replaced the program, and although the EPA designed it to address ozone attainment issues, it also contributed to improved visibility.
- Clean Air Interstate Rule (CAIR) (2009–2014): This annual and OS cap and trade program addressed power plant emissions of SO_2 and NO_x from power plants in 28 eastern states. The Cross-State Air Pollution Rule (CSAPR) replaced much of CAIR, but pollutant reductions improved visibility while the program was in place.

Figure 1: Dolly Sods Wilderness Area. Photo Credit: WV.gov

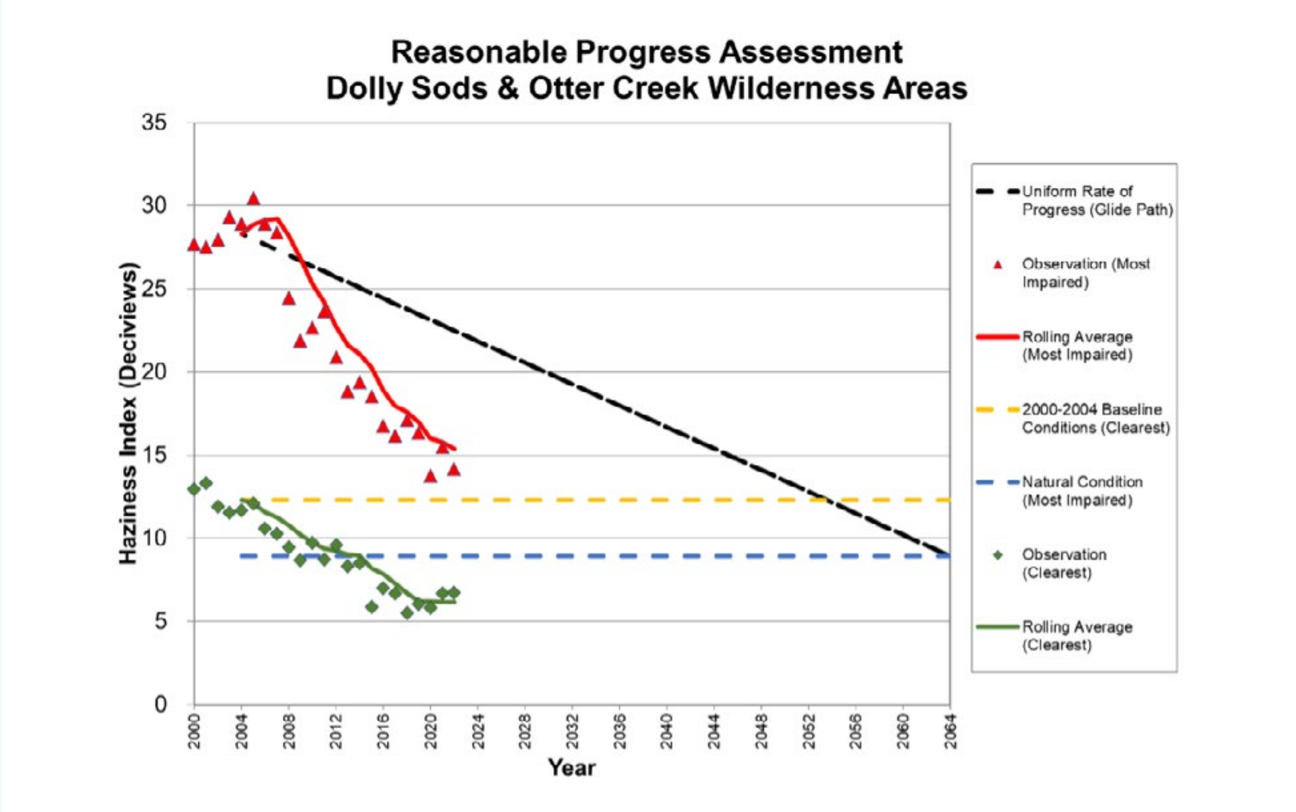
Regional Haze | Visibility Improvements in Dolly Sods and Otter Creek Wilderness Areas

- Mercury and Air Toxics Standards (MATS) (2011–present): While primarily focused on reducing hazardous mercury emissions from power plants via controls, MATS also resulted in co-benefits including decreased SO_2 emissions, further improving haze.
- Cross-State Air Pollution Rule (CSAPR) (Various iterations, 2011–present): CSAPR addresses the issue of interstate transport of air pollution via a market-based trading program. It encourages additional control of SO_2 and NO_x emissions from power plants in upwind states, further reducing regional haze throughout the U.S.

The combined impact of these successful EPA CAA programs has been a significant decline in SO_2 and NO_x emissions from large coal-fired sources. More recently, cheap plentiful unconventional shale-source natural gas displaced the operations of many smaller, less efficient coal-fired power plants and industrial boilers. Also, and even more recently, large growth in renewable electricity generation promises to further displace coal and even some natural gas power plants. As a result of these developments, national power plant emissions of SO_2 have declined by more than 94% between the years 2000 and 2023, while power plant NO_x emissions have concurrently fallen nearly 86%. Over the same period in West Virginia, power plant SO_2 emissions tumbled alongside national rates by more than 93%, while power plant NO_x emissions declined by more than 89%. This, in turn, led to a remarkably measured improvement in visibility at Dolly Sods and Otter Creek, as documented by the IMPROVE monitor and illustrated in Figure 2. In fact, the Dolly Sods monitor shows measured most impaired days for year 2022 to be significantly below the uniform rate of progress (URP) and within 0.1 deciviews of the year 2048 target; meanwhile, clearest days haze impairment is approaching natural background levels. Clearer skies not only enhance the breathtaking vistas, but also create a healthier environment for the sensitive ecosystems that call these areas home.

Haze reductions at Dolly Sods and Otter Creek stand as a testament to the success of environmental regulations and the dedication of scientists, policymakers, and industry. It serves as a beacon of hope, showcasing the power of collective action to restore and protect our natural treasures. As we move forward, continued vigilance and innovation in air pollution control are crucial to ensure the skies above these pristine locations, and all our treasured wilderness areas, remain clear and natural for generations to come.

Figure 2: Haze Reduction Progress at West Virginia's Class 1 Areas. Progress for most impaired days is a quarter century ahead of the URP.



Thank you to the West Virginia Division of Air Quality for the contribution of this case study.
More about the West Virginia DAQ can be found at https://dep.wv.gov/daq.

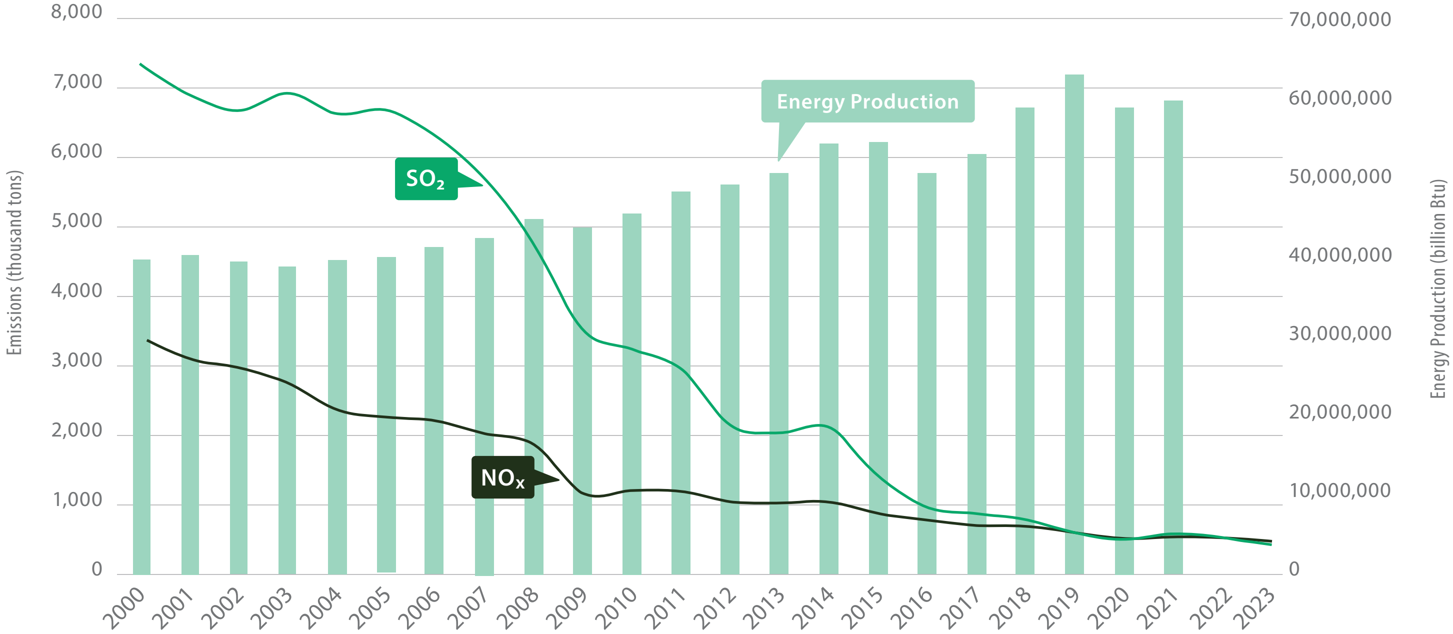
Emissions Reductions in the Electricity Sector

Since 2000, AAPCA Member States have overseen significant reductions in the emissions of sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) from the electricity sector:

- SO_2 emissions decreased 94 percent, from 7,322,232 tons in 2000 reduced to 437,703 tons in 2023; and
- NO_x emissions decreased 86 percent, from 3,405,187 tons in 2000 down to 482,711 tons in 2023.[17]

AAPCA Member States produced nearly 59,500,000 billion British thermal units (billion Btus) of energy in 2021, experiencing a 51 percent increase in energy production from 2000 levels.[18]

Figure 4. AAPCA Member States | Energy Production Compared to SO_2 and NO_x Emissions from the Electricity Sector, Since 2000

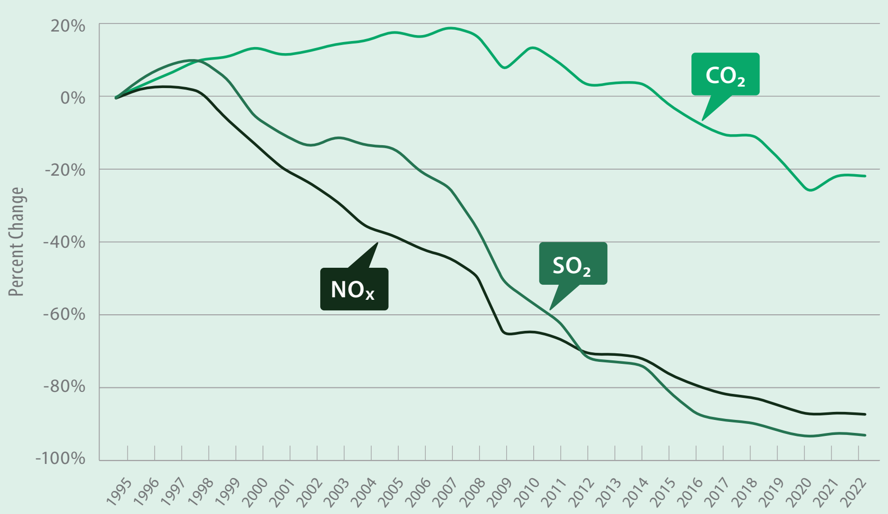


Source: U.S. Energy Information Administration, State Energy Data System (SEDS): 1960–2021; U.S. EPA, Air Pollutant Emissions Trends Data, State Tier 1 CAPS Trends, Criteria pollutants State Tier 1 for 1990–2023.

U.S. Power Plant Emissions Trends Annual Percent Change of Emissions from Power Plants, Since 1995

In February 2024, U.S. EPA released the 2023 annual emissions data for power plants across the United States, highlighting the following trends compared to 2022:

- A 24 percent decrease in sulfur dioxide (SO_2) emissions, 96 percent below 1995 levels;
- A 15 percent decrease in nitrogen oxides (NO_x) emissions, 90 percent below 1995 levels; and,
- A 7 percent decrease in carbon dioxide (CO_2) emissions, 28 percent below 1995 levels.



Source: U.S. EPA, "EPA Releases 2023 Power Plant Emissions Data," February 15, 2024. Data available here.

Emissions Reductions in the Electricity Sector

Data from U.S. EPA's Clean Air Markets Programs[19] show that the United States reduced sulfur dioxide (SO_2) emissions from the electricity sector by 95 percent, from 15,592,075 tons in 1990 to 823,156 tons in 2022.

AAPCA Member States accounted for nearly 65 percent of the total 14,768,919-ton national reduction, lowering SO_2 emissions from 10,013,501 tons in 1990 to 481,191 tons in 2022.[20]

Figure 5. AAPCA Member States Share of SO_2 Emissions Reductions in the Electricity Sector, 1990–2022 (tons of SO_2 reduced)

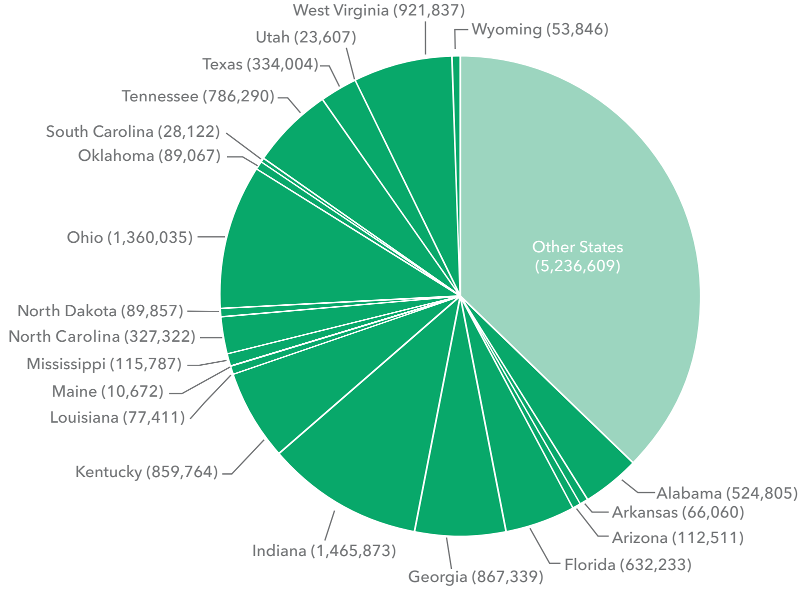
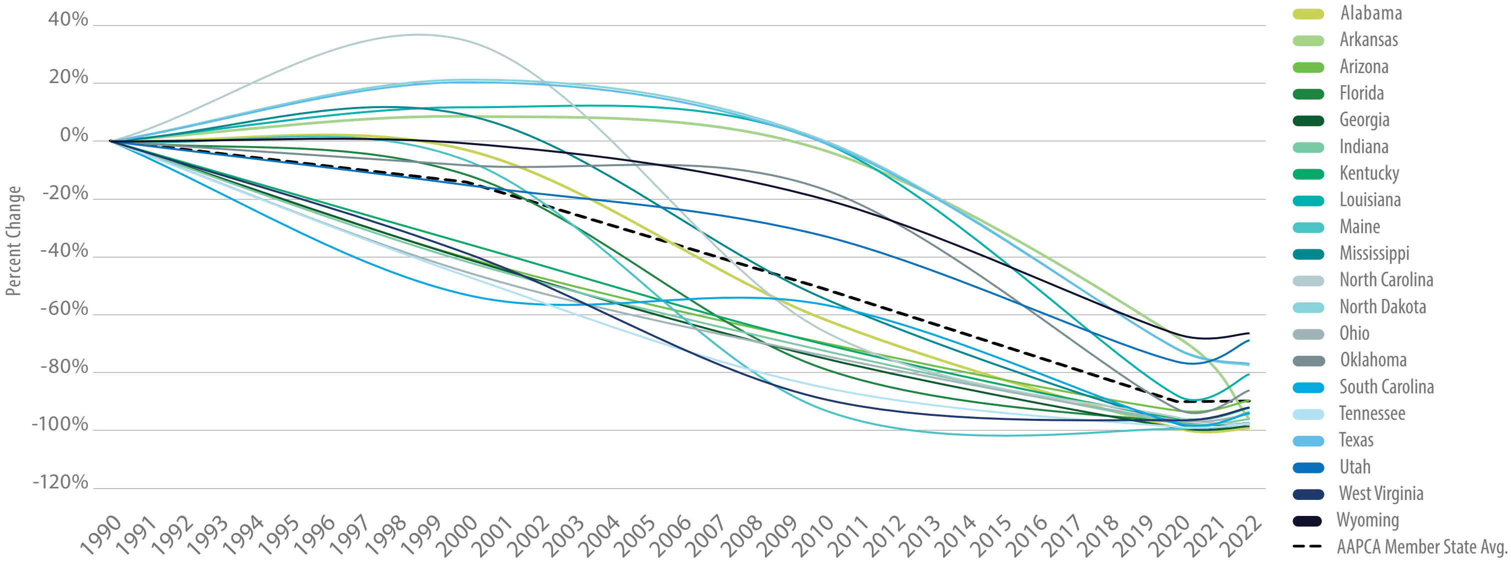


Figure 6. AAPCA Member States | Percent Reduction in SO_2 Emissions from the Electricity Sector, 1990–2022



Source: U.S. EPA, "State-by-State SO_2 Emissions from CSAPR and ARP Sources, 1990–2022," September 18, 2023.

