



# Science in Service to Community

# This Annual Report is Dedicated to HEI President Emeritus Daniel S. Greenbaum 1952–2024



Dan joined the Health Effects Institute in 1994. During his 29-year tenure, he was the visionary leader and guiding hand who helped HEI become a highly respected and globally recognized trusted expert on the health effects of air pollution, leading to numerous important air quality decisions.

Over the years, Dan served as a champion, a partner, a mentor, and a friend to countless sponsors, scientists, researchers, policymakers, colleagues, HEI staff, and many others. So much of the organization's success seen throughout these pages and other annual reports traces back to Dan's incredible commitment and dedication to improving the environment and the health of millions of people around the world.



# A Message From the Chair

In mid-2023, I wrote to many of you about the exciting news that the HEI Board of Directors had selected Elena Craft as the Institute's new President, following 29 years of exceptional growth and progress under Dan Greenbaum. I am pleased to say that barely six months after her start, Elena's vibrant leadership and vision for HEI have already taken hold.

Nowhere is Elena's leadership more apparent than in fostering an entrepreneurial responsiveness among staff to produce independent science to meet the emerging challenges faced by HEI's government and industry sponsors as they work to develop new fuels and technologies, promulgate effective regulations when needed, and make health-based energy choices to meet the daunting challenges of the energy transition.

I am especially pleased to report that as part of the process of introducing Elena to the HEI community, I had the privilege of meeting with senior leaders from both industry and government that sponsor HEI. In addition to sharing the Board's leadership decision, I also took the opportunity to ask for honest feedback on HEI's past and current performance, and importantly, on

how the Institute might best contribute in the coming years. I greatly enjoyed these personal conversations and was gratified to hear that HEI and the science we provide continue to be held in such high regard. Examples included studies that have informed national air quality standards, tracked progress made in reducing vehicle emissions while new gaps in knowledge were identified, and assessed the effectiveness of environmental regulations in improving public health, especially in historically disadvantaged communities.

I also heard about many opportunities that lie ahead for HEI to provide trusted and responsive science as its mission evolves to meet the needs of our sponsors and our stakeholder communities in the coming years. These opportunities, primarily driven by the broader need to decarbonize and compete in a global marketplace, begin with upstream energy production and extend through end stage carbon capture, including full battery, electric, hydrogen, and other new technologies and fuels that are still emerging. For the first time the larger energy transition will require HEI to not only respond to known questions around exposures and health effects, but anticipate questions that may arise around emerging technologies and provide

trusted science that minimizes risk from unintended consequences associated with these technologies. Finally, in looking ahead, we must continue to be mindful of the remaining unfinished business around emissions and exposures from legacy sources fueled by fossil fuel combustion and the communities that may be impacted.

As HEI looks to the future, I am confident that under the leadership of President Craft and her team, HEI's unique role in bringing diverse stakeholders together to identify key questions and respond to those questions with impactful science will continue and grow.

As always, the Board of Directors and all of us at HEI are grateful for the ongoing support from our many sponsors in government, industry, and global philanthropy.

Yours,



Richard A. Meserve  
*Chair, HEI Board of Directors*



# A Message From the President

**A**s we reflect on a year of growth and transition, it is with great pride that we share HEI's achievements in advancing Science in Service to Community, the theme of this report.

Operating at the nexus of science and policy, HEI remains a steadfastly neutral and trusted broker in funding research that informs discourse on impactful public health policies around the world. In the United States, the Environmental Protection Agency has strengthened the air quality standard for fine particulate matter (PM), based in part on HEI-funded research. And in Europe, findings from our work on health implications of exposure to low PM concentrations have informed decisions by the European Council and the European Parliament, which in early 2024 reached a provisional political agreement on toughening the Ambient Air Quality Directive (see page 6).

In the HEI Energy program, our community exposure research has begun delivering results that can inform health-protective decisions about oil and gas development. As research continues, we expect further impacts across the broader energy transition. We're also planning for the design of a cumulative impact assessment that can help jump-start assessments for communities that may be impacted by oil and gas operations. Other

aspects of our ambitious Energy program portfolio include ongoing "Energy & Health" webinars and participating in regional decarbonization efforts, along with hosting workshops and activities that foster collaboration among HEI staff, researchers, and communities.

HEI's Global Health program has continued gaining momentum as well, with new work in East Africa, where researchers and practitioners have convened and launched a review of current evidence on air pollution and health. In India, we've begun a program funding new regional "accountability" studies, which examine how effectively air pollution policies achieve air quality goals. At the same time, our State of Global Air report continues to inform policymakers and citizens around the world with detailed information on regional sources and health implications of air pollution.

HEI's new Environmental Justice program released its first RFA in July 2023 to explore how air quality policies, actions, or interventions have helped or hurt marginalized communities in the United States. The first funded research projects are expected to be underway later this year.

HEI-funded investigators have been evaluating the effectiveness of diesel school bus replacement programs and transportation and energy policies in reducing emissions and improving human health. They

have also been researching factors that influence exposure and identifying approaches to improve exposure assessment. In addition, the



first of five HEI-funded studies examining the relationship between air pollution exposure and incidence and severity of COVID-19 infections was released in November 2023.

HEI has approved funding for several studies that will evaluate exposure to and health effects of traffic-related air pollutants as fuels and technologies change, the fleet turns over, and electrification makes greater inroads. These contributions will no doubt provide valuable insights in understanding the complex nature of air pollution in the context of other stressors.

