



# 30 Years of HEI Science and American Air Quality Progress

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# EPA's Mission: Protect human health and the environment

Follow the Science



Follow the Law



Advance Justice and Equity



Be Transparent





# EPA's Office of Research and Development

Provides the scientific foundation for EPA to execute its mandate to protect human health and the environment.

1. *Innovative and anticipatory* research addressing a range of EPA program and regional needs to identify and solve longer term environmental challenges.
2. Research to support Agency priorities and to assist states, tribes, and communities with addressing *environmental challenges*.
3. Technical support to *respond to environmental crises and needs*, large and small.





# ORD Science Informs Decisions





# EPA's Relationship to HEI

- HEI was established as a public-private partnership with equal funding from EPA and the motor vehicle industry. Within EPA, HEI is funded through a science & policy partnership with equal funding coming from:

**Office of Air & Radiation**

**Office of Research & Development**

*Air, Climate, Energy Research Program*

- EPA provides input to HEI through:
  - Comments on HEI's 5-Year Strategic Plans and draft Request for Applications
  - Annual meetings of the sponsors with the Health Effects Research Committee
  - HEI staff outreach to all sponsors to listen and gather information
- Over time, HEI has become a significant part of our research program, addressing high priority science challenges.



# The Value of the HEI Approach

- Part of the success of HEI as a source of trusted and relevant science is due to features of its organizational structure.
- HEI's leaders have managed the relationship with sponsors and continually adapted to meet evolving needs for policy-relevant science.

## Producing Trusted Science

- Shared Funding
- Independent Scientific Committee Structure
- Rigorous Oversight and Review Procedures
- Careful Avoidance of Conflicts of Interest

## Producing Relevant Science

- Responsiveness to Sponsor Needs
- Anticipating Needs and Future Challenges
- Flexibility in Research & Assessment Approaches
- Effective Communication of Questions and Conclusions

- HEI has employed a wide range of approaches to meet sponsor needs:
  - Large epidemiological studies
  - Targeted exploratory studies
  - Comprehensive literature assessments
  - Focused workshops
  - Supporting young investigators.



# 1994 to Today

## 1994

CO emissions: 134 million tons  
CO concentration: 5.8 ppm (8 hr avg)

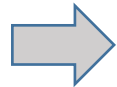
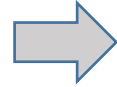
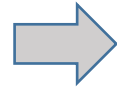
NO<sub>x</sub> emissions: 25 million tons

SO<sub>2</sub> emissions: 22 million tons

O<sub>3</sub> concentration: 84 ppb (8 hr avg)

PM<sub>10</sub> concentration: 73 µg/m<sup>3</sup> (24 hr avg)

PM<sub>2.5</sub> was not a metric used [13 µg/m<sup>3</sup> in 2000]



## Today

63 million tons (2022)  
1.2 ppm (2021)

8 million tons (2022)