Emissions Reductions in the Electricity Sector

U.S. EPA's Clean Air Markets Programs[21] data also show that the United States reduced nitrogen oxides (NO_x) emissions from the electricity sector by 87 percent, from 6,409,837 tons in 1990 to 806,087 tons in 2022.

AAPCA Member States accounted for 59 percent of the total 5,603,750-ton national reduction, lowering NO_x emissions from 3,861,642 tons in 1990 to 533,928 tons in 2022.[22]

Figure 7. AAPCA Member States Share of NO_x Emissions Reductions in the Electricity Sector, 1990–2022 (tons of NO_x reduced)

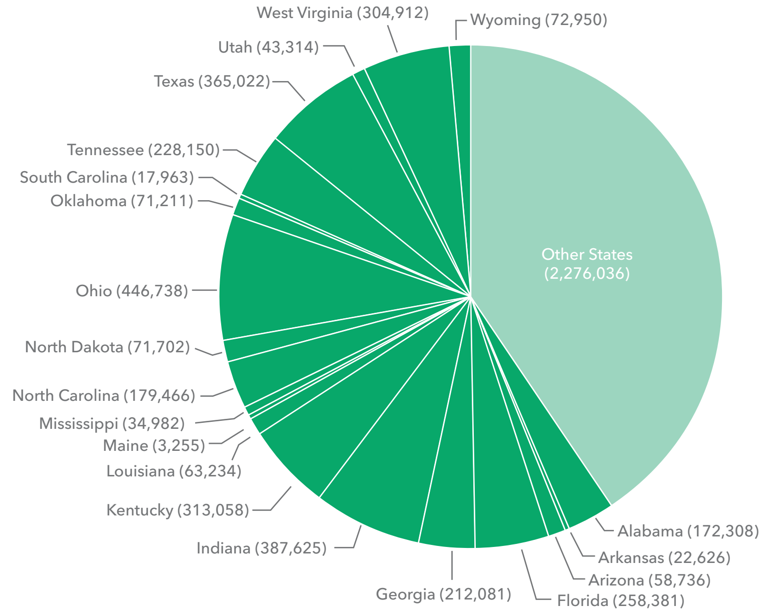
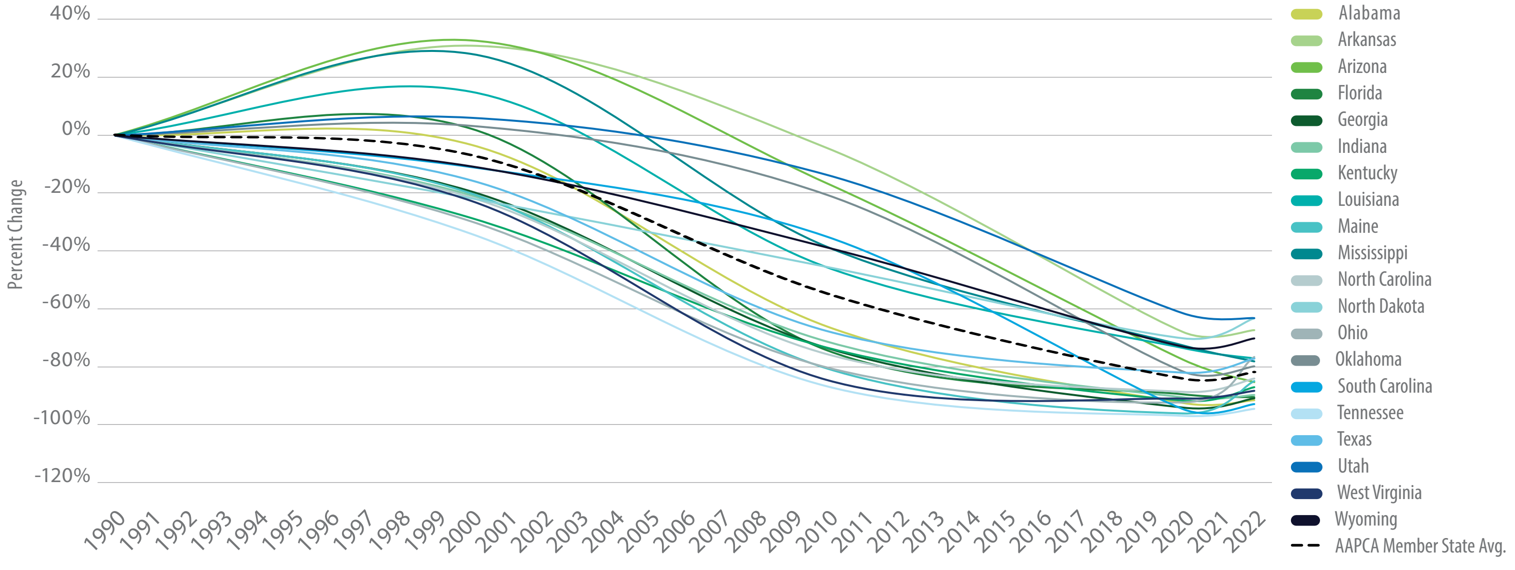


Figure 8. AAPCA Member States | Percent Reduction in NO_x Emissions from the Electricity Sector, 1990–2022

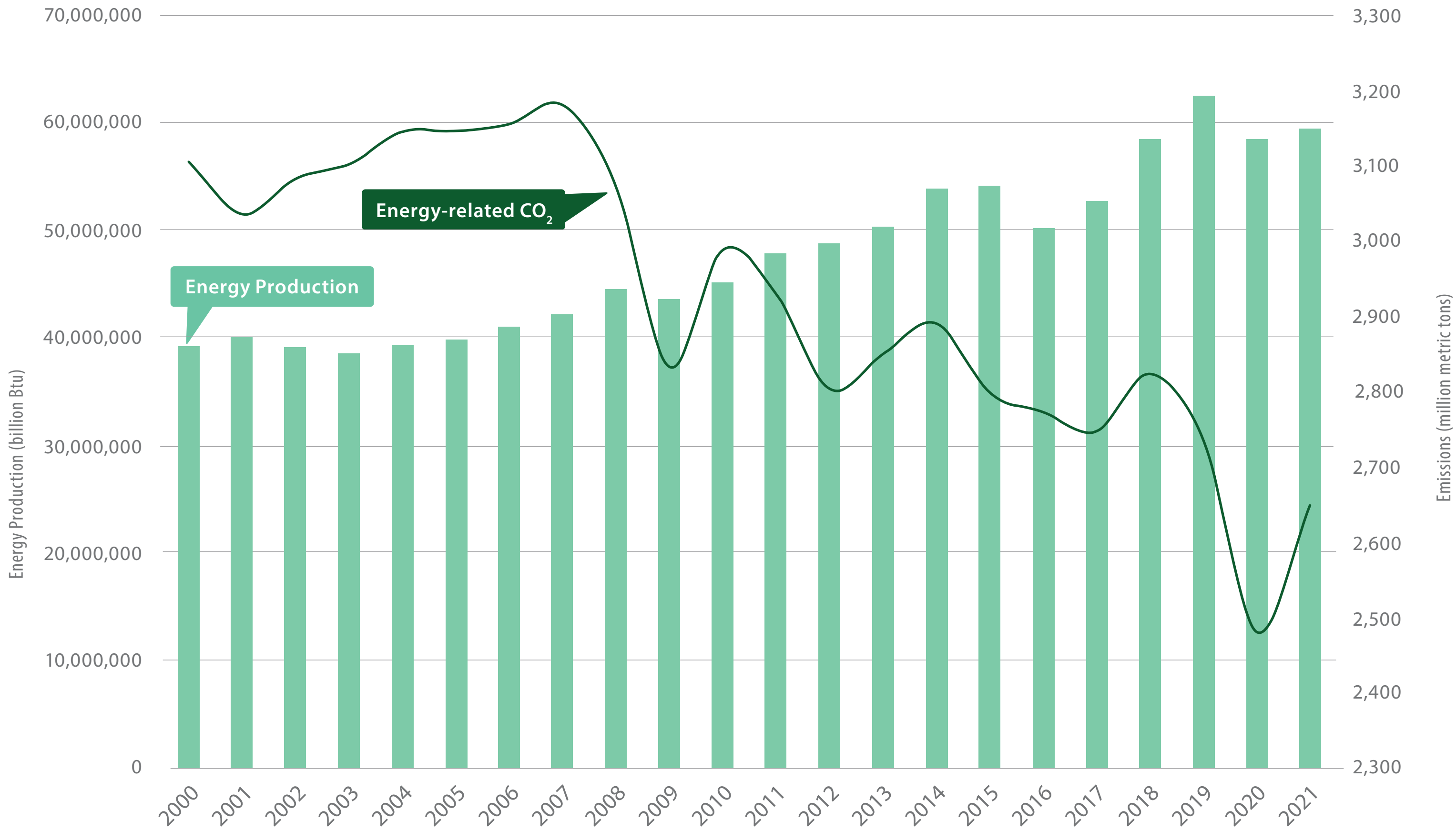


Source: U.S. EPA, "State-by-State NO_x Emissions from CSAPR and ARP Sources, 1990–2022," September 18, 2023.

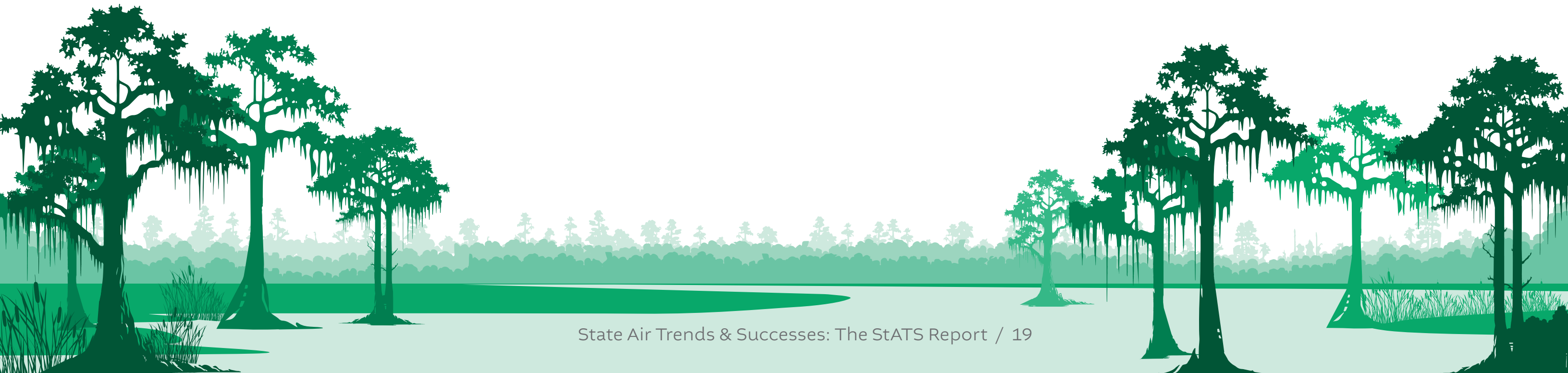
Greenhouse Gases

Data for 2021 from the U.S. Energy Information Administration (EIA) show that AAPCA Member States reduced energy-related carbon dioxide (CO_2) emissions by 15 percent compared to 2000 levels, from 3,107 million metric tons of CO_2 in 2000 to 2,649 million metric tons in 2021. Over the same period, energy production in AAPCA Member States increased by 51 percent. In 2021, total energy production in AAPCA Member States was more than 20,000,000 billion British thermal units (Btu) higher than in 2000.[23]

Figure 9. AAPCA Member States | Total Energy Production Compared to Energy-Related Carbon Dioxide Emissions, 2000—2021



Source: U.S. Energy Information Administration (EIA), **State Energy Data System (SEDS): 1960–2021**; U.S. EIA, **Energy-Related CO_2 Emission Data Tables**, Table 1. State energy-related carbon dioxide emissions by year.



Greenhouse Gases

The U.S. Energy Information Administration (EIA) also calculates carbon intensity of the economy by state as metric tons of energy-related CO_2 per chained 2012 million dollars of gross domestic product. The table below lists the percent reduction in carbon intensity of the economy for AAPCA Member States from 2000 to 2021. AAPCA's membership oversaw an average reduction in carbon intensity of the economy of 38.6 percent.[24]

Table 4

AAPCA Member State	Percent Reduction in Carbon Intensity of the Economy (2000–2021)
Alabama	-46.3%
Arizona	-40.7%
Arkansas	-35.4%
Florida	-43.6%
Georgia	-47.6%
Hawaii	-30.6%
Indiana	-39.4%
Kentucky	-36.9%
Louisiana	-17.0%
Maine	-46.2%
Mississippi	-31.6%
North Carolina	-48.7%
North Dakota	-35.9%
Ohio	-41.6%
Oklahoma	-47.2%
South Carolina	-44.1%
Tennessee	-48.6%
Texas	-44.4%
Utah	-50.1%
West Virginia	-10.9%
Wyoming	-24.0%

Source: U.S. Energy Information Administration, **Energy-Related CO_2 Emission Data Tables**, Table 7. Carbon intensity of the economy by state.

U.S. EIA | U.S. Energy-Related Carbon Dioxide Emissions, 2023

The U.S. Energy Information Administration (EIA) report, *U.S. Energy-Related Carbon Dioxide Emissions, 2023*, highlights notable trends in energy-related carbon dioxide (CO_2) emissions in the United States in 2023, including:

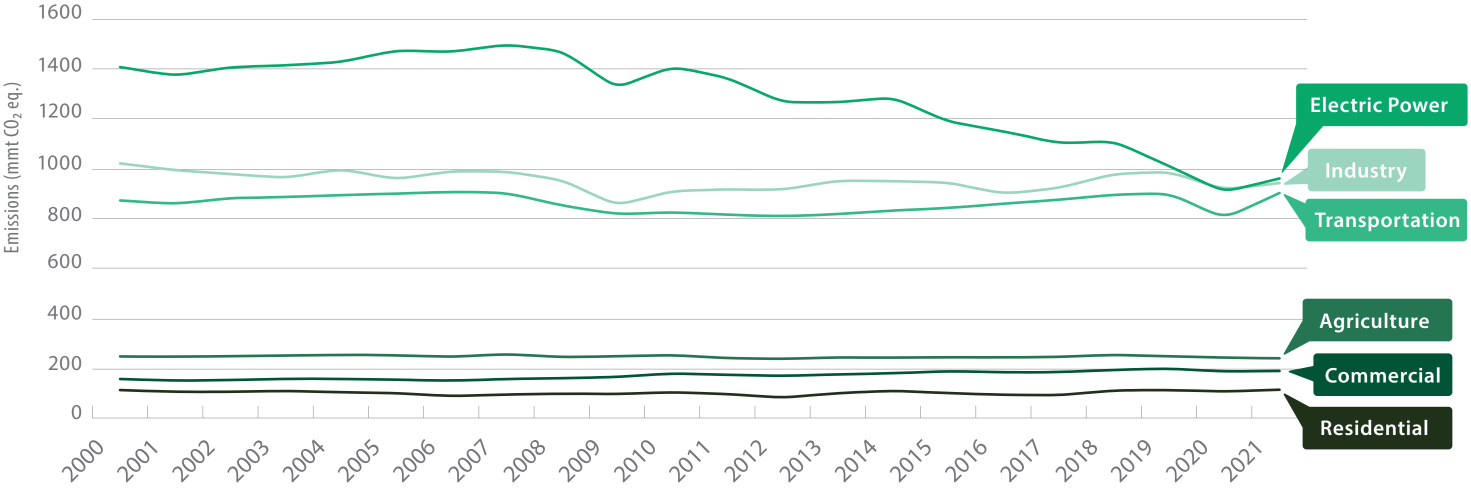
- U.S. energy-related CO_2 emissions decreased by 3 percent, about 134 million metric tons (MMmt), in 2023.
- Over 80 percent of the emissions reductions occurred in the electric power sector, which decreased to approximately 1,425 MMmt in 2023, about 7 percent less than in 2022.
- Emissions also decreased in the residential and commercial sectors by a combined 6 percent in 2023, to about 561 MMmt.
- Emissions from the industrial and transportation sectors remained relatively unchanged, with differences of less than 1 percent from 2022.

Source: U.S. EIA, *U.S. Energy-Related Carbon Dioxide Emissions, 2023*, April 25, 2024

Greenhouse Gases

U.S. EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks by State* provides estimated greenhouse gas (GHG) data at the state level, consistent with the national *Inventory of U.S. Greenhouse Gas Emissions and Sinks*.[25] The figure below shows estimated trends of GHG emissions in million metric tons of carbon dioxide equivalent (mmt CO_2 eq.) by economic sector from 2000 to 2021 in AAPCA Member States. The most significant reductions were achieved in the electric power sector,[26] with AAPCA's membership reducing electric power GHG emissions by an estimated 32 percent, from 1,416 mmt CO_2 eq. in 2000 to 956 mmt CO_2 eq. in 2021.

Figure 10. AAPCA Member States | Greenhouse Gas Emissions by Economic Sector, 2000–2021



Source: U.S. EPA, ***Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990–2022***, April 2024. See U.S. EPA's **Greenhouse Gas Inventory Data Explorer**.