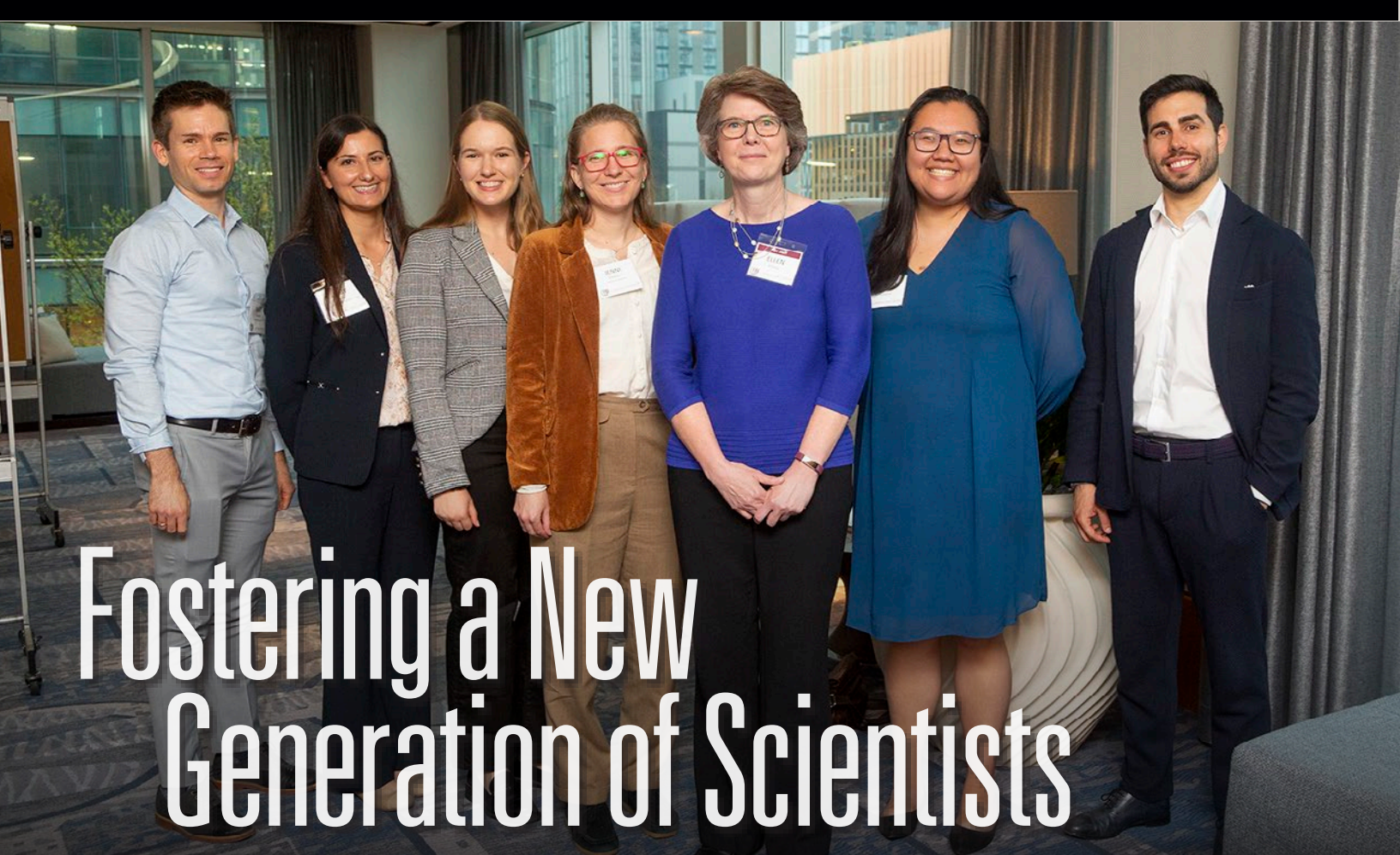
As we look toward an ambitious year ahead, including developing a new five-year strategic plan, I am eager to continue HEI's legacy of providing the highest quality impartial science to support a cleaner environment, a thriving economy, and healthier communities.

Yours,

A handwritten signature in black ink, appearing to read "E.C. Craft".

Elena Craft  
President





# Fostering a New Generation of Scientists

HEI Director of Science Ellen Mantus, third from right, with recipients of the 2023 Jane Warren Award. Each year this program funds students in the environmental sciences to present research as part of HEI's Annual Conference.

Even as we celebrate new advances and insights, we know that science is never “finished.” Challenges constantly emerge; the quest to understand our world spans generations. To empower tomorrow’s scientific leaders, HEI creates mentorship and funding opportunities for students and early-career scientists to pursue meaningful research on the health effects of air pollution. By investing in promising new researchers, we strengthen the next generation’s capacity to ask and answer vital questions that we can only imagine today.

## Jane Warren Awards

A gathering known for its combination of cutting-edge science and collegiality, HEI’s [Annual Conference](#) is an ideal venue for emerging researchers to share their work and exchange ideas with the broader scientific community. The prestigious [Jane Warren Conference Award](#) is presented each year to six applicants whose research abstracts align with HEI’s mission to provide high-quality and impartial science on air pollution and related health effects.

Winners are invited to present a poster and lightning talk on their research at the conference. The 2023 awardees presented on inno-

vative machine learning techniques and air cleaning technologies, racial and ethnic disparities in pollution exposure and impacts, short- and long-term health impacts of pollution exposure, and opportunities for using data to prioritize air pollution interventions.

## Rosenblith New Investigators

The [Walter A. Rosenblith New Investigator Award](#), established in 1999, has helped jump-start the careers of many new scientists. Each award provides three years of funding for an investigator at the assistant professor or equivalent level to pursue research relevant to



## 2023 Rosenblith Awardees



**Yoshira Ornelas Van Horne**  
Columbia University



**Rachel Nethery**  
Harvard University

HEI's interests. Rosenblith investigators have published more than 30 studies to date, including Manabu Shiraiwa, whose HEI study *Chemical and Cellular Formation of Reactive Oxygen Species from Secondary Organic Aerosols in Epithelial Lining Fluid* was published in early December 2023. Also during the fall, HEI selected two new Rosenblith awardees (see above).

## Summer Fellowships

HEI's new [Summer Fellowship program](#) had a highly successful start in 2023. Launched in collaboration with the [International Society of Exposure Science](#) and the [International Society for Environmental Epidemiology](#), with additional support from the [Burroughs Wellcome Fund](#) and other donors, the program pairs established environmental health researchers with undergraduates from backgrounds that have historically been underrepresented in the field. In its inaugural year, the pro-

## Ensuring Equity Within HEI

Consistent and sustainable progress toward HEI's diversity, equity, and inclusion (DEI) goals has been a driving intention throughout 2023. The success of the 2023 Summer Fellowship program is a milestone in HEI's ongoing commitment to creating equitable pathways into the environmental health sciences. Internally, too, we reflect these values by thoughtfully maintaining an organizational culture where all staff feel a sense of equity and belonging.

A central goal of this initiative is to empower staff to incorporate DEI principles into their work by identifying and sharing resources, providing regular learning opportunities, maintaining a central record of DEI-focused work throughout the organization, and helping to prioritize DEI activities across all its departments.

In 2023, the DEI Committee, which consists of five staff members representing HEI's science, administrative, and communications departments, continued its focus on evaluating internal policies and procedures as well as developing a 2024 HEI DEI Plan.