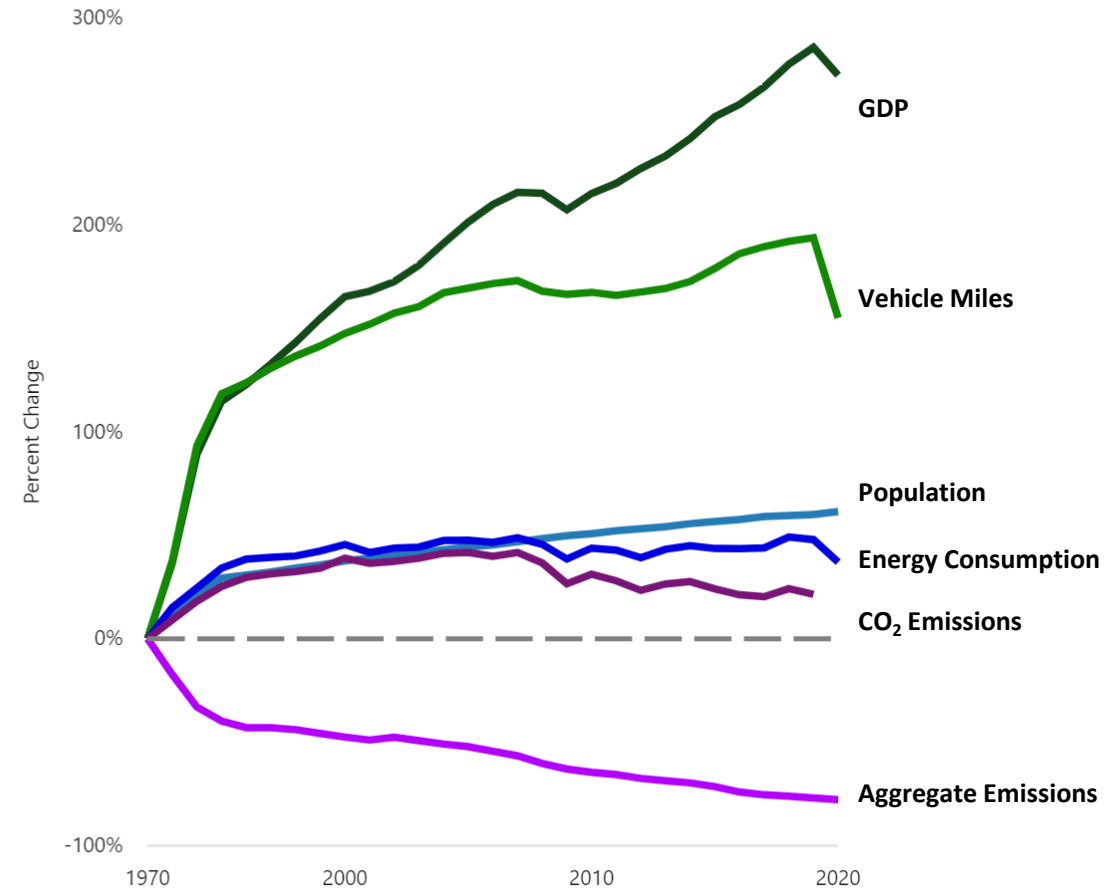
2 million tons (2022)

67 ppb (2021)

60 µg/m<sup>3</sup> (2021)

8 µg/m<sup>3</sup> (2021)