According to U.S. EPA's *Inventory*, AAPCA Member States reduced estimated gross total emissions of carbon dioxide (CO_2) by 14 percent from 2000 to 2021, from 3,179 mmt CO_2 eq. to 2,728 mmt CO_2 eq., respectively. In 2021, AAPCA Member States emitted a total of about 397 mmt CO_2 eq. of methane (CH_4), down from 437 mmt CO_2 eq. in 2000, or a reduction of 9 percent. Figures 11 and 12 show the distribution of CO_2 and CH_4 emissions by inventory sector for AAPCA's membership in 2021.[27]

Figure 11. AAPCA Member States Emissions of Carbon Dioxide by Inventory Sector, 2021

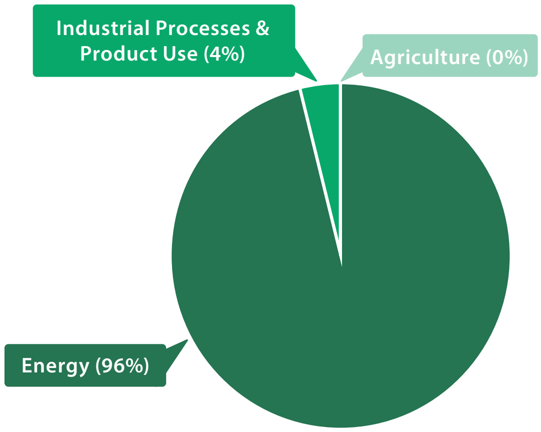
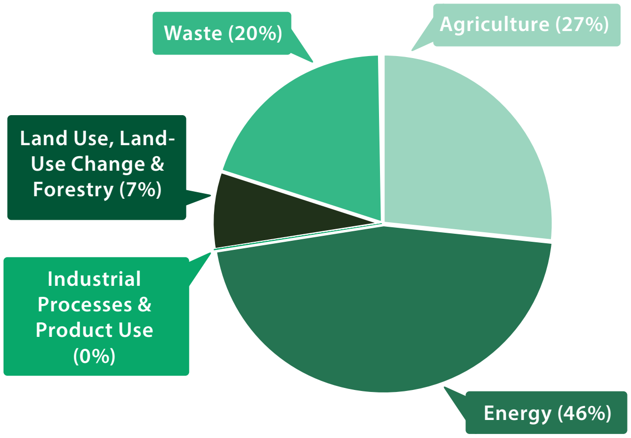


Figure 12. AAPCA Member States Emissions of Methane by Inventory Sector, 2021



Source: U.S. EPA, ***Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990–2022***, April 2024. See U.S. EPA's **Greenhouse Gas Inventory Data Explorer**.
The gross emissions total presented excludes CO_2 emissions and removals from Land Use, Land-Use Change, and Forestry (LULUCF).

Air Toxics

Data from U.S. EPA's *2022 Toxics Release Inventory (TRI) National Analysis* shows a national reduction in reported toxic air releases of 26 percent over the last decade, down from 775,021,513 pounds (lbs) in 2013 to 570,609,794 pounds in 2022.[28]

Of the 204,411,719-pound decrease in reported toxic air releases from 2013 to 2022, AAPCA Member States were responsible for 135,355,163 pounds, or 66 percent.[29]

Figure 13. AAPCA Member States Share of Total Reduction of Reported Toxic Air Releases, 2013–2022 (lbs reduced)

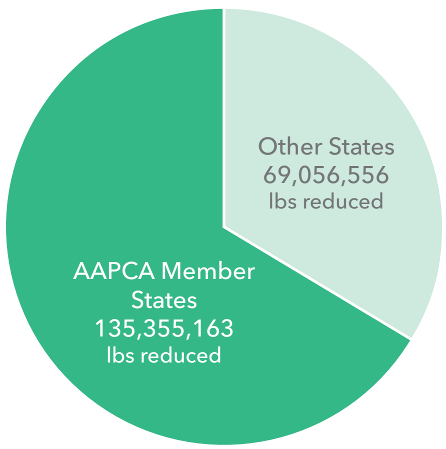
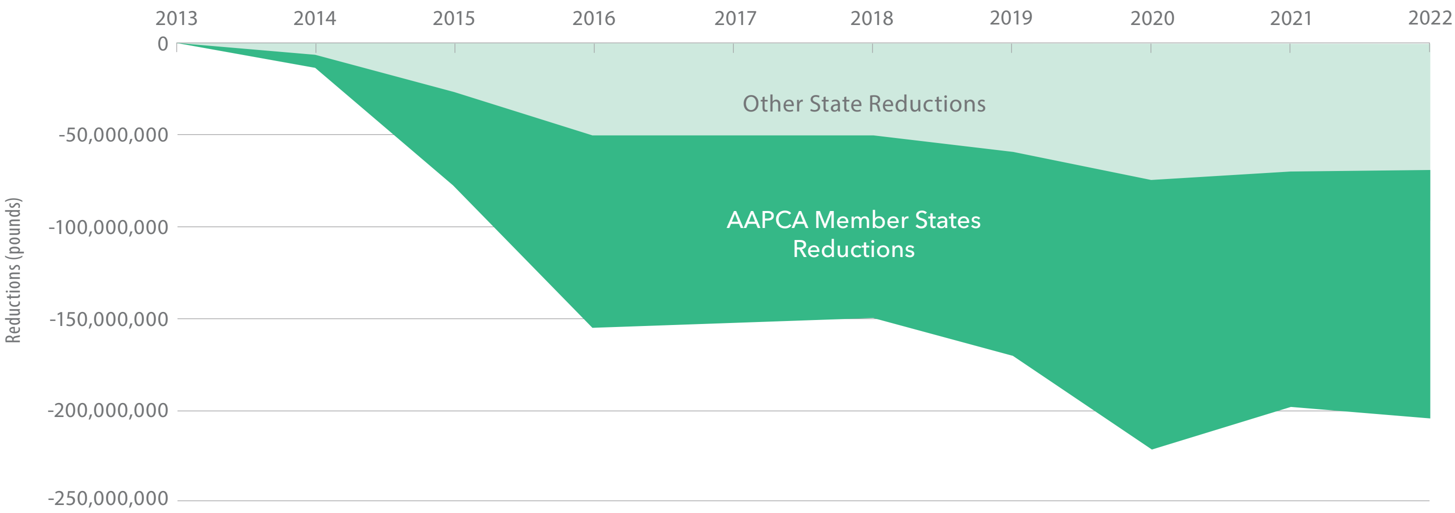


Figure 14. AAPCA Member States | Annual Share of National Reduction in Reported Toxic Air Releases, 2013–2022



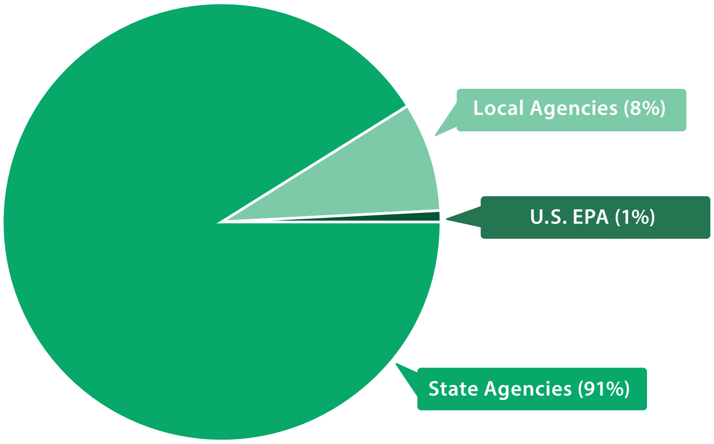
Source: U.S. EPA Toxics Release Inventory Explorer, **2022 TRI Factsheets**.

Compliance and Enforcement Activity

U.S. EPA's Enforcement and Compliance History Online (ECHO) Air Dashboard notes that "EPA delegates much of its [Clean Air Act] authority to state, local, and tribal agencies" to regulate air pollution from stationary sources.[30] ECHO documents compliance monitoring activities that are undertaken by state and local air agencies and U.S. EPA, such as compliance evaluations, compliance determinations, and enforcement actions.

The ECHO Air Dashboard shows that of the 50,973 facilities permitted under the Clean Air Act in federal fiscal year (FY) 2023, states were the permitting agency for 46,402 facilities, local agencies for 3,925, and U.S. EPA for 646 facilities. AAPCA Member States were the permitting agency for 21,592 facilities, or 47 percent of the state agency total in 2023.[31]

Figure 15. Facilities Permitted under Clean Air Act by Lead Agency, 2023

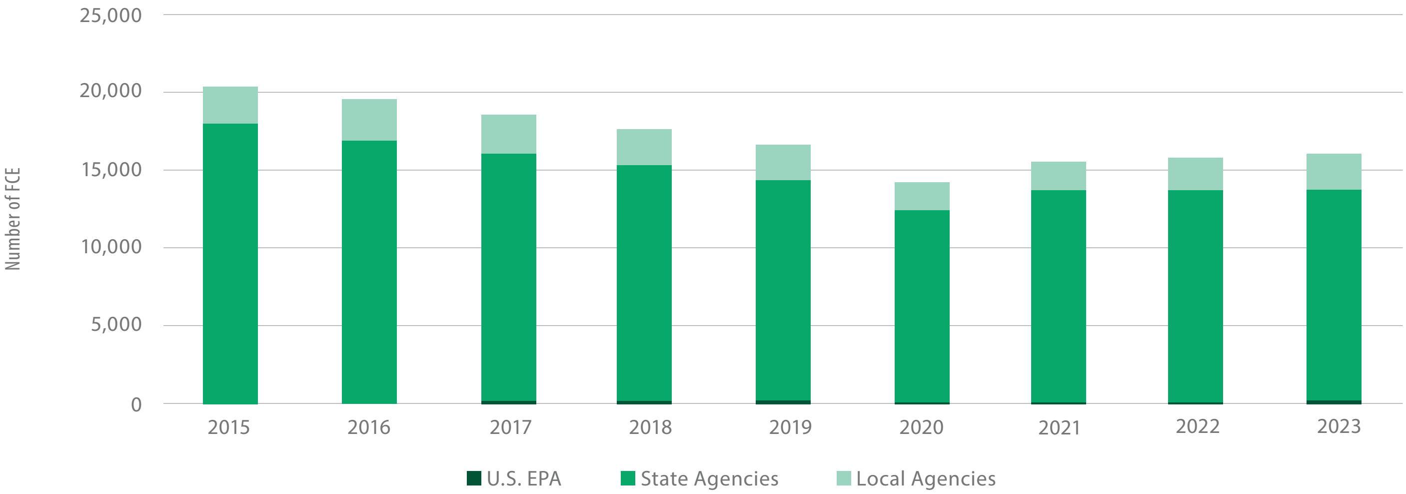


The ECHO Air Dashboard also provides data on Full Compliance Evaluations (FCE) performed by U.S. EPA and state and local agencies. U.S. EPA defines an FCE as "a comprehensive evaluation of the compliance status of the facility. It looks for all regulated pollutants at all regulated emission units, and it addresses the compliance status of each unit, as well as the facility's continuing ability to maintain compliance at each emission unit."[32]

In 2023, AAPCA Member States were the lead agency for 6,916 FCE, approximately 51 percent of the state lead agency total. In federal FY 2023, ECHO details the following FCE lead agency distribution:

- States were the lead agency for 13,489 FCE, averaging more than 14,700 FCE annually since 2015;
- Local programs were the lead agency for 2,298 FCE, averaging more than 2,200 FCE annually since 2015; and,
- U.S. EPA was the lead agency for 208 FCE, averaging about 160 FCE annually since 2015.[33]

Figure 16. Full Compliance Evaluations under Clean Air Act by Lead Agency, 2015–2023



Source: U.S. EPA ECHO, Analyze Trends: **EPA/State Air Dashboard**.

Local Program Case Study | Jefferson County, AL

School Air Sensors

Over the last several years, low-cost air pollution sensors have been made available to the public for purchase with a large range of variance on their accuracy. While these low-cost sensors do not meet the rigorous standards required for regulatory monitors, they can help get a picture of air quality especially when increased levels of particulate matter are in an area.

Children are a group that pose a higher risk for breathing in particulate matter pollution. This is because they spend more time outdoors, run around more often, have higher breathing rates, have narrower airways, and their lungs are still developing. A common location for most children are schools and installing low cost particulate matter sensors at schools would provide a more detailed assessment of air quality at schools and neighboring communities. Placing sensors at these schools will enhance air quality data in EJ areas within Jefferson County.

The Jefferson County Department of Health (JCDH) is offering every public school in Jefferson County, Alabama, one low-cost sensor and outreach to students on the air sensors and air quality. The maximum number of sensors that would need to be purchased is 166, which is the number of public schools in Jefferson County. The actual number of sensors will be lower as some schools may be clustered together where only one sensor is needed to serve the area. JCDH is fully funding this project and no grant dollars or federal funds are being used.

JCDH is giving schools the PurpleAir PA-II-FLEX sensor, which is an air quality monitoring device that provides real-time measurements of $PM_{1.0}$, $PM_{2.5}$, and PM_{10} (different sizes of particulate matter) mass concentrations and environmental parameters such as temperature and relative humidity. The U.S. EPA recognizes the usefulness of the PurpleAir sensors by displaying data from them side-by-side on the AirNow **Fire and Smoke Map** with regulatory monitor data.

JCDH plans on using the sensors as an outreach tool to facilitate education on air quality and may include using sensors to promote anti-idling at schools. JCDH encourages schools to access U.S. EPA's Fire and Smoke Map to see the sensor data. Using this site ensures that JCDH and the schools are looking at the most appropriate data for Air Quality Index (AQI) purposes.

Thank you to the Jefferson County Department of Health for the contribution of this case study.
More on the Jefferson County DOH can be found at **www.jcdh.org**.

Local Program Case Study | Mojave Desert, CA

Participation in AQI Flag Program increases significantly in Mojave Desert AQMD

The Mojave Desert Air Quality Management District (MDAQMD) recently renewed its endeavor to partner with local schools to raise air quality awareness among students, parents, teachers, and school administrators.

MDAQMD Executive Director/Air Pollution Control Officer Brad Poiriez spearheaded the effort to engage superintendents at two of the most populated school districts in San Bernardino County to increase participation in the AQI Flag Program. Launched and supported by the U.S. EPA, the program provides flags color-coordinated with the Air Quality Index (AQI) to schools. Students at those schools, guided by a teacher or advisor, check the following day's air quality forecast for their city and then raise the colored flag that corresponds to the AQI color forecast.

Between January and March 2024, 23 schools in the town of Apple Valley and city of Hesperia volunteered to participate in the program. In contrast, between 2017 and 2021, MDAQMD had secured participation from six schools, but by November 2023, all but two of those schools had discontinued their active participation.

The increase in participation significantly expands MDAQMD's reach to local K-12 students. Along with providing the flags, MDAQMD visits each school to conduct a brief training with school staff and students as well as provide an introductory presentation on air quality awareness and air pollution concerns in the Mojave Desert. That reach also expands among parents and families of those students, as the flags at most of the participating schools are flying within clear line of sight of school drop-off and pick-up areas, providing a visible indicator of that day's air quality forecast.

Quick facts about MDAQMD:

- More than 20,000 square miles of jurisdiction;
- Regulatory authority in three county supervisorial districts: San Bernardino County's 1st and 3rd districts, and Riverside County's 4th District;
- Nine incorporated cities;
- Population approximately 600,000.

The increase in flag program participation in Apple Valley and Hesperia has led to an uptick in interest from surrounding school districts. MDAQMD plans to continue reaching out and adding schools in the program, with an ultimate goal of having at least some schools in nearly every school district within its boundaries.

Thank you to the Mojave Desert Air Quality Management District for the contribution of this case study. More on the Mojave Desert AQMD can be found at **www.mdaqmd.ca.gov**.

Yucca Loma is one of two dozen schools in the Mojave Desert Air Quality Management District to recently join the AQI Flag Program. Students at these schools participate by checking the air quality forecast for the area daily and then raising the color-coded flag that corresponds to the forecasted AQI level the following morning.

Students at Yucca Loma Elementary School in Apple Valley, Calif. raise a green Air Quality Index (AQI) flag to their school's flagpole on an early week day morning.

A green Air Quality Index (AQI) flag flies just below the State of California and American flags over Yucca Loma Elementary School in Apple Valley, Calif. The green flag corresponds to the "Good" AQI level.