## 2023 Summer Fellows



**Diana Abigail Cantoran-Perez**  
University of California, Berkeley. *Mentor: Jun Wu, University of California, Irvine*



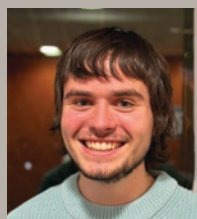
**Thomas Elijah Ealey**  
Savannah State University. *Mentor: Yang Liu, Emory University*



**Andrew Gallego**  
Boston University. *Mentor: Sally Pusede, University of Virginia*



**Alyssa Aminata Kamara**  
University at Albany. *Mentor: Yanelli Nunez, PSE Healthy Energy*



**Kai Kibilko**  
Brandeis University. *Mentor: Jon Levy, Boston University*



**Kyara Ralliford**  
Columbia University. *Mentor: Robin Dodson, Silent Spring Institute*



**Lawrence Tran**  
University of California, Los Angeles. *Mentor: Regan Patterson, University of California, Los Angeles*

gram [awarded seven students](#) (see above) \$6,500 each to spend 10 to 12 weeks of their summer gaining direct experience in laboratory and

departmental research activities. Following this impressive launch, planning is now underway for the 2024 Summer Fellowships.





# New Directions for 2025–2030

In a complex world with myriad competing priorities, HEI puts public health front and center to focus on what it does best: delivering high-quality, impartial science relevant to the pressing environmental decisions facing humankind.

Our work is guided by a comprehensive strategic research plan, developed every five years, that lays out a cohesive vision for HEI’s programs. As we approach the close of the current cycle and begin the process of developing the 2025–2030 Strategic Plan, we’re reflecting on progress made while looking ahead at the evolving priorities for HEI’s sponsors and the scientific community. We’re also soliciting feedback from our sponsors on the research priorities to inform our work moving forward.

The current (2020–2025) strategic plan outlines four key



priority areas for HEI: accountability research to test the links between air quality interventions and health; complex questions for the air pollution mixture; global health; and transport and urban health. Targeted and cross-cutting initiatives are advancing progress in all of these important areas. The [HEI Energy](#) program (page 10) complements this work with a focus on understanding community impacts from oil and gas development.

## Initiatives with Impact

Funding studies and convening experts are two primary ways that HEI supports scientific progress

and facilitates science-informed decision making. For example, a [Request for Applications](#) issued in early 2023 will fuel a new wave of investigations into the health effects of long-term exposure to traffic-related air pollution. Funded studies will build upon novel and improved methods to evaluate exposure in the context of a shifting mobility landscape, including changing technologies and fuels as well as inroads toward electrification. Under another initiative, 2023 saw the launch of [two new studies on the health effects of non-tail-pipe emissions](#), including those from the use and wear of brakes and tires.



HEI's Environmental Justice (EJ) program has begun soliciting applications aimed at identifying ways to reduce environmental health inequities, and it has carried out initiatives to incorporate concepts of equity and justice into HEI's scientific activities (see page 7).

Events convened by HEI in the past year, including major workshops in the United States and Europe (see below), have been instrumental in

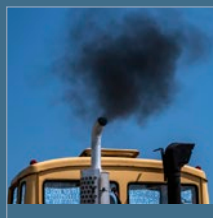
translating scientific insights into policy-relevant discussions and decisions. A session at HEI's 2023 Annual Conference, building upon our [major review of the literature published in 2022](#) and other recent developments, brought mobility to the forefront. Experts discussed how environmental, social, behavioral, and other factors interact to influence traffic-related air pollution and its health impacts.

HEI also co-hosted a workshop in Nairobi (see page 8) to review current data on air quality and associated health effects in East Africa and to identify strategies for technical collaborations. In addition, continuing its engagement in South Asia and longstanding accountability work, HEI initiated a study to quantify the impact of India's National Clean Air Program on air quality across major cities.

## Sharing Science, Informing Policy

In meetings that we host and cosponsor, government officials, industry representatives, and scientists learn from HEI's work and each other as they consider research priorities and continental-scale policy changes. Here are two recent examples.

### Understanding PM Health Effects



It is well established that exposure to particulate matter (PM) air pollution contributes to millions of premature deaths each year. Recent studies by HEI and others have detected PM health effects at doses previously considered too low to affect health. Yet the toxicity of this widespread

pollutant varies by source, composition, and size — complicating efforts to pinpoint which sources are most harmful and inform interventions and regulatory standards. At the same time, many PM sources are in a state of flux amid technological, economic, and environmental changes.

In 2024, HEI will embark on an ambitious new effort to refine understanding of PM health effects against this changing landscape. To begin to scope this new research program, HEI gathered 40 experts from academia, industry, and government for a two-day workshop in December 2023. Alongside an international array of scientists, participants hailed from the U.S. Army Corps of Engineers, Department of Defense, National Institute for Environmental Health Sciences, California EPA and California Air Resources Board, and the Dutch National Institute for Public Health and the Environment, as well as from HEI sponsors including EPA, Cummins, ExxonMobil, Manufacturers of Emission Controls Association, and Toyota. They explored research needs and priorities surrounding the biological plausibility of health effects at low-dose exposures; the complexities of assessing

health impacts of outdoor air pollution when indoor environments can modify personal exposures; the long-term health effects of episodic air pollution events such as wildfire smoke; and questions around emerging particulates such as brake and tire wear and microplastics. Based on the priorities identified at the workshop, HEI staff and research advisors will collaborate to develop a request for applications and share a vision of future PM research needs with the broader scientific community.

### Our Impact in Europe



The Ambient Air Quality Directive (AAQD) is a major European law setting limits on air pollutants. In early 2024 the European Parliament and European Council reached a provisional political agreement on a proposal to tighten the AAQD with the aim of providing important benefits to public health. The proposal calls for lowering annual limit values for fine particulate matter and nitrogen dioxide across the EU by 2030 and full alignment with the 2021 World Health Organization (WHO) Air Quality Guidelines by 2035.

A trio of HEI-funded studies have played a significant role in helping to inform Europe's deliberations over air quality. They were conducted as part of a comprehensive HEI research initiative to investigate the health effects of long-term exposure to low levels of air pollution in [Europe](#), [Canada](#), and the [United States](#). Their findings were in the spotlight at a meeting that HEI co-hosted in May 2023 with the European Respiratory Society and the International Society for Environmental Epidemiology. EU and WHO officials joined leading scientists for the daylong event in Brussels, Belgium, to discuss scientific and policy questions relevant to the proposed AAQD revisions. (A [workshop summary](#) appears in the *European Respiratory Journal*.)







# Including Community Voices in Science

In fall 2022, HEI hosted a workshop in Atlanta, Georgia, where scientists, community leaders, and others shared knowledge and identified best paths forward for HEI's environmental justice efforts.

Everyone has a stake in clean air. But some communities have been left out of the processes through which decisions affecting air quality are carried out. In the United States, historically marginalized populations often suffer disproportionate environmental exposures and health impacts as a result of this legacy of exclusion and discrimination.

Environmental justice (EJ) demands the fair treatment and meaningful involvement of people directly impacted by activities that affect their environment. To move toward addressing historic injustices and the needs of communities overburdened by environmental pollutants, HEI has launched a suite of new research and programmatic initiatives aimed at promoting equity. As part of these efforts, HEI supports community-engaged research that delivers meaningful science with meaningful solutions.