Comparison of Growth Areas and Declining Emissions  
1970-2020



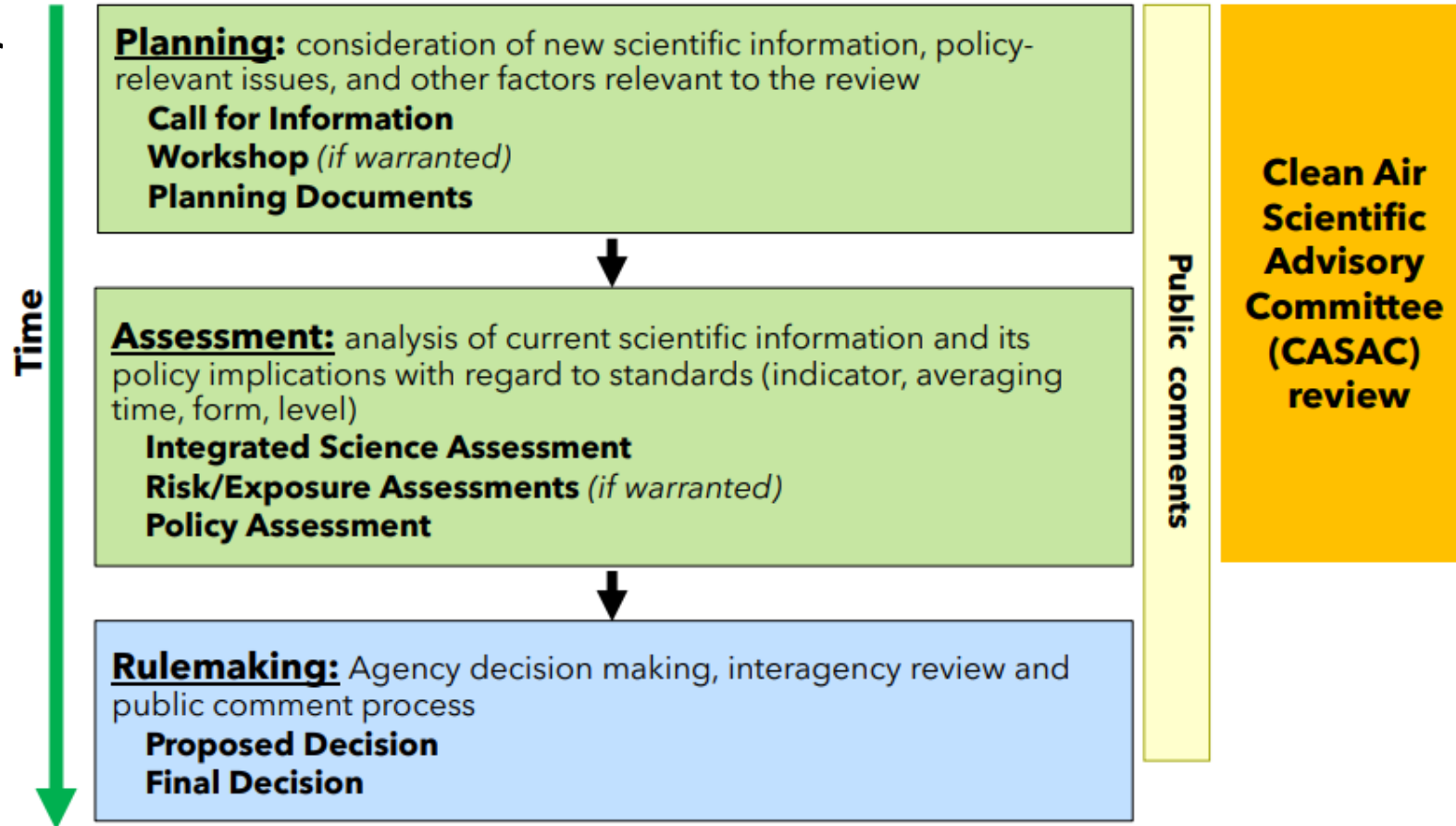


# National Ambient Air Quality Standards

EPA sets National Ambient Air Quality Standards (NAAQS) for six principal air pollutants

- Ground-level ozone
- Particulate matter
- Oxides of nitrogen
- Oxides of sulfur
- Carbon monoxide
- Lead

The Clean Air Act requires EPA to review these standards every 5 years





## Air Quality Criteria Documents (*then*) and Integrated Science Assessments (*now*)

- Form the scientific foundation for the NAAQS review
- Comprehensive evaluation and synthesis of the policy-relevant scientific information
  - Characterization of strengths and uncertainties of the evidence
  - Draw conclusions on causality for health and welfare effects
  - Characterize evidence for at-risk populations
  - Assess evidence for dose/concentration response relationships





# HEI leadership informing decisions on the NAAQS *(then...)*

- Harvard Six Cities and American Cancer Society Studies
  - Panel formation, public meetings and workshops
  - Special reanalysis report
    - Rigorous independent replication and validation of air pollution mortality findings
    - Sensitivity analyses
- Impact on the NAAQS
  - HEI weighed in on research instrumental in informing decisions to establish new Primary and Secondary 24-hour and annual PM<sub>2.5</sub> standards





# HEI leadership informing decisions on the NAAQS (...and now)

- Effects of Exposures to Low Levels of Air Pollution
  - HEI funded major investigations in the U.S., Canada, and Europe
  - Investigators applied novel approaches for confounder control (i.e., causal inference approaches)
- Impact on the NAAQS
  - Studies address a critical uncertainty with regard to the persistence of health effects at low ambient concentrations
  - Provide support for EPA's current proposal to revise the annual PM<sub>2.5</sub> standard





# HEI's leadership in understanding the health impacts of Traffic

- Critical reviews of Traffic-Related Air Pollution and Health
  - HEI created expert panels to critically evaluate the growing literature about near-roadway exposure and health
  - Panel critically reviewed epidemiology and experimental studies, applied weight-of-evidence determination
  - HEI communicated results to global audiences, helping inform decision making in many places
  - Remains HEI's most-accessed report for over 10 years
  - In 2022, HEI published: "Systematic Review and Meta-analysis of Selected Health Effects of Long-Term Exposure to Traffic-Related Air Pollution"
- Strengthening Mobile Source Regulations
  - Provided robust public health basis for national rules, including the Tier 3 vehicle and fuel standards
  - Informed consideration of health in decisions about new transportation infrastructure (e.g., NEPA)