AAPCA **Best Practices** in Air Pollution Control

Each year, AAPCA designates Best Practices that identify ground-breaking technology, innovative approaches, and exemplary operations in the field of air pollution control, with particular focus on activities that are directly transferable to the operation of an air pollution control agency. Below are recipients of AAPCA's Best Practices in Air Pollution Control for the last five years:

2023

Streamlined Response to Comments Approach for State Implementation Plans
Georgia Environmental Protection Division

Representative Sample Guidance Document
Oklahoma Department of Environmental Quality

Wyoming Pond Emissions Calculator
Wyoming Department of Environmental Quality

Healthy Air Living Schools Program
San Joaquin Valley Air Pollution Control District (Local Government Best Practice)

2022

Open Burn Permit Program
Arizona Department of Environmental Quality

2022 Air Quality Workshop
Oklahoma Department of Environmental Quality

Environmental Trainee Mentoring Program
Pennsylvania Department of Environmental Protection

Wyoming Environmental Audit Process
Wyoming Department of Environmental Quality

Air Quality Action Partners Program
Louisville Metro Air Pollution Control District (Local Government Best Practice)

Streamlined Communication and Collaboration for Air Monitoring Programs via Microsoft Teams
Mecklenburg County Air Quality (Local Government Best Practice)

Residential Woodsmoke Reduction Strategy
San Joaquin Valley Air Pollution Control District (Local Government Best Practice)

2021

COVID-19 Air Quality Inspection/Compliance Determinations
Arizona Department of Environmental Quality

Efficiencies in the Data Quality Review of Ambient Air Monitoring Data
Georgia Environmental Protection Division

NESHAP 6H Reg Nav Tool
North Carolina Department of Environmental Quality

Shiny Dashboard for Remote Monitoring of Air Quality Data
Tennessee Department of Environment and Conservation

2020

Georgia PSD Emissions Inventory
Georgia Environmental Protection Division

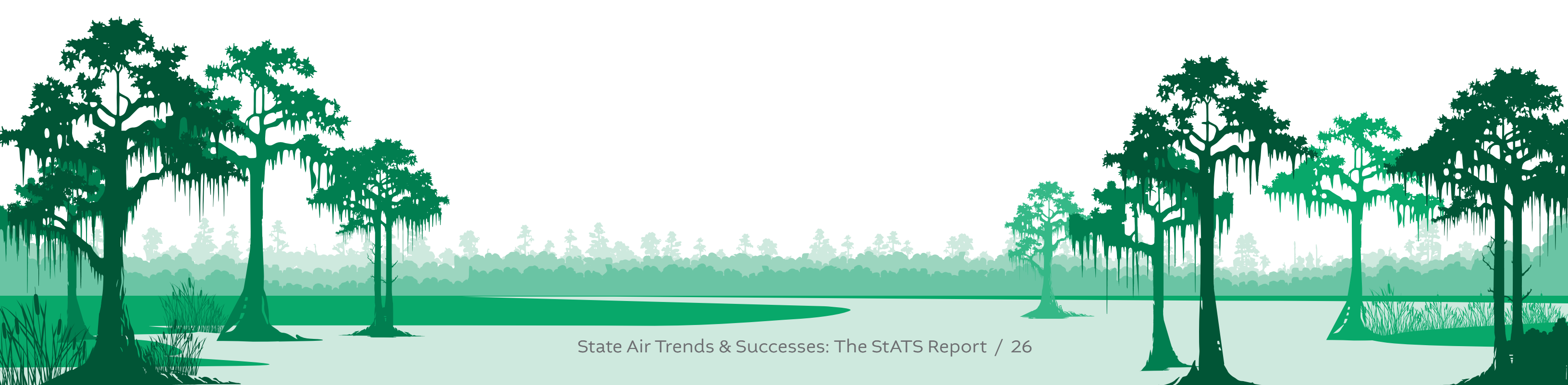
2019

Data Verification Procedures
Georgia Environmental Protection Division

Ozone Design Value Predictor Tool
North Carolina Division of Air Quality

Louisville Community Workshop Series
Louisville Metro Air Pollution Control District (Local Government Best Practice)

Presentations from all past recipients can be found on AAPCA's website at **www.cleanairact.org**.



American Air Quality in an International Context

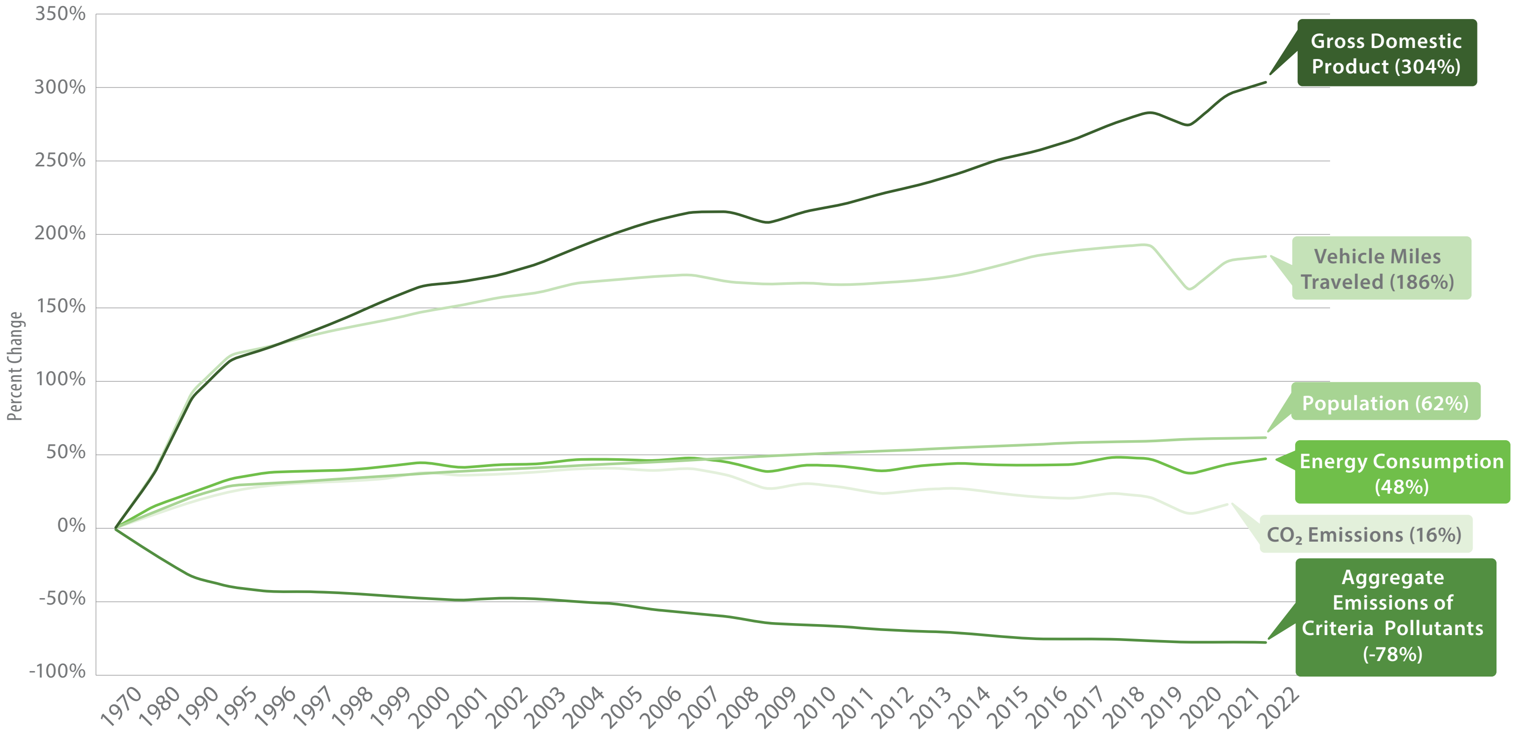
"Internationally, EPA is seen as the gold standard for environmental protection, based on our commitment to science, setting of strong standards and introducing new and innovative approaches to the most persistent and difficult environmental concerns."

Source: Michael Regan, U.S. EPA Administrator, "***Global Problems Require Global Action, and EPA is Leading the Way***," March 29, 2022.

Economic Growth and Air Quality in the United States

Since enactment of the Clean Air Act in 1970, the United States has reduced aggregate emissions of the six criteria air pollutants by 78 percent.[34] U.S. EPA's June 2023 report, *Our Nation's Air: Trends Through 2022*, indicates that the substantial progress in emissions reductions and air quality improvements have occurred while economic indicators in the United States remain strong. Between 1970 and 2022, national gross domestic product (GDP) grew by 304 percent, vehicle miles traveled increased by 186 percent, population grew by 62 percent, and energy consumption rose by 48 percent.[35]

Figure 17. Growth Indicators and Emissions Reductions in the United States, 1970–2022



Source: U.S. EPA, ***Our Nation's Air: Trends Through 2022***, Section: "Economic Strength with Cleaner Air," June 2023.

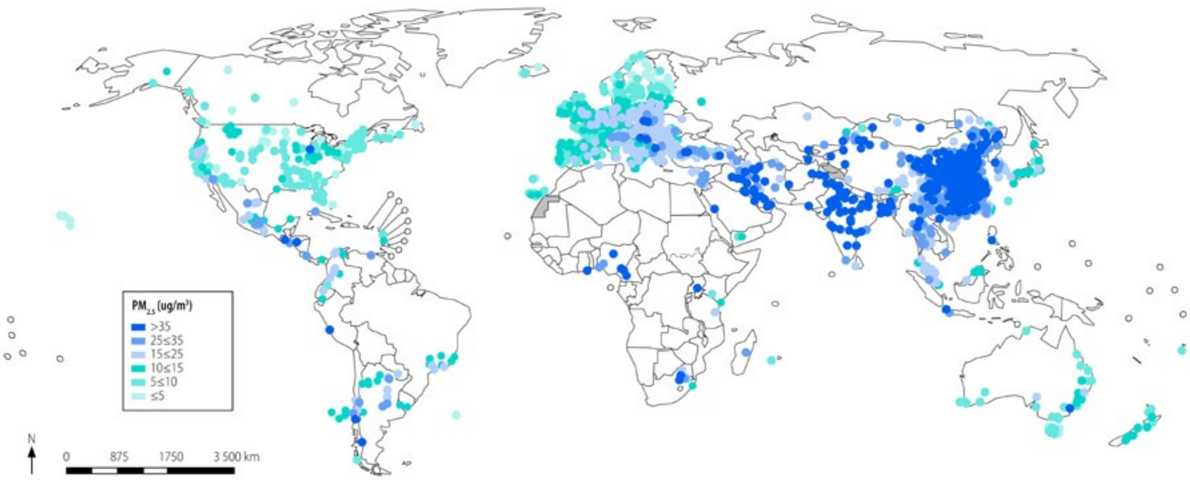
Internationally, the United States ranks:

- First in GDP, at $25.44 trillion in 2022, representing 25 percent of gross world product.[36]
- Second in both total energy supply, at 89,554,569 terajoules (TJ), and total electricity generation, at 4,374,676 gigawatt hours (GWh), representing 15 percent of the world total in 2021 for both categories.[37]
- Third in population, at more than 336 million people in 2024, representing 4 percent of the world population.[38]

International Air Quality | Fine Particulate Matter

Since 1987, the World Health Organization (WHO) has periodically issued health-based air quality guidelines to assist governments and civil society to reduce human exposure to air pollution and its adverse effects. In 2021, WHO published updated global air quality guidelines (AQG) for particulate matter ($PM_{2.5}$ and PM_{10}), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO).[39] The WHO Ambient Air Quality Database shows that ground measurements of $PM_{2.5}$ are concentrated in North America, Europe, India, and China.[40]

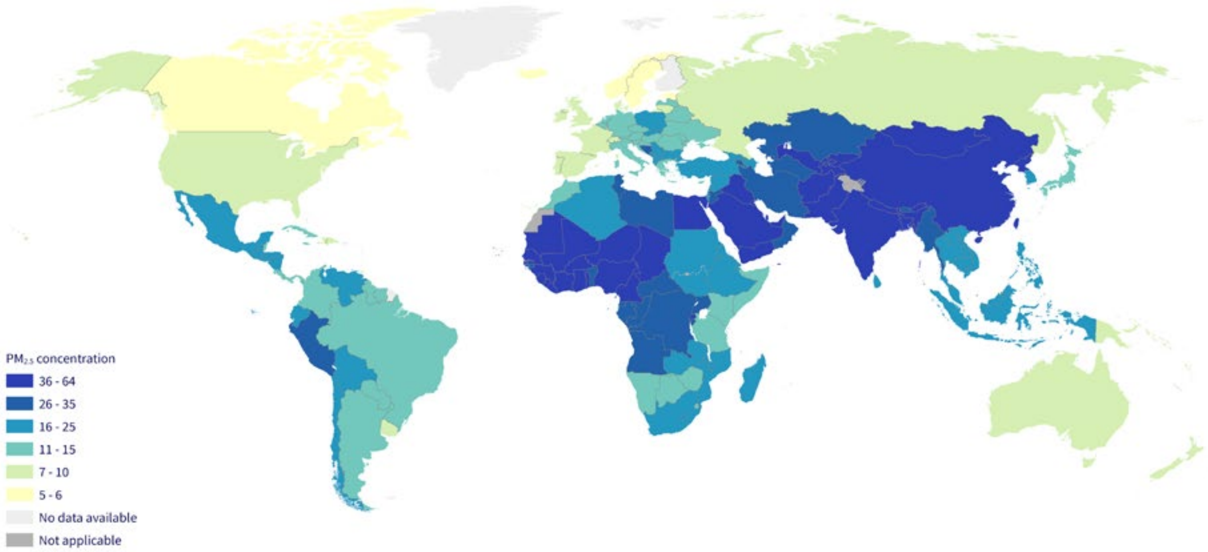
Figure 18. Locations With Data on $PM_{2.5}$, by Number of Ground Measurements, 2010–2019



Source: Shairsingh K, et. al. WHO air quality database: relevance, history and future developments. Bulletin of the World Health Organization. December 1, 2023. doi.org/10.2471/blt.23.290188.

According to the WHO Ambient Air Quality Database, the United States had an annual mean level of $PM_{2.5}$ in cities (population weighted) of 7.18 μg/m³ in 2019.[41]

Figure 19. Annual Mean Concentrations of $PM_{2.5}$, 2019

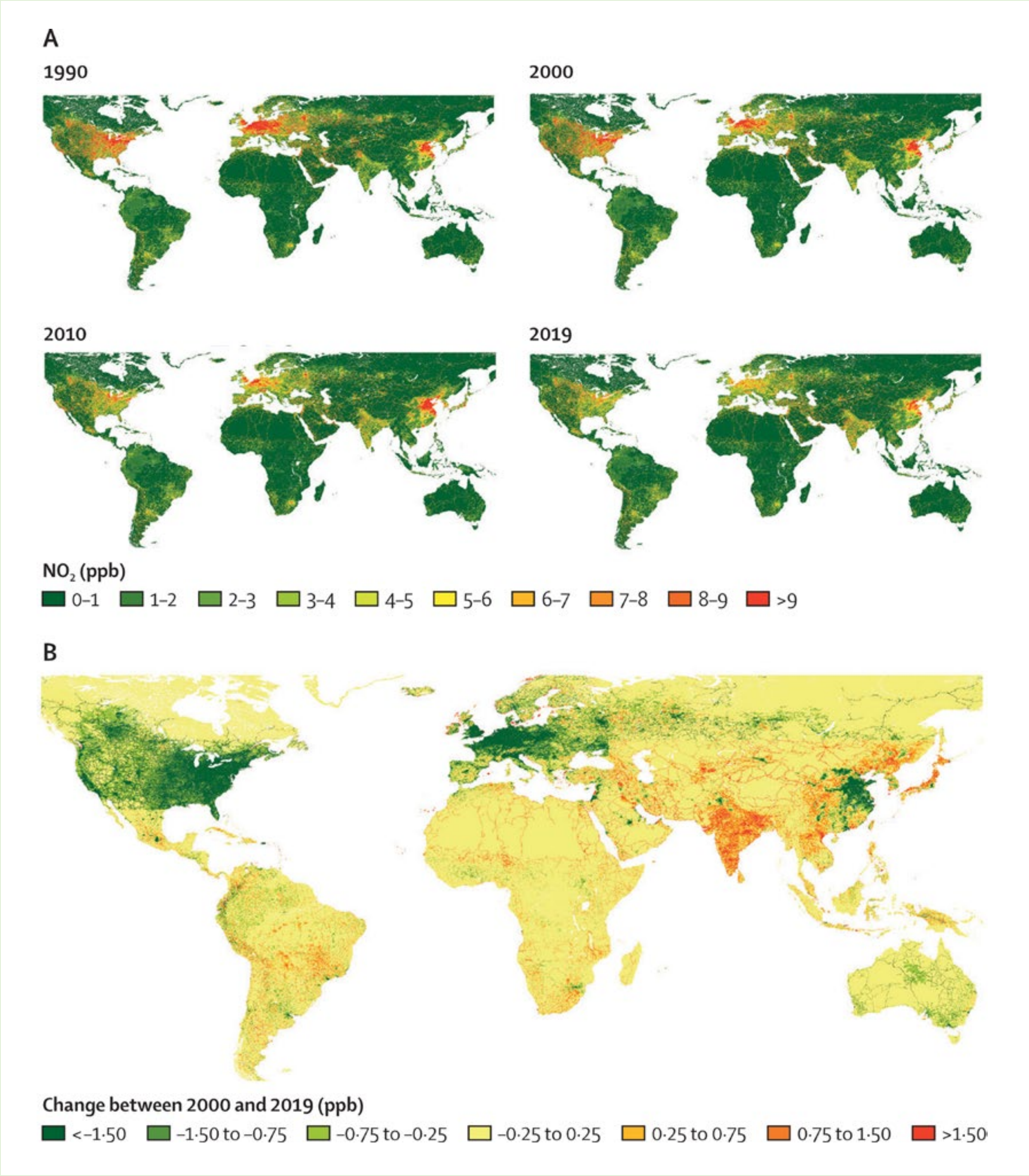


Source: World Health Organization, GIS Centre for Health, "The Global Health Observatory," June 28, 2023.