---

## We seek to bring scientists and communities together to deliver meaningful science with meaningful solutions.

---

A new Advisory Council and Oversight Panel guide and oversee HEI's EJ efforts. Both groups are comprised of experts in environmental health, community engagement, air pollution modeling and monitoring, epidemiology, and biostatistics. The Advisory Council identifies high-priority research areas and other initiatives for advancing EJ, helps develop research solicitations and guidance documents related to community engagement, and offers guidance on integrating EJ considerations into HEI-wide activities. The Oversight Panel develops requests for proposals, recommends studies

and programs for funding, and provides study oversight and feedback.

HEI's EJ program will fund studies that evaluate policies or interventions at the national, regional, tribal, state, or local level that have affected or could affect ambient or indoor air quality, exposure, or health outcomes in historically marginalized communities in the United States. The program's first [Request for Applications](#) is modeled after HEI's successful accountability research program, which assesses health outcomes from air quality actions. In 2024 a second RFA will solicit proposals for cumulative impacts research.

HEI Energy has also been active in incorporating community perspectives into its research programs on the potential impacts of unconventional oil and gas development (see page 10).





# Expanding Our Global Impact

From left, HEI's Pallavi Pant and Victor Nthusi with members of the Eastern Africa GEOHealth Hub research team at the University of Nairobi, Kenya: Beldine Okoth, Lydia Okolla, Noah Adera and Stephen Anyango. The team, led by Otienoh Oguge, has been collecting real-time air quality data in Nairobi as part of the project's ongoing air pollution exposure assessment focusing on lung function and cognitive development in children.

Pollution does not stop at national borders, but neither do science and innovation. Although every place faces its own set of air quality challenges, experiences and lessons learned in one country can inform interventions and decisions with widespread impacts around the world.

Global collaboration has always been important to HEI, and 2023 saw a marked expansion of our reach with new opportunities for cross-border information sharing and research program development.

## A Focus on Africa

Countries in Africa account for about half of the world's population growth — a trend that is projected to continue over the next few

decades. Unfortunately, Africa is also seeing some of the world's highest levels of air pollution, with detrimental impacts on health and longevity across the continent.

---

## Global collaboration has always been important to HEI, and 2023 saw a marked expansion of our reach.

---

In spring 2023, HEI held a [workshop](#) in Nairobi, Kenya, on air pollution and health in East Africa in partnership with the Stockholm Environment Institute–Africa Centre, World Resources Institute, Eastern Africa GEOHealth Hub, and AirQo with financial support from the Clean Air Fund. The workshop provided a forum for discussing current data and policy

debates along with strategies for strengthening technical expertise on pollution impacts in the region.

HEI followed up the workshop with a four-part East Africa [webinar series](#) in late 2023 and early 2024 featuring local experts to help build momentum for research and programs on air pollution and health in the region.

To provide a foundational resource for future efforts, HEI created [a new interactive database](#) that researchers, journalists, decision-makers, and the public can use to explore published papers and policy briefs relevant to air pollution and health in East Africa.

## Furthering Our Work in India

HEI has also received funding from [Open Philanthropy](#) to conduct a study in India looking at changes in





air quality as a result of the National Clean Air Programme launched in 2019. In addition, HEI recently hired a new India-based consultant to continue our work and oversee this new initiative (see sidebar).

## Global and Regional Resources

Throughout the year, HEI's [State of Global Air](#) initiative released a variety of new [Resources](#) relevant to specific regions, including the European Union and South Asia, providing vital air quality and health information to areas that need it most. In addition, in November 2023, State of Global Air published a story map, [Air Pollution and Health: The Global Impacts of Fossil Fuels](#). This innovative resource provides in-depth insights into the health impacts associated with exposure



Our State of Global Air website has a new look, with improved navigation to access reports, resources, data tools, and informative pages on air pollution's health impact around the world.

to air pollution from fossil fuel combustion, including the role of climate change in pollution's severity, as well as a globally comparable dataset that allows for cross-country comparisons.

## Livestreaming Science

HEI's [Science on the 7th](#) program brings together leading experts to discuss issues at the forefront of air quality and global health in lively 30-minute conversations. With over a dozen episodes to date, the series

## New Staff in Africa, India



HEI's Global Health program now has two consulting research fellows. **Victor Nthusi** (left), based in Nairobi, Kenya, has worked for many years in environmental health and pollution control in low- and middle-income countries in Africa, Asia, and Latin America, and has extensive experience in environmental monitoring and policy evaluation. **Abinaya Sekar** joins us from Delhi, India, where she has worked with leading public policy think tanks to develop a framework for revising India's National Ambient Air Quality Standards and for regulating air quality through a regional approach.

provides a platform for engaging with communities around the world on issues such as children's health, decarbonization, air pollution and climate, gender disparities, the energy transition, and emerging challenges in global regions like Europe, Africa, and Latin America.





# Opening Doors to Engagement

## As HEI Energy expands, scientists and communities connect

A [research team led by Lea Hildebrandt Ruiz](#) of the University of Texas demonstrates mobile instrumentation to community members during their November 2023 public open house in the Eagle Ford Shale region.

The HEI Energy program advances impartial science on the potential community exposure and health effects associated with unconventional oil and gas development. Five initial studies, launched in 2022, are well



underway with two nearing completion, and funding for four additional studies has been approved.

Progress at HEI Energy is reported regularly in quarterly updates, and all of the first five research teams shared their latest updates with poster presentations and recorded interviews during HEI's 2023 Annual Conference in Boston.

Communities near unconventional oil and gas development sites have raised a number of concerns

about their potential exposures and health effects associated with these activities. It is vital that any research in these topic areas is responsive to their needs and priorities. Toward this end, a series of in-person [Community Open House](#) events at several HEI Energy study locations gave residents a chance to meet the investigators and learn about the research underway.

At one such event, held in the North Front Range region of Colorado in August 2023, community members were invited to learn about potential noise and air pollution exposure from oil and gas development, see the equipment being used, ask questions, and share ideas and concerns. Similar events have been held in Loving, New Mexico, and the Eagle Ford Shale region of Texas.

Drawing upon lessons learned

from previous community-engaged research on environmental exposures and health effects, HEI Energy

---

**At study location events, researchers share project goals with community members, hear their concerns, and exchange information.**

---

hosted a [webinar](#) in the summer of 2023. Speakers shared three case studies on successful research collaborations between social scientists and environmental health scientists, providing valuable examples for others involved in similar interdisciplinary work.