SPECIAL REPORT 17

HEALTH  
EFFECTS  
INSTITUTE

January 2010

PRESS  
VERSION  
January 12, 2010

**Traffic-Related Air Pollution:  
A Critical Review of the Literature  
on Emissions, Exposure, and  
Health Effects**

HEI Panel on the Health Effects  
of Traffic-Related Air Pollution







# HEI's leadership in understanding the health impacts of New Technology

- Advanced Collaborative Emission Study (ACES)
  - In collaboration with the Coordinating Research Council (CRC), obtained pre-production prototype heavy-duty diesel engines meeting EPA's 2007 and 2010 emission standards
  - Gathered the expertise and insight of top industry and government experts in diesel technology
  - ACES demonstrated greatly reduced PM and toxicity from new diesel technologies
- Impact on Diesel Programs
  - ACES underscored the tremendous public health benefits that EPA's diesel standards are achieving

HEI

December 2015



The Advanced Collaborative  
Emissions Study (ACES)

EXECUTIVE SUMMARY

Health Effects Institute



## Other examples of HEI input informing NAAQS reviews

- National Particle Component Toxicity (NPACT, 2013)
  - Improved understanding of PM composition and particle toxicity
  - Informed causal conclusions in the 2019 ISA for PM
- Multicenter Ozone Study in oldEr Subjects (MOSES, 2017)
  - Provided critical information on our understanding of ozone-associated cardiovascular effects
  - Informed causal conclusions in the 2020 ISA for Ozone and Related Photochemical Oxidants
- Accountability Studies
  - Provided critical evaluations of the public health impacts of air pollution policies and regulations



# Ongoing Research Needs

- **Multi-Pollutant, Multi-Stressor Exposures & Effects**
  - Contributions to Cumulative Exposure and Impacts
- **Near-Road Exposure & Health Impacts**
  - Changing Transportation Technologies
  - Non-Tailpipe Emissions
  - Role of Land Use, Noise, and Other Stressors
  - Evaluation of Green Infrastructure and other Solutions
- **Environmental Justice & Distributional Impacts**
  - Air Toxics and Criteria Pollutant Exposures
  - Quantifying Differences in Exposures (from Sensors and Satellites)
  - Identifying Differences in Responses
  - Multiple Scales of Interest, from Neighborhood to National
- **Climate, Air Quality, & Health Linkages**
  - Vulnerable Populations
  - Temperature and Humidity as Health Effect Modifiers
  - Impacts of Adaptation & Mitigation Measures on Air Quality & Health
- **Indoor Exposure & Health Impacts**



# Addressing Evolving Challenges

- **Evolving Transportation and Energy Technology and Behavior**
  - Understanding Benefits and Unintended Consequences of Electrification and Non-Fossil Fuels
  - Mitigating the Impact of the Legacy Fossil-Fueled Fleets and Facilities
- **Understanding and Mitigating Inequities in Environmental Protection**
  - Understanding the Cumulative Impacts of Exposures to Pollutants and Other Stressors
  - Identifying and Mitigating Sources in Overburdened Communities
  - Anticipating and Mitigating Inequities Resulting from Transitions to Clean Energy
- **Harnessing New Methods and Data Sources**
  - From Satellite Observations to Low Cost Sensors
  - From Medical Records Databases to Cell Phone Tracking
  - Computational Toxicology and New Approach Methods
- **Addressing the Global Public Health Challenge of Air Pollution**
  - Improving the Common Knowledge Base for Setting Standards and Targets (e.g., with WHO, EU, and beyond)
  - Creating Awareness and Motivating Action (through GBD and State of Global Air)
  - Building Technical Capacity and Sharing Lessons Learned (e.g., India, Africa)
- **Meeting Increasing Expectations for Transparency and Data Access**
  - Leading by Example to Create Transparency and Provide Access to Policy-Relevant Research Data