International Air Quality | Nitrogen Dioxide

Research from the Health Effects Institute (HEI) and National Aeronautics and Space Administration (NASA) indicates that nitrogen dioxide (NO_2) concentrations have changed substantially in response to socioeconomic changes and regulation. Figure 20 shows global annual average NO_2 concentrations measured in parts per billion (ppb) in 1990, 2000, 2010, and 2019 (A), as well as the difference in these concentrations between 2000 and 2019 (B). The study found estimated NO_2 concentrations were highest in the most populated regions of the world – including North America, Europe, and South and East Asia – and the ten cities with the highest NO_2 concentrations in 2019 were in the Middle East, China, and Russia.[42]

Figure 20. Annual Average NO_2 Concentrations and Change, 2000–2019

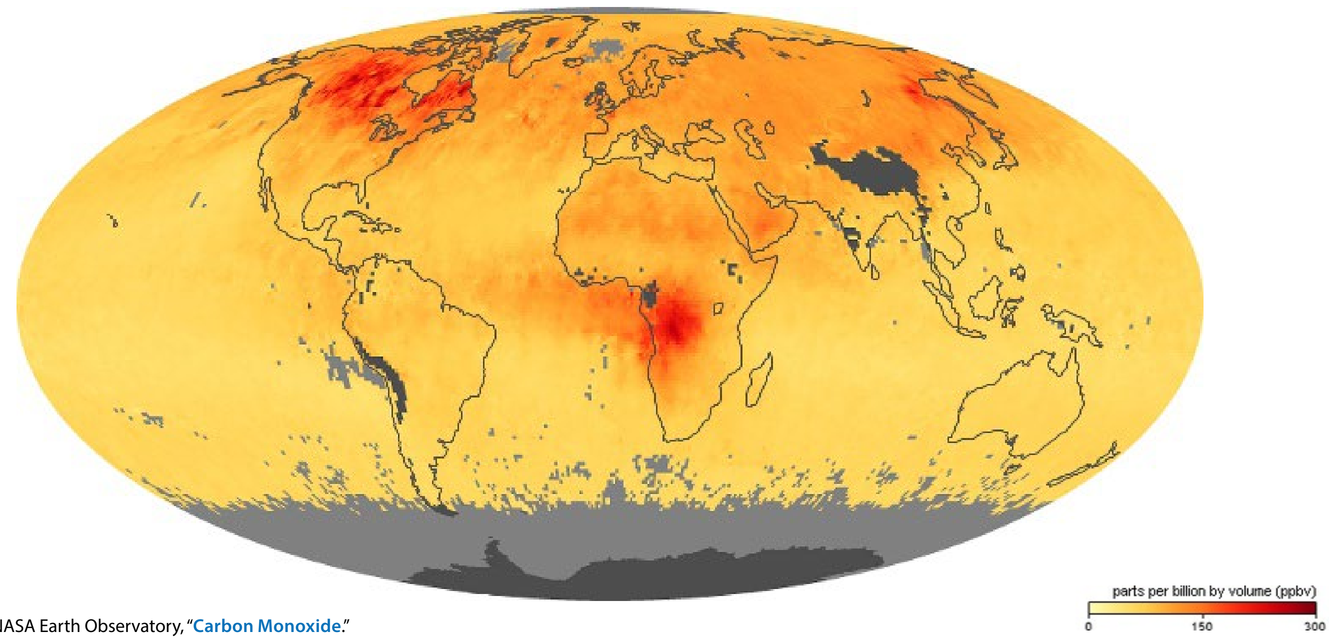


Source: Anenberg, S.C., et al. Long-term trends in urban NO_2 concentrations and associated paediatric asthma incidence: estimates from global datasets. *The Lancet Planetary Health*, January 2022. **doi.org/10.1016/S2542-5196(21)00255-2**.

Satellite Snapshot | Carbon Monoxide

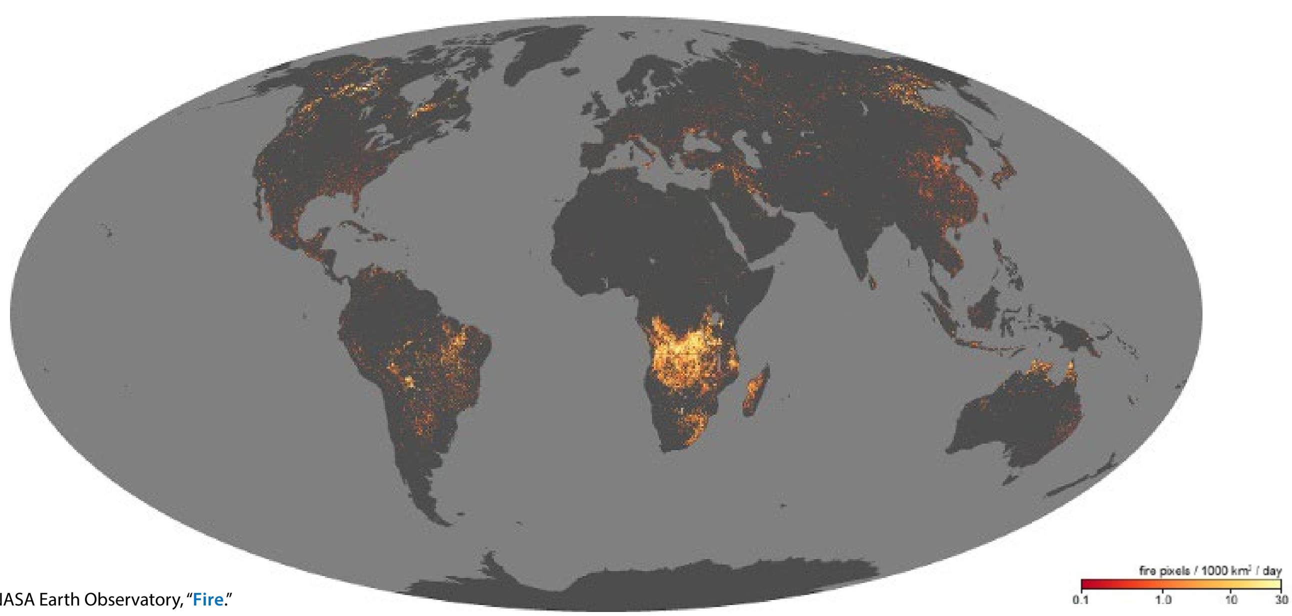
Data from National Aeronautics and Space Administration (NASA) Earth Observations (EO) visualize monthly averages of global concentrations of tropospheric carbon monoxide[43] and locations of actively burning fires,[44] which are an important source of carbon monoxide pollution around the world. Figures 21 and 22 show observations from NASA's Terra satellite[45] in July 2023 when fires burned over large areas in Canada, impacting air quality across North America.

Figure 21. NASA Earth Observations of Carbon Monoxide, July 2023



Source: NASA Earth Observatory, "**Carbon Monoxide**."

Figure 22. NASA Earth Observations of Fire, July 2023

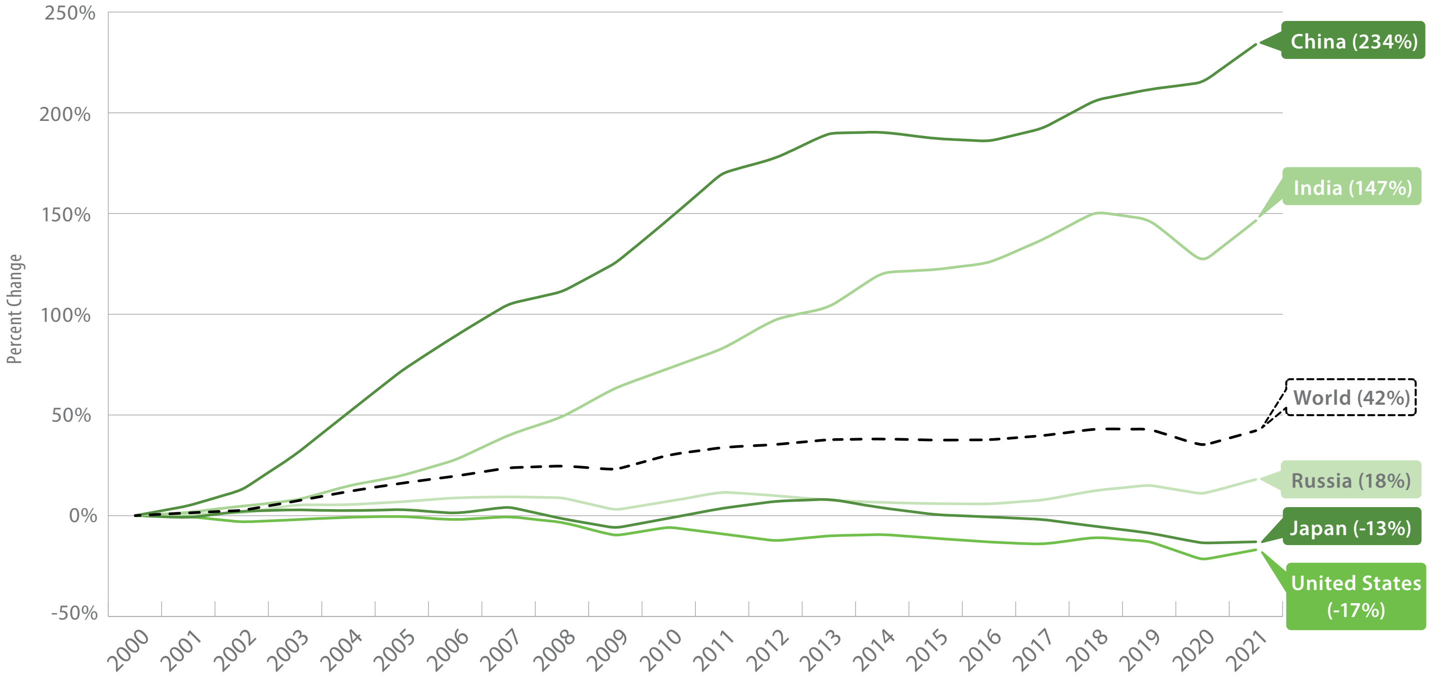


Source: NASA Earth Observatory, "**Fire**."

International Air Quality | Greenhouse Gases

The International Energy Agency's (IEA) database, *Greenhouse Gas Emissions from Energy*, is designed to help understand the contributions to greenhouse gas (GHG) emissions associated with energy from 1971 to 2021 for more than 205 countries. In 2021, China and the United States together were responsible for 45 percent of global fuel combustion emissions, followed by India, Russia, and Japan. By 2021, GHG emissions from energy in the United States totaled 5018.5 million tonnes of CO_2 eq., a decrease of 17 percent compared to emissions levels in 2000.[46]

Figure 23. Annual Percent Change of Greenhouse Gas Emissions from Energy by Country, 2000–2021



Source: International Energy Agency, ***Greenhouse Gas Emissions from Energy***, August 2, 2023.

International Energy Agency | CO_2 Emissions in 2023

In March 2024, IEA published the report, *CO_2 Emissions in 2023*, highlighting the following global carbon dioxide (CO_2) emissions trends:

- Global energy-related CO_2 emissions grew by 1.1 percent in 2023, increasing 410 million tonnes (Mt) to reach a new record high of 37.4 billion tonnes (Gt). This compares with an increase of 490 Mt, or 1.3 percent, in 2022.
- Over the ten years ending with 2023, global gross domestic product (GDP) growth averaged a robust 3 percent per year, while global CO_2 emissions grew substantially slower by approximately 0.5 percent per year.
- From 2022 to 2023, total CO_2 emissions from energy combustion in the United States declined by 4.1 percent, a reduction of 190 Mt, while the economy grew by 2.5 percent. Two-thirds, or 35 percent, of the emissions reduction came from the electricity sector.

Source: International Energy Agency, ***CO_2 Emissions in 2023***, March 2024.

Air Quality Trends in the United States

> "Cleaner air provides important public health benefits, and we commend our state, local, community and industry partners for helping further long-term improvement in our air quality."
>
> Source: U.S. EPA, ***Our Nation's Air: Trends Through 2022*** (Section: "Introduction"), June 2023.

Concentration Trends | Criteria Air Pollutants

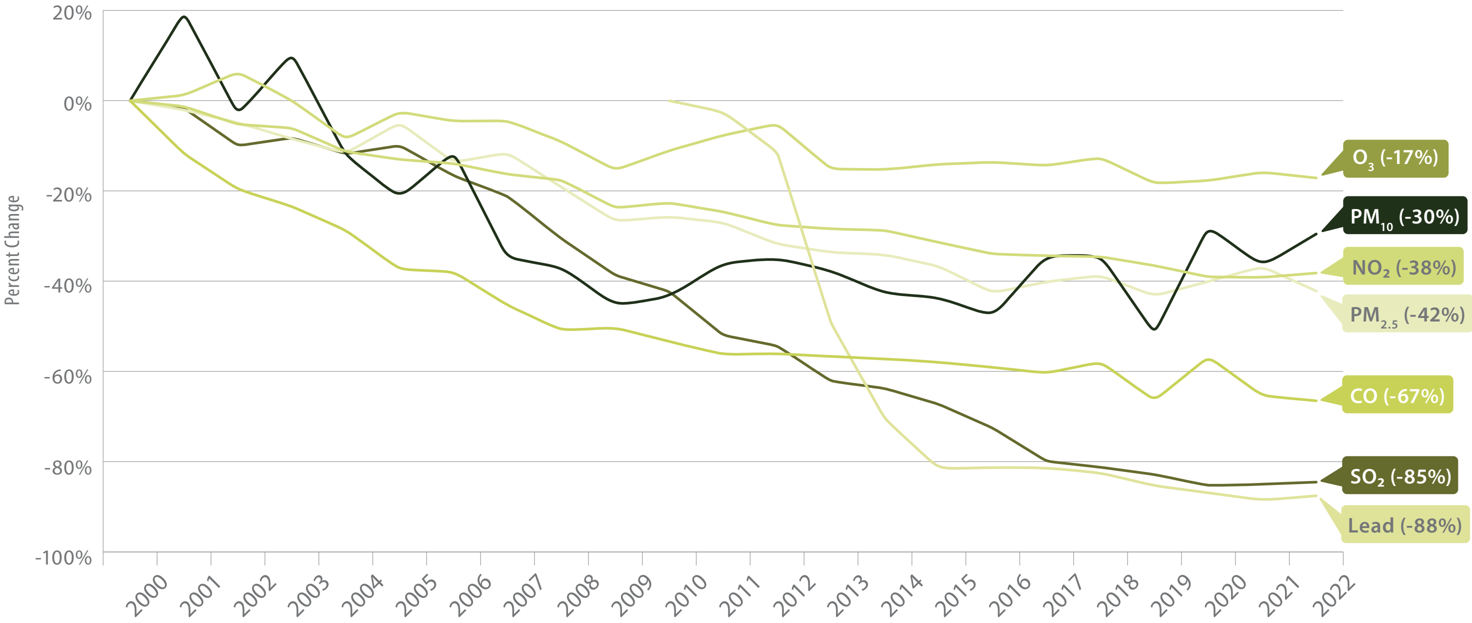
U.S. EPA's national-level analysis of 2022 monitoring data show the substantial reductions in ambient concentrations of all criteria pollutants over the past several decades. As the table below indicates, the United States has seen at least a 29 percent decline in the ambient levels of carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), and sulfur dioxide (SO_2) since 1980. Available data show that fine and coarse particulate matter ($PM_{2.5}$ and PM_{10}) ambient concentrations have declined by at least 30 percent since 2000. And more recent data point to a sustained trend of meaningful improvements, with monitored concentrations of nearly all criteria pollutants now below 2010 levels.[47]

Table 5

Ambient Concentrations	1980 vs 2022	1990 vs 2022	2000 vs 2022	2010 vs 2022
Carbon Monoxide	-88%	-81%	-67%	-27%
Lead	---	---	---	-88%
Nitrogen Dioxide (annual)	-66%	-60%	-52%	-27%
Nitrogen Dioxide (1-hour)	-65%	-54%	-38%	-21%
Ozone (8-hour)	-29%	-22%	-17%	-7%
PM_{10} (24-hour)	---	-34%	-30%	+21%
$PM_{2.5}$ (annual)	---	---	-42%	-21%
$PM_{2.5}$ (24-hour)	---	---	-42%	-16%
Sulfur Dioxide (1-hour)	-94%	-90%	-85%	-75%

Source: U.S. EPA, Air Quality—National Summary: Air Quality Trends, Last updated November 1, 2023.