In [another webinar](#), held in December, HEI Energy investigators presented their research on





Jennifer Baka of Penn State University (left) with members of her research team and Richard Negrin, secretary of the Pennsylvania Department of Environmental Protection, at a Shale Network Workshop on environment and policy. [Baka's HEI Energy study](#) is focusing on water quality.

potential groundwater contamination related to unconventional oil and gas development in Southwestern Pennsylvania. The team explained their interdisciplinary research approach involving geoscience and community engagement.

## New Work in Appalachia

HEI Energy's initial round of funded studies are part of the Tracking Community Exposures and Releases (TRACER) Collaboration, which aims to understand community exposures to air emissions and noise from unconventional oil and gas development in the Denver-Julesburg region of Colorado, the Permian region of New Mexico, and the Eagle Ford Shale region of Texas. The Collaboration began in 2022 and will continue through 2024 so that investigators can see how levels of exposure vary over time and across seasons. In January 2024, TRACER expanded its geographic reach to the Marcellus region, the country's



A detector stationed near a well pad in Colorado's Denver-Julesburg Basin is monitoring air quality during drilling operations as part of a [study led by Jeffrey Collett](#) of Colorado State University.

top dry shale gas-producing region (see [US Energy Information Administration data](#)), which lies under the Appalachian Basin. TRACER includes a research team, led by Lea Hildebrandt Ruiz of the University of Texas, Austin, that is uniquely positioned to expand its scope of research to the Marcellus region. The new work will dovetail with an existing research collabora-

tion there that involves a separate industry-funded air quality monitoring program. TRACER is scheduled to wrap up in late 2024, with results presented at Community Open Houses in each study region early in 2025.

## More Studies Underway

In October 2023, HEI Energy released two [Requests for Qualifications \(RFQs\)](#) to pursue specific research ideas offered by Energy Research Committee members. With the RFQs, the committee sought qualified research teams to assess trends in air quality and community exposures associated with unconventional oil and gas development operations in one or more US regions, and conduct regional groundwater quality modeling to help understand how documented oil or gas spills from such operations might affect groundwater used as a source of drinking water in the Marcellus region.

Four research teams have been selected for funding and will be invited to present early work in posters at HEI's 2024 Annual Conference along with HEI Energy-funded research teams who began their work in 2022 under the TRACER Collaboration.



# Committees

Current as of early 2024. Institutional affiliations are in USA unless otherwise indicated.

## RESEARCH COMMITTEE

---

### **David A. Savitz, Chair**

Professor of Epidemiology, School of Public Health, and Professor of Obstetrics and Gynecology and Pediatrics, Alpert Medical School, Brown University

### **Benjamin Barratt**

Professor, Environmental Research Group, School of Public Health, Imperial College London, United Kingdom

### **David C. Dorman**

Professor, Department of Molecular Biomedical Sciences, College of Veterinary Medicine, North Carolina State University

### **Christina H. Fuller**

Associate Professor, School of Environmental, Civil, Agricultural and Mechanical Engineering, University of Georgia College of Engineering

### **Marianne Hatzopoulou**

Professor, Civil and Mineral Engineering, University of Toronto; Canada Research Chair in Transport Decarbonization and Air Quality

### **Amy H. Herring**

Sara & Charles Ayres Distinguished Professor of Statistical Science, Global Health, Biostatistics, and Bioinformatics, Duke University

### **Heather A. Holmes**

Associate Professor, Department of Chemical Engineering, University of Utah

### **Neil Pearce**

Professor of Epidemiology and Biostatistics, London School of Hygiene and Tropical Medicine, United Kingdom

### **Evangelia (Evi) Samoli**

Professor of Epidemiology and Medical Statistics, Department of Hygiene, Epidemiology and Medical Statistics, School of Medicine, National and Kapodistrian University of Athens, Greece

### **Alexandra M. Schmidt**

Professor of Biostatistics, School of Population and Global Health, McGill University, Canada

### **Neeta Thakur**

Associate Professor of Medicine, University of California, San Francisco

### **Gregory Wellenius**

Professor, Department of Environmental Health, Boston University School of Public Health and Director, BUSPH Center for Climate and Health

## REVIEW COMMITTEE

---

### **Melissa Perry, Chair**

Dean, College of Public Health, George Mason University

### **Sara D. Adar**

Associate Professor and Associate Chair, Department of Epidemiology, University of Michigan School of Public Health

### **Kiros Berhane**

Cynthia and Robert Citrone-Roslyn and Leslie Goldstein Professor and Chair, Department of Biostatistics, Mailman School of Public Health, Columbia University

### **Ulrike Gehring**

Associate Professor, Institute for Risk Assessment Sciences, Utrecht University

### **Michael Jerrett**

Professor, Department of Environmental Health Sciences, Fielding School of Public Health, University of California, Los Angeles

### **Frank Kelly**

Humphrey Battcock Chair in Community Health and Policy and Director of the Environmental Research Group, Imperial College School of Public Health, United Kingdom

### **Jana B. Milford**

Professor Emerita, Department of Mechanical Engineering and Environmental Engineering Program, University of Colorado

### **Jennifer L. Peel**

Professor of Epidemiology, Department of Environmental and Radiological Health Sciences, Colorado State University, and the Colorado School of Public Health

### **Eric J. Tchetgen Tchetgen**

Luddy Family President's Distinguished Professor, Professor of Statistics and Data Science, The Wharton School, University of Pennsylvania

### **John Volckens**

Professor, Department of Mechanical Engineering, Walter Scott Jr. College of Engineering, Colorado State University

## HEI ENERGY RESEARCH COMMITTEE

---

### **George Hornberger**

Director, Vanderbilt Institute for Energy and Environment, Vanderbilt University

### **Stefanie Ebelt**

Professor of Environmental Health and Epidemiology, Rollins School of Public Health, Emory University

### **Alfred Eustes**

Associate Professor Emeritus, Petroleum Engineering Department, Colorado School of Mines

### **Julia Haggerty**

Associate Professor of Geography, Department of Earth Sciences, Montana State University

### **Kirsten Koehler**

Associate Professor, Department of Environmental Health and Engineering, Bloomberg School of Public Health, Johns Hopkins University

### **Christopher Paciorek**

Adjunct Professor and Research Computing Consultant, Department of Statistics, University of California, Berkeley

### **Armistead (Ted) G. Russell**

Howard T. Tellepsen Chair and Regents Professor of Civil and Environmental Engineering, Georgia Institute of Technology

### **Peter S. Thorne**

University of Iowa Distinguished Chair and Professor, Department of Occupational and Environmental Health, University of Iowa College of Public Health

### **Yifang Zhu**

Professor of Environmental Health Sciences, UCLA Fielding School of Public Health, University of California, Los Angeles

## HEI ENERGY REVIEW COMMITTEE

---

### **Isabelle Cozzarelli**

Research Hydrologist, USGS Geology, Energy, & Minerals Science Center

### **Jim Crompton**

Professor of Practice, Petroleum Engineering Department, Colorado School of Mines

(List continues on next page)



# Committees

Continued from previous page.