Figure 24. Percent Change in Criteria Air Pollutant Mean Ambient Concentrations, 2000–2022

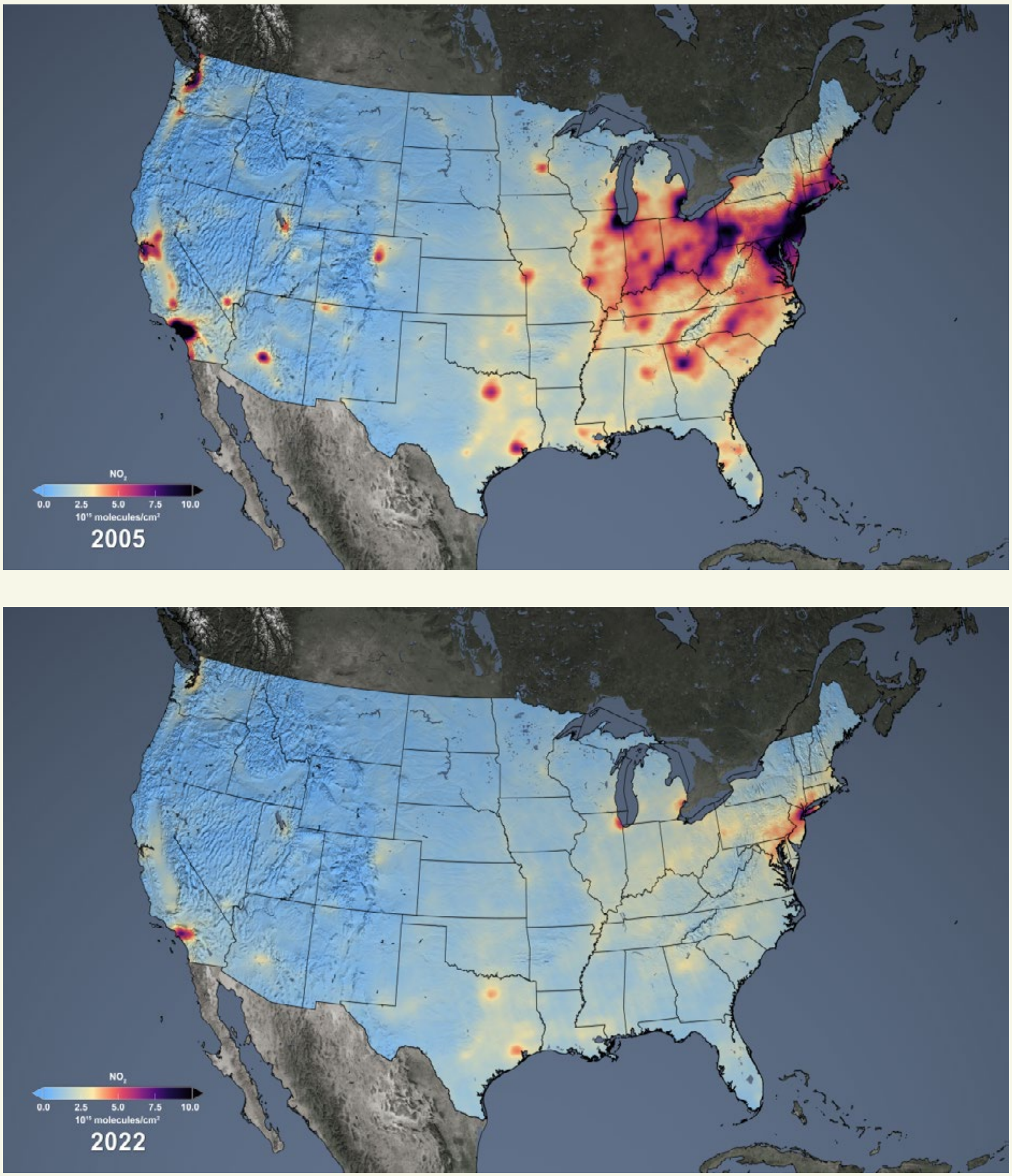


Source: U.S. EPA, National Air Quality: Status and Trends of Key Air Pollutants, Air Quality Trends, Last updated November 1, 2023.

Satellite Snapshot | Nitrogen Dioxide Over the United States, 2005–2022

Data from the Ozone Monitoring Instrument (OMI) on the NASA Aura satellite captures changes in nitrogen dioxide (NO_2) from 2005 to 2022. NASA attests "the large decreases (20–50 percent) are associated with the implementation of state and federal regulations to reduce [nitrogen oxides] emissions from power plants and cars."[48]

Figure 25. Changes in Nitrogen Dioxide in the United States



Source: NASA Air Quality Observations from Space, "Nitrogen Dioxide," Last updated November 30, 2023.

Emissions Trends | Criteria Air Pollutants

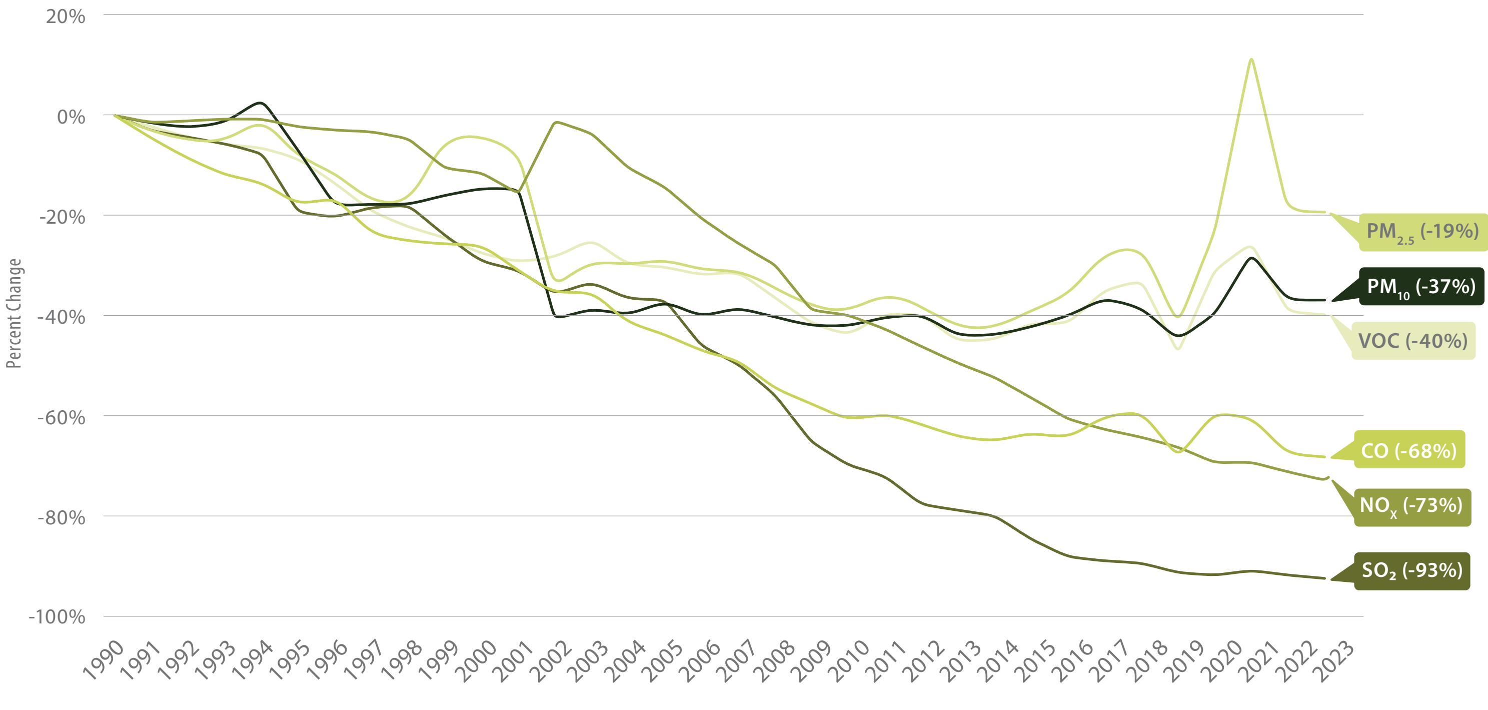
In coordination with state and local air agencies, tribes, and industry, U.S. EPA develops annual nationwide emissions estimates, which are "based on actual monitored readings or engineering calculations of the amounts and types of pollutants emitted by vehicles, factories, and other sources."[49] In the below table, U.S. EPA's most recently published estimates show that the emissions of all criteria pollutants and precursors declined by at least 27 percent from 1990 to 2022. Recent data point to a sustained trend of meaningful reductions, with estimated emissions of all criteria pollutants and precursors at least 10 percent lower than 2010 levels.[50]

Table 6

Emissions	1980 vs 2022	1990 vs 2022	2000 vs 2022	2010 vs 2022
Carbon Monoxide	-75%	-70%	-58%	-27%
Lead*	-99%	-88%	-78%	-36%
Nitrogen Oxides	-72%	-71%	-67%	-52%
Volatile Organic Compounds	-61%	-48%	-29%	-10%
Direct PM_{10}	-65%	-27%	-24%	-13%
Direct $PM_{2.5}$	---	-27%	-35%	-11%
Sulfur Dioxide	-93%	-92%	-89%	-74%

Source: U.S. EPA, **Air Quality—National Summary: Emissions Trends**, Last updated November 1, 2023.

Figure 26. Percent Change in Criteria Air Pollutant Emissions, 1990–2023

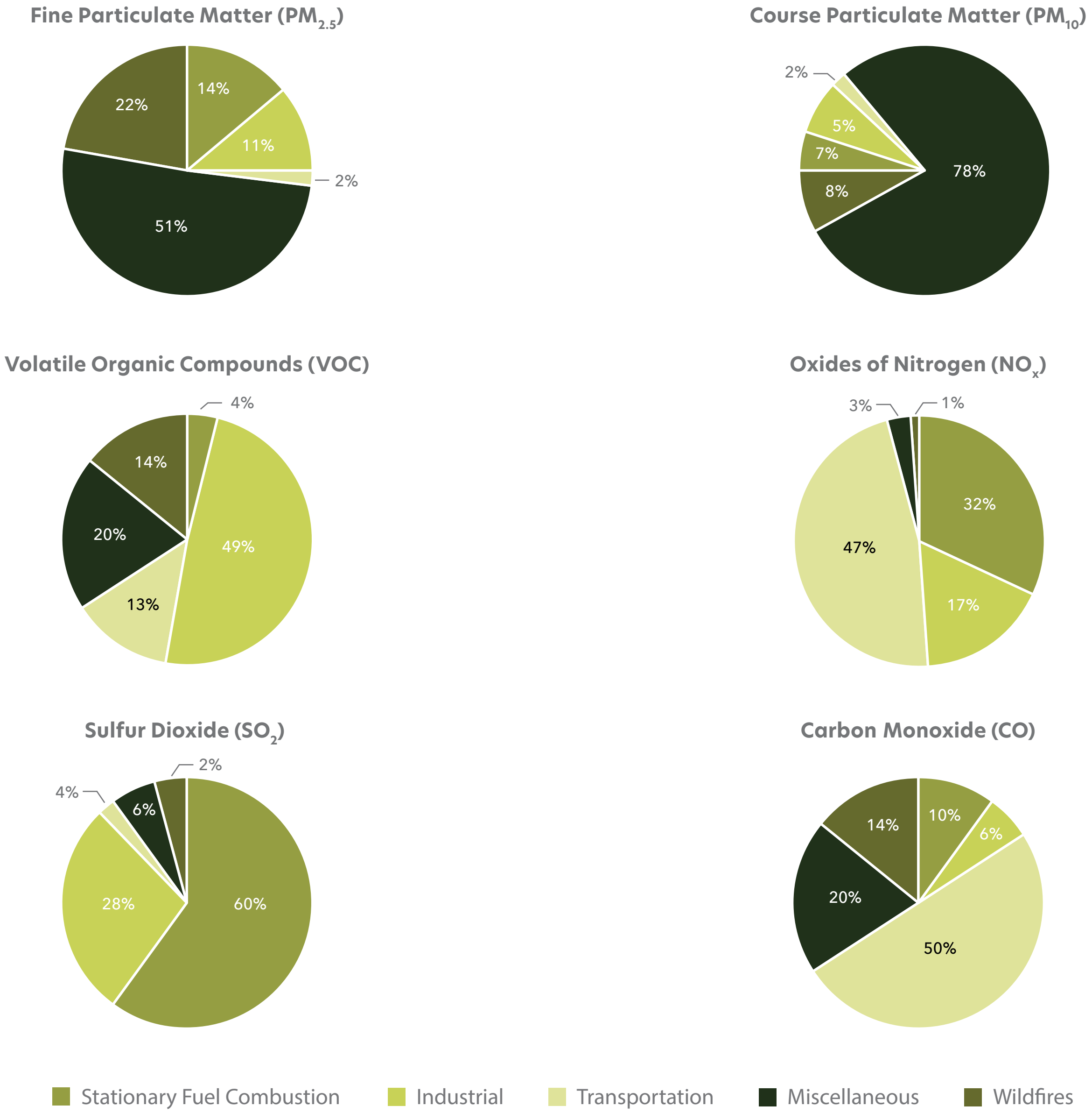


Source: U.S. EPA, **Air Pollutant Emissions Trends**, National Tier 1 CAPS Trends, Criteria pollutants National Tier 1 for 1970–2023. U.S. EPA's data for lead emissions trends can be found **here**.

Emissions Sources | Criteria Air Pollutants

U.S. EPA tracks emissions from the following source categories: Stationary Fuel Combustion, Industrial, Transportation, Wildfires, and Miscellaneous. Included below are the sources of criteria air pollutant and precursor emissions for the year 2023.[51]

Figure 27. Sources of Criteria Air Pollutant Emissions, 2023

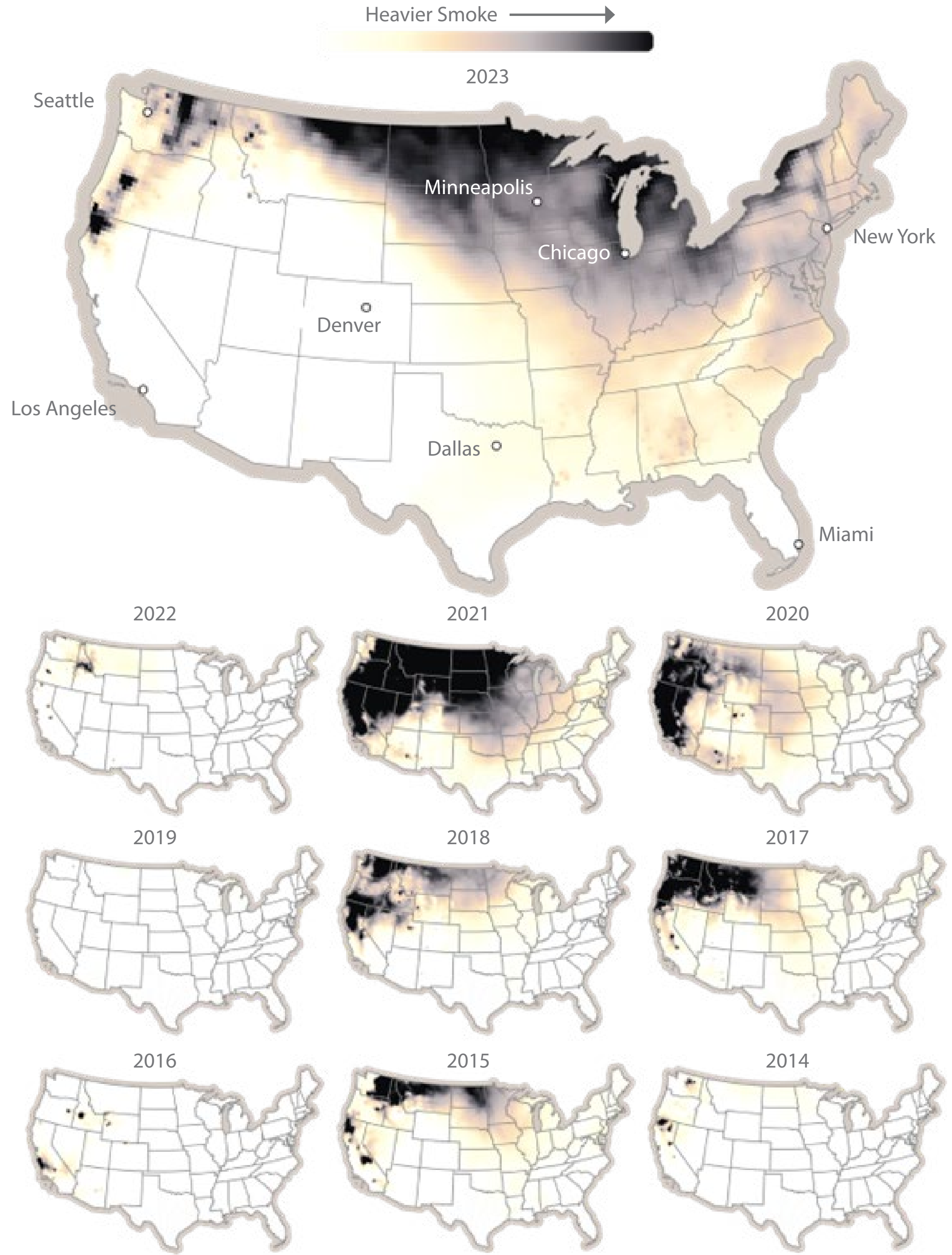


Source: U.S. EPA, **Air Pollutant Emissions Trends Data**, National Tier 1 CAPS Trends, Criteria pollutants National Tier 1 for 1970–2023.