## **Elizabeth Mannshardt**

National Science Foundation (serving in personal capacity); Adjunct Associate Professor, North Carolina State University

## **Jun Wu**

Professor of Environmental and Occupational Health, University of California, Irvine

## **ENVIRONMENTAL JUSTICE ADVISORY COUNCIL**

### **Maria Harris**

Senior Scientist, Environmental Defense Fund

### **Mychal Johnson**

Co-Founder, South Bronx Unite

### **Yukyan Lam**

Research Director and Senior Scientist, Tishman Center at the New School

### **Beto Lugo Martinez**

Executive Director, Clean Air Now  
Kansas City

### **Lesliam Quirós-Alcalá**

Assistant Professor, Johns Hopkins Bloomberg School of Public Health

### **Elizabeth Scheehle**

Research Division Chief, California Air Resources Board

## **ENVIRONMENTAL JUSTICE OVERSIGHT PANEL**

### **Jayajit Chakraborty**

Professor and Mellichamp Chair in Racial Environmental Justice at the Bren School of Environmental Science & Management, University of California, Santa Barbara

### **Christina H. Fuller**

Associate Professor, School of Environmental, Civil, Agricultural and Mechanical Engineering, University of Georgia College of Engineering

### **Melissa Gonzales**

Chair and Professor, Department of Environmental Health, Tulane University School of Public Health and Tropical Medicine

### **Madeleine Scammell**

Associate Professor of Environmental Health, Boston University School of Public Health

### **Neeta Thakur**

Associate Professor of Medicine, University of California, San Francisco

### **Linda Valeri**

Assistant Professor of Biostatistics, Columbia University

### **Sherri White-Williamson**

Director of Environmental Justice Strategy for the North Carolina Conservation Network

## **GLOBAL HEALTH OVERSIGHT COMMITTEE**

### **Abdus Salam**

Professor, Department of Chemistry, University of Dhaka, Bangladesh

### **Jonathan M. Samet**

Professor, Department of Environmental & Occupational Health, and Dean, Colorado School of Public Health, Department of Epidemiology

### **Kalpna Balakrishnan**

Associate Dean (Research), Department of Environmental Health Engineering, Sri Ramachandra Institute of Higher Education and Research and Director, World Health Organization Collaborating Center for Occupational and Environmental Health, ICMR Centre for Advanced Research on Air Quality, Climate and Health, India

### **Jill Baumgartner**

Associate Professor and William Dawson Scholar, Institute for Health and Social Policy and Department of Epidemiology, Biostatistics & Occupational Health, McGill University, Canada

### **Kiros T. Berhane**

Professor and Chair, Department of Biostatistics, Mailman School of Public Health, Columbia University

### **Michal Krzyzanowski**

Visiting Professor, Imperial College London, UK

### **Caradee Wright**

Chief Specialist Scientist, South African Medical Research Council, South Africa



# Sponsors Funding HEI Programs During 2023



Representatives from the Japan Automobile Manufacturers Association and Japan Automobile Research Institute visited HEI in October 2023.

## CORE SPONSORS

### U.S. Environmental Protection Agency

Office of Research and Development

Office of Air and Radiation

*Office of Air Quality Planning and Standards*

*Office of Transportation and Air Quality*

*Office of Atmospheric Programs*

*Office of Radiation and Indoor Air*

Office of International Affairs

### Motor Vehicle Industry

BMW of North America, LLC

Caterpillar, Inc.

Cummins Inc.

Daimler AG

Detroit Diesel Corporation

Ford Motor Company

General Motors Corporation

Hino Motors, Ltd.

American Honda Motor Company, Inc.

Hyundai America Technical Center, Inc.

Isuzu Motors, Ltd.

Jaguar Land Rover North America, LLC

John Deere and Company

KIA Motors America, Inc.

Mazda Motor Corporation

Mitsubishi Motors Corporation

Nissan Motor Company, Ltd.

North American Subaru, Inc.

PACCAR, Inc.

Stellantis

Toyota Motor Corporation

Volkswagen of America, Inc.

Volvo Cars of North America, LLC

Volvo Powertrain North America



## OTHER SPONSORS

American Petroleum Institute

Children's Investment Fund Foundation

Clean Air Fund

ConocoPhillips

ExxonMobil

Open Philanthropy





# Ongoing Studies and Reports under Review and in Press

Status as of December 31, 2023. Institutional affiliations are in USA unless otherwise indicated. For continually updated listings of our studies in progress, visit [www.healtheffects.org/research/ongoing-research](http://www.healtheffects.org/research/ongoing-research) and [www.heienergy.org/research/quarterly-updates](http://www.heienergy.org/research/quarterly-updates).

## ACCOUNTABILITY

---

\*Assessing the national health and educational benefits of the EPA's School Bus Retrofit and Replacement Program: A randomized controlled trial design. *Sara Adar, University of Michigan*

\*Quantifying marginal societal health benefits of transportation emission reductions in the United States and Canada. *Amir Hakami, Carleton University, Canada*

\*How do household energy interventions work? *Sam Harper and Jill Baumgartner, McGill University, Canada*

Impacts of vehicle emission regulations and local congestion policies on birth outcomes associated with traffic air pollution. *Perry Hystad, Oregon State University*

Accounting for the health benefits of air pollution regulations in China, 2008–2020. *Patrick Kinney, Boston University*

Environmental and health benefits of mobile source and electricity generating unit policies to reduce particulate pollution. *Stefanie Ebelt, Emory University; David Rich, University of Rochester*

## AIR POLLUTION EPIDEMIOLOGY

---

COUPH: COpenhagen Ultrafine Particles and Health. *Heresh Amini, University of Copenhagen, Denmark*

Urban air and noise pollution in sub-Saharan Africa: A study of prenatal exposures, birth outcomes, and sleep disturbances in infants. *Raphael Arku, University of Massachusetts, Amherst*

\* Report in the HEI review process as of December 31, 2023.

\*Air pollution exposure and prefrontal connectivity in early adolescence. *Megan Herting, University of Southern California*

\*Impact of exposure to air pollution on asthma: A multi-exposure assessment. *Marie Pedersen, University of Copenhagen, Denmark*

\*Long-term outdoor air pollution and cause-specific mortality in a pooled analysis of 23 Asian cohorts. *Roel Vermeulen, Utrecht University, Netherlands*

## COVID-19, AIR POLLUTION, AND HEALTH

---

\*Effect of air pollution reductions on mortality during the COVID-19 lockdown: A natural experiment study. *Kai Chen, Yale University*

Ambient air pollution and COVID-19 in California. *Michael Kleeman, University of California, Davis*

\*Race, Ethnicity, and Air pollution in COVID-19 Hospitalization OUTcomes (REACH OUT). *Jeanette Stingone, Columbia University*

\*Air pollution in relation to COVID-19 morbidity and mortality: A large population-based cohort study in Catalonia, Spain (COVAIR-CAT). *Cathryn Tonne, Barcelona Institute for Global Health (ISGlobal), Spain*

## EMISSIONS AND EXPOSURE ASSESSMENT

---

\*Scalable multipollutant exposure assessment using routine mobile monitoring platforms. *Joshua Apte, University of California, Berkeley*

Accounting for mobility in air pollution exposure estimates in studies on long-term health effects. *Kees de Hoogh, Swiss Tropical and Public Health Institute, Switzerland*

Spatial statistical learning methods for estimating ambient air pollution. *Gerard Hoek, Utrecht University, Netherlands*

Investigating the consequences of measurement error of gradually more sophisticated long-term personal exposure models in assessing health effects: The London Study (MELONS). *Klea Katsouyanni, Imperial College London, United Kingdom*

Optimizing exposure assessment for inference about air pollution effects with application to the aging brain. *Lianne Sheppard, University of Washington*

Comparing the estimated health impacts of long-term exposure to traffic-related air pollution using fixed-site, mobile, and deep learning models. *Scott Weichenthal, McGill University, Canada*

## HEI ENERGY

---

\* Using Geoscientific Analysis and Community Engagement to Analyze Exposures to Potential Groundwater Contamination Related to Hydrocarbon Extraction in Southwestern Pennsylvania. *Jennifer Baka, Pennsylvania State University*

Measuring and Modeling Air Pollution and Noise Exposure Near Unconventional Oil and Gas Development in Colorado. *Jeffrey Collett, Colorado State University*

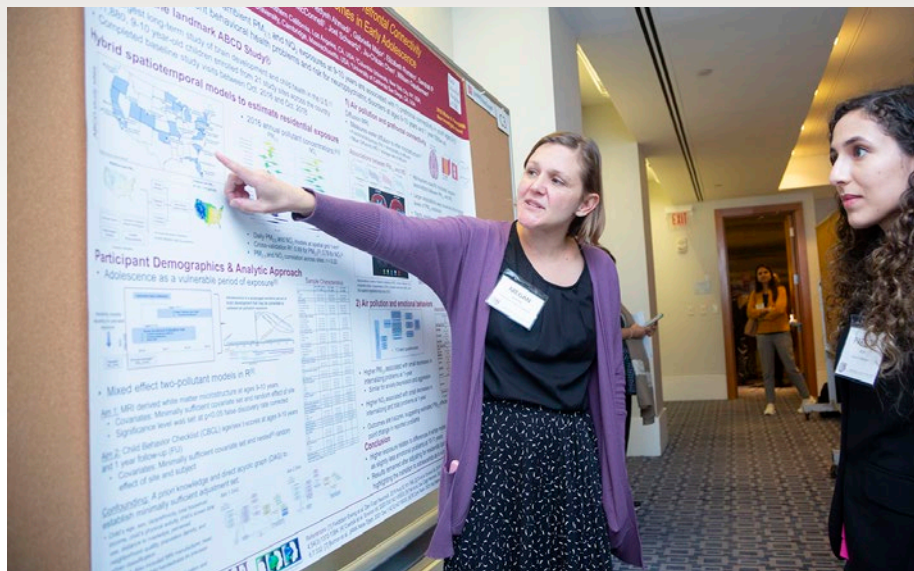
Assessing Source Contributions to Air Quality and Noise in Unconventional Oil Shale Plays. *Meredith Franklin, University of Toronto*

(List continues on next page)



# Ongoing Studies and Reports Under Review and in Press

Continued from previous page



HEI investigator Megan Herting, University of Southern California, discusses her study with Pargool Arab of the Clean Air Task Force at the 2023 HEI Annual Conference.

Predictive, Source-oriented Modeling and Measurements to Evaluate Community Exposures to Air Pollutants and Noise from Unconventional Oil and Gas Development. *Lea Hildebrandt Ruiz, University of Texas at Austin*

Assessing the Effects of Unconventional Oil and Gas Development on Community Water Sources. *Joseph Ryan, University of Colorado Boulder*

## GLOBAL HEALTH

Modeling long-term PM<sub>2.5</sub> exposure and its impact on premature coronary artery disease: A pooled analysis of multiple cohorts in India. *Santu Ghosh, St. John's Research Institute, India*

## MECHANISMS AND METHODS

Air pollutants and the gut microbiota and metabolome during early life: Implications for childhood obesity. *Tanya Alderete, University of Colorado*

Robust statistical approaches to understanding the causal effect of air pollution mixtures. *Joseph Antonelli, University of Florida*

## TRAFFIC POLLUTION AND NOISE

Traffic-related air pollution and birth weight: The roles of noise, placental function, green space, physical activity, and socioeconomic status (FRONTIER). *Payam Dadvand and Jordi Sunyer, Barcelona Institute for Global Health (ISGlobal), Spain*

Improved characterization of the real-world contributions and impacts of non-tailpipe particulate matter emissions. *Greg Evans, University of Toronto, Canada*

\*Intersections as hot spots: Assessing the contribution of localized non-tailpipe emissions and noise on the association between traffic and children's health. *Meredith Franklin, University of Southern California*

Assessing the impact of non-exhaust emissions from traffic on the asthmatic airway. *Chris Griffiths, Queen Mary University of London, United Kingdom*

\*Health effects of air pollution components, noise and socioeconomic status ("HERMES"). *Ole Raaschou-Nielsen, Danish Cancer Society Research Center, Copenhagen, Denmark*

## WILDLAND FIRES AND AGRICULTURAL BURNING

Australian fires and perinatal health risks. *Michelle Bell, Yale University*

Contributions of prescribed fire and agricultural burning to air quality and health. *Talat Odman, Georgia Institute of Technology*



# 2023 Publications, RFAs and Resources

Our publications and resources are available at [www.healtheffects.org/publications](http://www.healtheffects.org/publications), [www.heienergy.org/publications](http://www.heienergy.org/publications) (HEI Energy), and [www.stateofglobalair.org/reports-resources](http://www.stateofglobalair.org/reports-resources) (State of Global Air). Institutional affiliations are in USA unless otherwise indicated.