Satellite Snapshot | Wildfire Smoke Over the United States

Data from the National Aeronautics and Space Administration (NASA) Global Modeling and Assimilation Office Goddard Earth Observing System (GEOS) Forward Processing (FP) produced the following maps of cumulative wildfire smoke across the United States from June through September for the last decade.[52] In 2023, unprecedented levels of smoke from wildfires in Canada reached "hundreds of miles into the U.S., pushing air quality into the unhealthy or worse categories in areas from the mid-Atlantic through the Northeast and parts of the Upper Great Lakes."[53]

Figure 28. Cumulative Wildfire Smoke Over the United States, 2014–2023

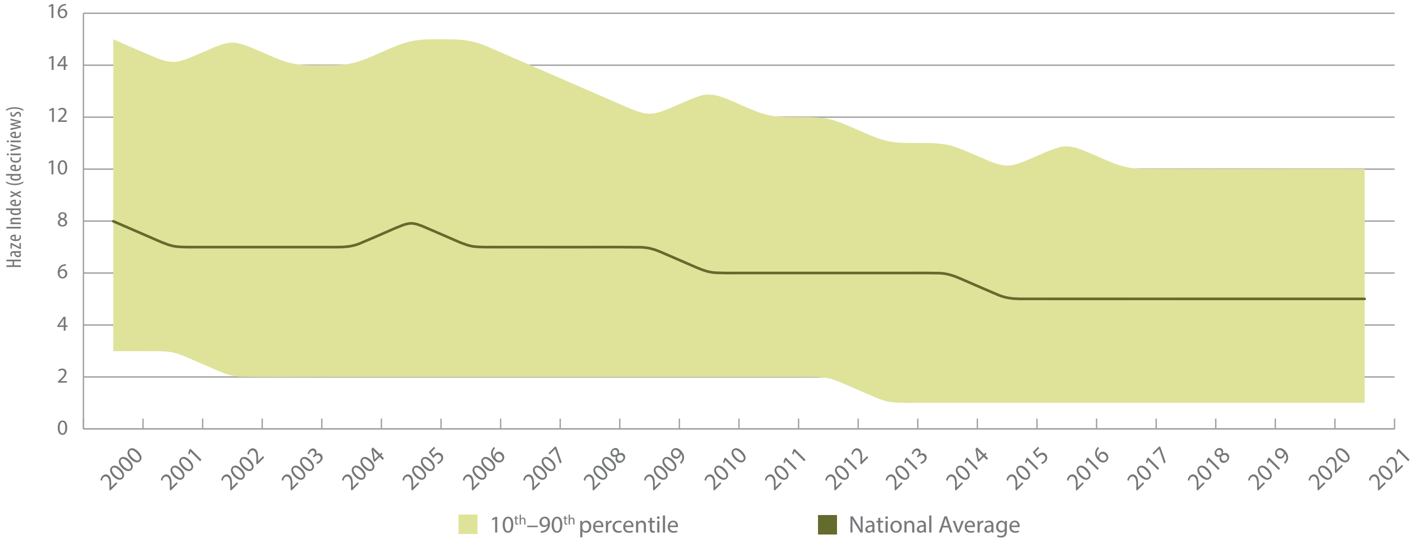


Source: Axios, "Haze," December 15, 2023. Data from NASA Global Modeling and Assimilation Office GEOS-FP.

Visibility Improvements

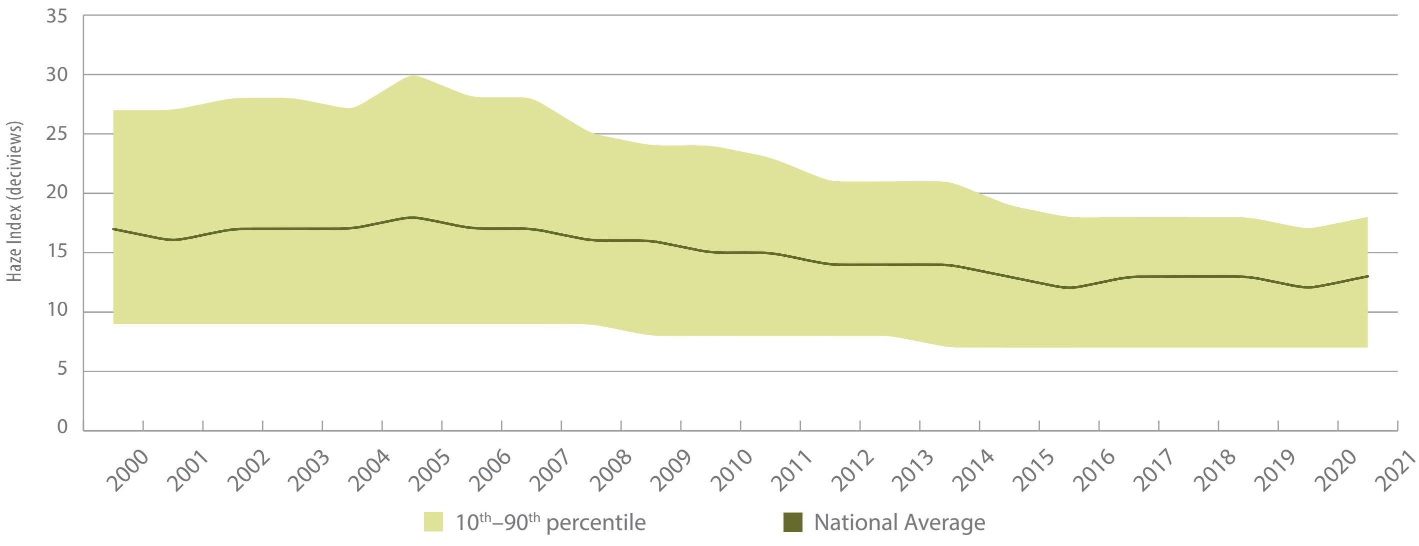
Under the national Regional Haze Program, state and federal agencies monitor visibility in 156 national parks and wilderness areas, or Class I areas.[54] U.S. EPA's latest annual air trends report, *Our Nation's Air: Trends Through 2022*, provides visibility data for Class I areas through 2021. On average from 2000 to 2021, visibility on the 20 percent clearest days improved by 32 percent, while visibility on the 20 percent most impaired days improved by 25 percent.[55]

Figure 29. National Visibility Trends on Clearest Days, 2000–2021



Source: U.S. EPA, ***Our Nation's Air: Trends Through 2022***, Section: "Visibility Improves in Scenic Areas," June 2023.

Figure 30. National Visibility Trends on Most Impaired Days, 2000–2021

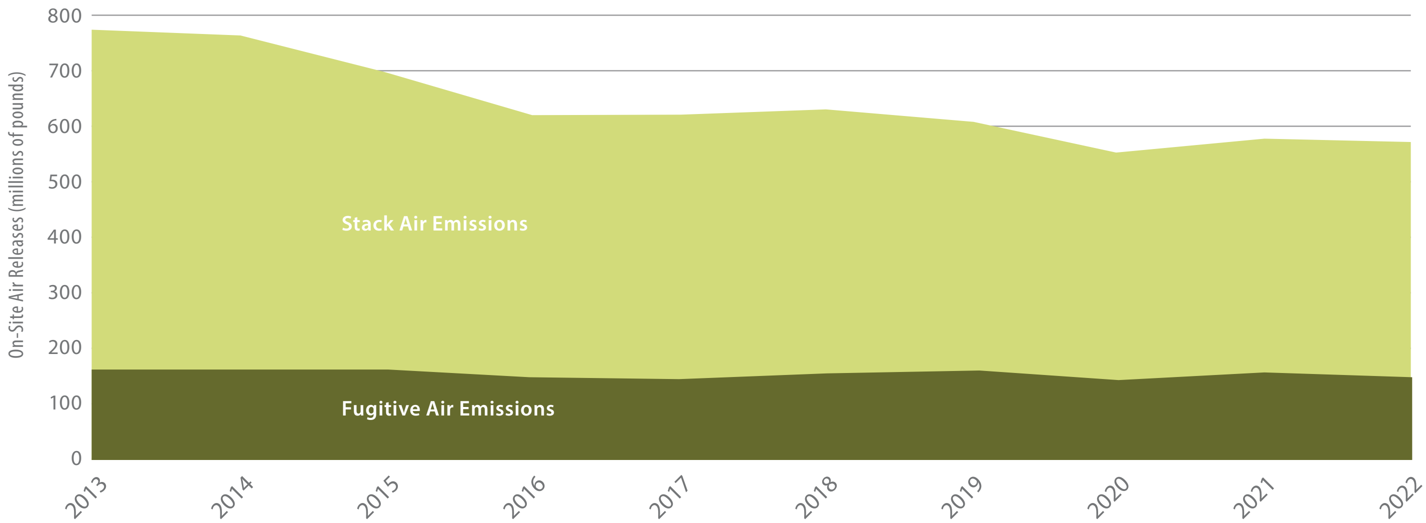


Source: U.S. EPA, ***Our Nation's Air: Trends Through 2022***, Section: "Visibility Improves in Scenic Areas," June 2023.

Air Toxics

U.S. EPA's *2022 Toxics Release Inventory (TRI) National Analysis* data show declining emissions of hazardous air pollutants, or air toxics, over the last decade. From 2013 to 2022, reported on-site releases of chemicals into the air decreased by 26 percent, a total reduction of 204 million pounds. In 2022, national air releases reportedly decreased by 1 percent compared to 2021.[56]

Figure 31. National Toxic Air Releases, 2013–2022

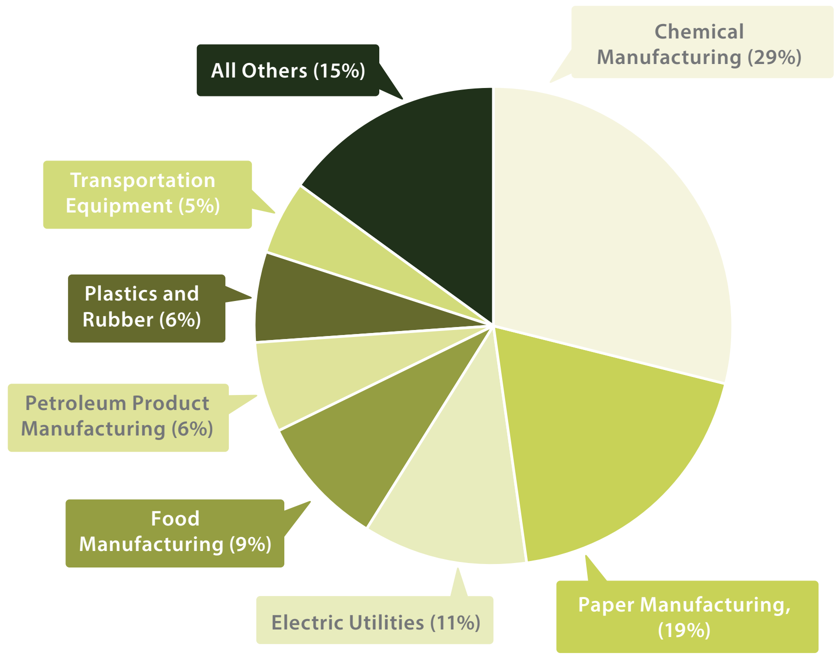


Source: U.S. EPA, *2022 Toxics Release Inventory National Analysis*, **Air Releases**, March 2024.

Figure 32. National Toxic Air Releases by Industry, 2022

In 2022, a total of 21,752 facilities reported to U.S. EPA's *Toxics Release Inventory*.[57] Of the total 571 million pounds of air releases reported in 2022, the top three sectors were chemical manufacturing, paper manufacturing, and electric utilities. The chemicals released in the largest quantities by these three sectors were ammonia and ethylene, methanol, and sulfuric acid, respectively.[58]

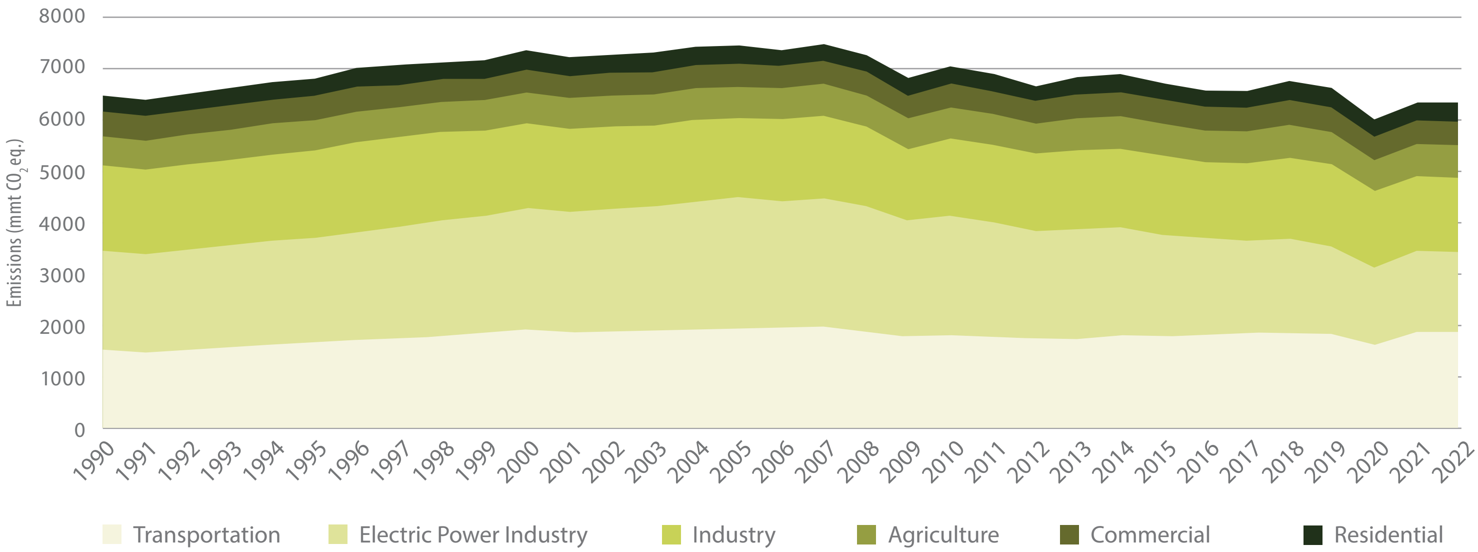
Source: U.S. EPA, *2022 Toxics Release Inventory National Analysis*, **Air Releases by Chemical & Industry**, March 2024.



Greenhouse Gas Trends

Released in April 2024, U.S. EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2022* tracks greenhouse gas emissions and sinks by source, economic sector, and greenhouse gas in the United States. The annual report documents that gross greenhouse gas emissions in the United States totaled 6,343 million metric tons of carbon dioxide equivalent (mmt CO_2 eq.) in 2022, which was nearly 15 percent below 2000 levels and 3 percent below 1990 levels.[59]

Figure 33. United States | Greenhouse Gas Emissions by Economic Sector, 2000–2022



Source: U.S. EPA, ***Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990–2022***, April 2024. See U.S. EPA's **Greenhouse Gas Inventory Data Explorer**.

Also reported by U.S. EPA's *Inventory*, the United States reduced estimated gross total emissions of carbon dioxide (CO_2) by 16 percent from 2000 to 2021, from 6,010 mmt CO_2 eq. to 5,032 mmt CO_2 eq., respectively. In 2021, the United States emitted a total of 868 mmt CO_2 eq. of methane (CH_4), down from 793 mmt CO_2 eq. in 2000, or a reduction of about 9 percent. Figures 34 and 35 show the distribution of CO_2 and CH_4 emissions by inventory sector for the United States in 2021.[60]

Figure 34. United States | Emissions of Carbon Dioxide by Inventory Sector, 2022

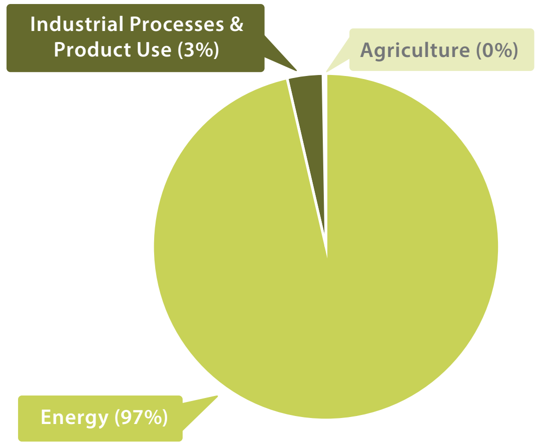
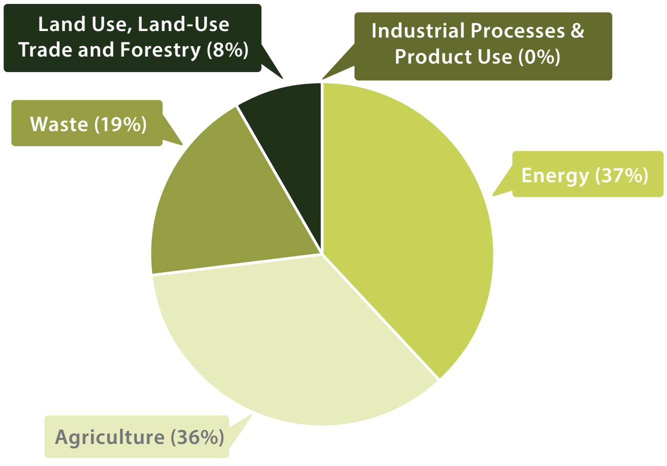


Figure 35. United States | Emissions of Methane by Inventory Sector, 2022

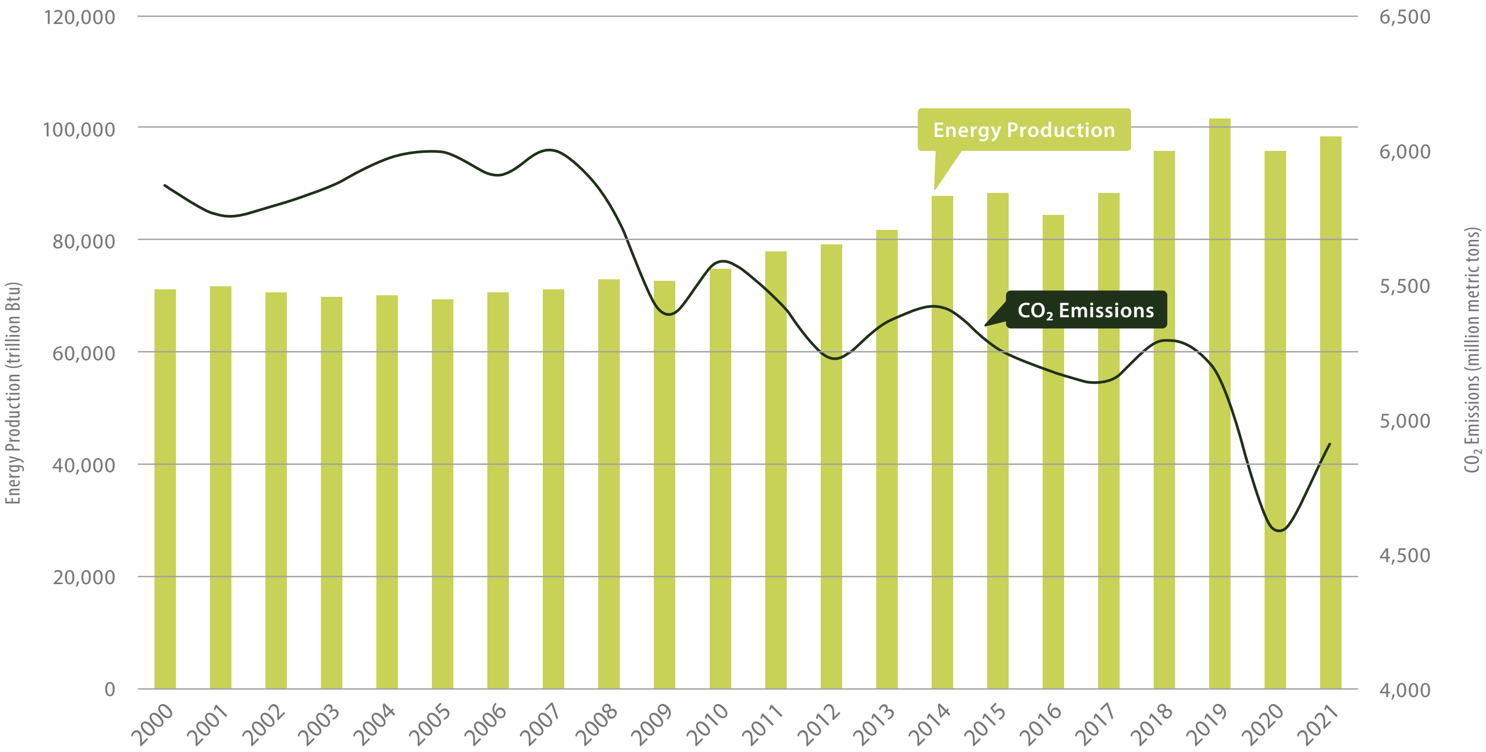


Source: U.S. EPA, ***Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990–2022***, April 2024. See U.S. EPA's **Greenhouse Gas Inventory Data Explorer**.
The gross emissions total presented excludes CO_2 emissions and removals from Land Use, Land-Use Change, and Forestry (LULUCF).

Emissions Trends | Energy-Related Carbon Dioxide

From 2000 to 2021, the United States reduced energy-related carbon dioxide (CO_2) emissions by 16 percent while experiencing a 38 percent increase in total energy production, according to recent data from the U.S. Energy Information Administration (EIA). National energy-related CO_2 emissions fell from 5,868 million metric tons in 2000 to 4,911 million metric tons in 2021.[61] Conversely, total energy production rose from 71,238 trillion British thermal units (Btu) in 2000 to 98,361 trillion Btu in 2021.[62]

Figure 36. United States | Total Energy Production Compared to Energy-Related CO_2 Emissions, 2000–2021



Sources: U.S. Energy Information Administration (EIA), **State Energy Data System (SEDS): 1960–2021**; U.S. EIA, **Energy-Related CO_2 Emission Data Tables**, Table 1. State energy-related carbon dioxide emissions by year (1970–2021).

International Energy Agency | Energy System of the United States

The International Energy Agency (IEA) Energy Statistics Data includes the following energy and emissions trends for the United States:

- Energy-related carbon dioxide (CO_2) emissions in the United States in 2021 totaled 4,549 Mt CO_2, a 21 percent decline since 2000;
- Energy intensity of the economy declined by 38 percent from 2000 to 2022;
- Crude oil production increased 111 percent from 2000 to 2022;
- Natural gas production increased 89 percent from 2000 to 2022; and
- Coal production decreased 46 percent from 2000 to 2022.

Source: International Energy Agency, **United States**, Data accessed April 1, 2024.

Sources

1 U.S. EPA, **Air Pollutant Emissions Trends Data**, State Tier 1 CAPS Trends, Criteria pollutants State Tier 1 for 1990–2023.

2 U.S. Bureau of Economic Analysis, "**Gross Domestic Product by State and Personal Income by State**," released March 29, 2024.

3 U.S. Census Bureau, data available **here**.

4 U.S. Office of Highway Policy Information, data available **here**.

5 U.S. EIA, **State Energy Data Systems (SEDS): 1960–2021**.

6 U.S. EIA, **Energy-Related CO_2 Emission Data Tables**, Table 1. State energy-related carbon dioxide emissions by year.

7 U.S. EPA's Green Book can be found **here**.

8 U.S. EPA's listing of areas designated nonattainment or maintenance for the 1997 annual $PM_{2.5}$ NAAQS can be found **here**. In 2012, the NAAQS for $PM_{2.5}$ was lowered to 12.0 µg/m3, based on an annual arithmetic mean averaged over three years (the 2006 review maintained the 1997 NAAQS). In 2020, U.S. EPA **retained** the 2012 standard of 12.0 µg/m3. In June 2021, U.S. EPA announced the **reconsideration** of the 2020 decision to retain the 2012 $PM_{2.5}$ standards. On February 7, 2024, U.S. EPA promulgated a final rule revising the annual $PM_{2.5}$ NAAQS to 9.0 µg/m3, based on an annual arithmetic mean averaged over three years.

9 U.S. EPA defines a design value as "a statistic that describes the air quality status of a given location relative to the level of the [NAAQS]." More information is available **here**.

10 U.S. EPA's **Air Quality System** "contains ambient air pollution data collected by EPA, state, local, and tribal air pollution control agencies from over thousands of monitors."

11 U.S. EPA, **Air Quality Design Values**, $PM_{2.5}$ Design Values, 2022. Data for this chart is based on overlapping three-year averages beginning with 2000–2002 and ending with 2020–2022.

12 U.S. EPA's listing of areas designated nonattainment or maintenance for the 2012 $PM_{2.5}$ NAAQS can be found **here**.

13 U.S. EPA, "**EPA finalizes stronger standards for harmful soot pollution, significantly increasing health and clean air protections for families, workers, and communities**," February 7, 2024. More information available **here**.

14 U.S. EPA's February 7, 2024, memorandum on Initial Area Designations for the 2024 Revised Primary Annual Fine Particle National Ambient Air Quality Standard can be found **here**.

15 U.S. EPA's listing of areas designated nonattainment or maintenance for the 2008 ozone NAAQS can be found **here**. In 2015, U.S. EPA lowered the NAAQS for ozone to .070 parts per million (ppm), based on the annual fourth-highest daily maximum 8-hour average concentration, averaged over three years. In 2020, U.S. EPA **retained** the 2015 standard of .070 ppm. In August 2023, U.S. EPA **initiated a new review** of the ozone NAAQS.

16 U.S. EPA, **Air Quality Design Values**, Ozone Design Values, 2022. Data for this chart is based on overlapping three-year averages beginning with 2000–2002 and ending with 2020–2022.

17 U.S. EPA, **Air Pollutant Emissions Trends Data**, State Tier 1 CAPS Trends, Criteria pollutants State Tier 1 for 1990–2023.

18 U.S. Energy Information Administration, **State Energy Data System (SEDS): 1960–2021**.

19 More information on U.S. EPA Clean Air Markets Programs can be found **here**, and include the **Acid Rain Program** (ARP), the **Cross-State Air Pollution Rule** (CSAPR), and the **CSAPR Update**.

20 U.S. EPA, "**State-by-State SO_2 Emissions from CSAPR and ARP Sources, 1990–2022**," September 18, 2023.

21 More information on U.S. EPA Clean Air Markets Programs can be found **here**, and include the **Acid Rain Program** (ARP), the **Cross-State Air Pollution Rule** (CSAPR), and the **CSAPR Update**.

22 U.S. EPA, "**State-by-State SO_2 Emissions from CSAPR and ARP Sources, 1990–2022**," September 18, 2023.

23 U.S. Energy Information Administration (EIA), **State Energy Data System (SEDS): 1960–2021**; U.S. EIA, **Energy-Related CO_2 Emission Data Tables**, Table 1. State energy-related carbon dioxide emissions by year.

24 U.S. Energy Information Administration, **Energy-Related CO_2 Emission Data Tables**, Table 7. Carbon intensity of the economy by state.

25 U.S. EPA recognizes that there will be differences between the EPA's state-level GHG estimates and some inventory estimates developed independently by individual state governments. Inventory data presented **here** should not be viewed as official data of any state government. More information is available **here**, including official state greenhouse gas inventories **here**.

26 U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks **defines electric power sector emissions** as involving "the generation, transmission, and distribution of electricity. Carbon dioxide (CO_2) makes up the vast majority of greenhouse gas emissions from the sector, but smaller amounts of methane (CH_4) and nitrous oxide (N_2O) are also emitted. These gases are released during the combustion of fossil fuels, such as coal, oil, and natural gas, to produce electricity."

27 U.S. EPA, ***Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990–2022***, April 2024. See U.S. EPA's **Greenhouse Gas Inventory Data Explorer.** The **executive summary** of the report notes that the energy inventory sector "contains emissions of all greenhouse gases resulting from stationary and mobile energy activities including fuel combustion and fugitive fuel emissions, and the use of fossil fuels for non-energy purposes.

28 U.S. EPA, **2022 Toxic Release Inventory (TRI) National Analysis**, October 2023.

29 U.S. EPA Toxic Release Inventory Explorer, **2022 TRI Factsheets**.

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33 See **EPA/State Air Dashboard**, part of **Enforcement and Compliance History Online** (ECHO). Data accessed March 22, 2024.

34 U.S. EPA, ***Our Nation's Air: Trends Through 2022***, Section: "Economic Strength with Cleaner Air," June 2023.

Sources

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[37] International Energy Agency (IEA), ***World Energy Outlook 2023***, October 2023. See IEA's **World Energy Mix**.

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[39] World Health Organization, "**WHO global air quality guidelines: particulate matter ($PM_{2.5}$ and PM_{10}), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide**," September 22, 2021.

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[44] NASA Earth Observatory, "**Fire**," maps show the locations of actively burning fires around the world on a monthly basis, based on observations from the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite. The colors are based on a count of the number (not size) of fires observed within a 1,000-square-kilometer area.

[45] More information about NASA's Terra satellite is available **here**.

[46] International Energy Agency, ***Greenhouse Gas Emissions from Energy, Highlights***, August 2, 2023. See IEA's **Greenhouse Gas Emissions from Energy Data Explorer**.

[47] U.S. EPA, **Air Quality—National Summary: Air Quality Trends**, Last updated November 1, 2023.

[48] NASA Air Quality Observations from Space, "**Nitrogen Dioxide**," Last updated November 30, 2023.

[49] U.S. EPA, **Air Quality—National Summary: Emissions Trends**, Last updated November 1, 2023. Note: EPA estimates nationwide emissions of ambient air pollutants and the pollutants they are formed from (their precursors). These estimates are based on actual monitored readings or engineering calculations of the amounts and types of pollutants emitted by vehicles, factories, and other sources. Emission estimates are based on many factors, including levels of industrial activity, technological developments, fuel consumption, vehicle miles traveled, and other activities that cause air pollution. See U.S. EPA's **Air Pollutant Emissions Trends Data**.

[50] U.S. EPA, **Air Quality—National Summary: Emissions Trends**, Last updated November 1, 2023.

[51] U.S. EPA, **Air Pollutant Emissions Trends Data**, National Tier 1 CAPS Trends, Criteria pollutants National Tier 1 for 1970–2023.

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[54] A list of areas protected by the Regional Haze Program is available **here**.

[55] U.S. EPA, ***Our Nation's Air: Trends Through 2022***, Section: "Visibility Improves in Scenic Areas," June 2023.

[56] U.S. EPA, *2022 Toxics Release Inventory National Analysis*, **Air Releases**, March 2024. These releases include both fugitive air emissions and stack air emissions. Fugitive air emissions are defined as chemical releases to the air that are not released through stacks, vents, ducts, pipes, or any other confined air stream. Stack air emissions are defined as chemical releases to the air that occur through stacks, vents, ducts, pipes, or any other confined air stream.

[57] U.S. EPA, *2022 Toxics Release Inventory National Analysis,* ***Executive Summary***, March 2024.

[58] U.S. EPA, *2022 Toxics Release Inventory National Analysis*, **Air Releases by Chemical & Industry**, March 2024.

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[60] U.S. EPA, ***Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990–2022***, April 2024. See U.S. EPA's **Greenhouse Gas Inventory Data Explorer**. The **executive summary** of the report notes that the energy inventory sector "contains emissions of all greenhouse gases resulting from stationary and mobile energy activities including fuel combustion and fugitive fuel emissions, and the use of fossil fuels for non-energy purposes.

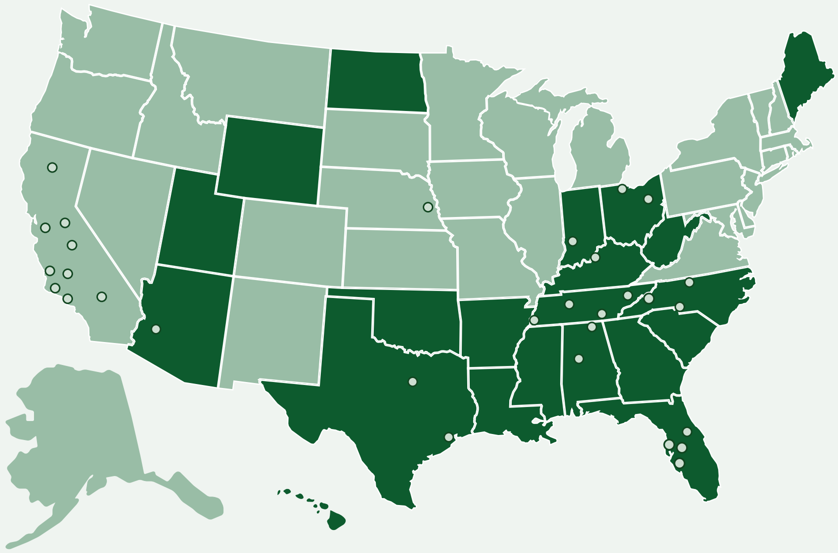
[61] U.S. Energy Information Administration, **Energy-Related CO_2 Emission Data Tables**, Table 1. State energy-related carbon dioxide emissions by year (1970–2021).

[62] U.S. Energy Information Administration, **State Energy Data System (SEDS): 1960–2021**.

Air Quality Resources

AAPCA State Agencies

- Alabama Department of Environmental Management
- Arizona Department of Environmental Quality
- Arkansas Division of Environmental Quality
- Florida Department of Environmental Protection
- Georgia Environmental Protection Division
- Hawaii Department of Health
- Indiana Department of Environmental Management
- Kentucky Division for Air Quality
- Louisiana Department of Environmental Quality
- Maine Department of Environmental Protection
- Mississippi Department of Environmental Quality
- North Carolina Department of Environmental Quality
- North Dakota Department of Environmental Quality
- Ohio Environmental Protection Agency
- Oklahoma Department of Environmental Quality
- South Carolina Department of Health & Environmental Control
- Tennessee Department of Environment & Conservation
- Texas Commission on Environmental Quality
- Utah Department of Environmental Quality
- West Virginia Department of Environmental Protection
- Wyoming Department of Environmental Quality



AAPCA Local Agencies

- Asheville-Buncombe Air Quality Agency (NC)
- Butte County Air Quality Management District (CA)
- Canton City Health Department Air Pollution Control Division (OH)
- Chattanooga-Hamilton County Air Pollution Control Bureau (TN)
- City of Fort Worth Environmental Quality Division (TX)
- City of Huntsville Natural Resources Office (AL)
- City of Indianapolis (IN)
- El Dorado County Air Pollution Control District (CA)
- Environmental Protection Commission of Hillsborough County (FL)
- Forsyth County Office of Environmental Assistance & Protection (NC)
- Galveston County Health District, Air & Water Pollution Services (TX)
- Jefferson County Department of Health, Air & Radiation Protection Division (AL)
- Knox County Air Quality Management (TN)
- Louisville Metro Air Pollution Control District (KY)
- Manatee County Environmental Protection Division (FL)
- Maricopa County Air Quality Department (AZ)
- Mecklenburg County Air Quality (NC)
- Mojave Desert Air Quality Management District (CA)
- Nashville-Davidson Metro Public Health Department (TN)
- Omaha Air Quality Control Division (NE)
- Orange County Air Quality Management (FL)
- Pinellas County Air Quality Monitoring Program (FL)
- San Joaquin Valley Air Pollution Control District (CA)
- Shelby County Health Department (TN)
- Toledo Division of Environmental Services (OH)
- Ventura County Air Pollution Control District (CA)
- Yolo-Solano Air Quality Management District (CA)

Additional Air Quality Resources

- U.S. EPA Air Quality Trends Website
- U.S. EPA Nonattainment Areas for Criteria Pollutants (Green Book)
- U.S. EPA Report on the Environment (ROE) Website
- U.S. EPA Air Quality Index (AQI)
- U.S. EPA Power Plant Emissions Trends
- The Environmental Council of the States (ECOS)
- Western Regional Air Partnership (WRAP) Regional Haze Planning Work Group

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