## AIR POLLUTION AND HEALTH PROGRAM

---

### Research Report 213

MAY 2023

Ambient Air Pollution and All-Cause and Cause-Specific Mortality in an Analysis of Asian Cohorts

*George S. Downward and Roel Vermeulen, Utrecht University, the Netherlands*

### Research Report 214

NOVEMBER 2023

Long-Term Exposure to AIR Pollution and COVID-19 Mortality and Morbidity in DENmark: Who Is Most Susceptible? (AIRCODEN)

*Zorana J. Andersen, University of Copenhagen, Denmark*

### Research Report 215

DECEMBER 2023

Chemical and Cellular Formation of Reactive Oxygen Species from Secondary Organic Aerosols in Epithelial Lining Fluid

*Manabu Shiraiwa, University of California, Irvine*

### RFA 23-1

Assessing Health Effects of Traffic-Related Air Pollution in a Changing Urban Transportation Landscape

### RFA 23-2

Assessing Changes in Exposures and Health Outcomes in Historically Marginalized and Environmentally Overburdened Communities from Air Quality Actions, Programs, or Other Interventions

### RFA 23-3

Walter A. Rosenblith New Investigator Award

### Workshop Summary

New Science to Inform Environmental Justice

JANUARY 2023

### Factsheet

Traffic Pollution and Your Health

OCTOBER 2023

## HEI ENERGY PROGRAM

---

### Research Brief 5

Potential Human Exposures to Produced Water from Onshore Oil and Gas Production

DECEMBER 2023

### RFQs E23-1 and E23-2

Community Exposures Associated with Unconventional Oil and Natural Gas Development

OCTOBER 2023

## STATE OF GLOBAL AIR INITIATIVE

---

### Factsheets

European Union Regional Air Quality

Snapshot

JANUARY 2023

South Asia Snapshot

SEPTEMBER 2023

Air Pollution and Your Health (available in English, French, Spanish, Hindi, and Swahili)

NOVEMBER 2023

### StoryMap

Air Pollution and Health: The Global Impacts of Fossil Fuels

NOVEMBER 2023



# Financial Summary 2022–2023

HEI made significant progress in fiscal year 2023 toward the objectives of the Health Effects of Air Pollution program by completing research on possible health effects from low levels of exposure and examining the potential effects of traffic exposure in its broader context. We have also made progress in expanding our efforts to produce and communicate Global Health Science. These activities were made possible by funding from our core government and industry partners with additional funding from government, industry, and foundation sponsors. Separate funding has also allowed us to move forward with our Energy Research Program.

## STATEMENTS OF FINANCIAL POSITION

	Years Ended June 30,	
	2023	2022
<b>Assets</b>		
Cash and cash equivalents	\$2,348,832	\$6,454,725
Restricted cash	147,995	147,962
Investments	855,411	—
Contributions and accounts receivable	3,704,669	3,609,717
Unbilled incurred costs on grants	8,676,298	5,500,000
Prepaid expenses	18,291	43,788
Office equipment, office furniture and fixtures, and leasehold improvements, net	4,722	24,815
Operating lease right-of-use assets	994,044	—
<b>Total assets</b>	<b>\$16,750,262</b>	<b>\$15,781,007</b>
<b>Liabilities and Net Assets</b>		
Liabilities:		
Contracted research payables	\$855,409	\$312,057
Accrued contracted research	3,010,791	2,769,329
Deferred revenue	263,799	—
Deferred rent payable	—	36,019
Other accounts payable and accruals	1,070,039	1,675,543
Operating lease obligations	991,052	—
<b>Total liabilities</b>	<b>\$6,191,090</b>	<b>\$4,792,948</b>
Net Assets:		
Without donor restrictions	1,835,662	722,041
With donor restrictions	8,723,510	10,266,018
<b>Total net assets</b>	<b>\$10,559,172</b>	<b>\$10,988,059</b>
<b>Total liabilities and net assets</b>	<b>\$16,750,262</b>	<b>\$15,781,007</b>

The HEI Financial Statement and the Mayer Hoffman McCann P.C. Independent Auditors' Report may be obtained by contacting Jacqueline C. Rutledge at [jrutledge@healtheffects.org](mailto:jrutledge@healtheffects.org).



# Financial Summary 2022–2023

## STATEMENTS OF ACTIVITIES

	Years Ended June 30,	
	2023	2022
Revenues and support:		
EPA grants for the Health Effects of Air Pollution Program	\$6,000,000	\$5,744,711
EPA contracts for Energy Research	3,530,214	3,421,866
Industry contributions	5,299,744	5,399,530
Other non-federal grant and contract revenue	50,153	449,080
Other revenues	103,707	65,798
<b>Total revenues and support</b>	<b>\$14,983,818</b>	<b>\$15,080,985</b>
Expenses:		
Research programs:		
Research studies	\$6,096,035	\$5,940,177
Research planning and study selection	720,746	642,306
Scientific study management	323,486	342,818
Scientific study review	353,050	300,276
Scientific publication and communication	1,364,274	1,153,281
<b>Total Research Program</b>	<b>8,857,591</b>	<b>8,378,858</b>
Special Scientific projects:		
Energy research	2,822,329	1,048,193
Traffic studies review	40,042	329,993
Global health science	1,009,428	1,042,768
<b>Total special scientific projects</b>	<b>3,871,799</b>	<b>2,420,954</b>
<b>Total research and scientific expenses</b>	<b>12,729,390</b>	<b>10,799,812</b>
Administration	2,683,315	2,316,313
<b>Total expenses</b>	<b>\$15,412,705</b>	<b>\$13,116,125</b>
<b>Net increase (decrease) in net assets</b>	<b>(428,887)</b>	<b>1,964,860</b>
<b>Net assets at beginning of year</b>	<b>10,988,059</b>	<b>9,023,199</b>
<b>Net assets at end of year</b>	<b>\$10,559,172</b>	<b>\$10,988,059</b>

## REPORT CREDITS

### Writing

Anne Frances Johnson

### Art Direction/Design

Glenn Ruga

### Project Management and Editing

Hope Green

### Website Support

Diana Sterling, Charles River Web

### Additional Contributors

We gratefully acknowledge assistance in the preparation of this report from HEI staff members Amy Andreini, Kristin Eckles, Pallavi Pant, Anna Rosofsky, and Donna Vorhees, as well as guidance from HEI President Elena Craft, Vice President Robert O'Keefe, and Director of Science Communications Tom Champoux.



# HEI Staff and Boards of Directors

## OFFICERS AND STAFF

---

**Elena Craft**

*President*

**Robert M. O’Keefe**

*Vice President*

**Ellen K. Mantus**

*Director of Science*

**Donna J. Vorhees**

*Director of Energy Research*

**Thomas J. Champoux**

*Director of Science Communications*

**Jacqueline C. Rutledge**

*Director of Finance and Administration*

**Jason Desmond**

*Deputy Director of Finance and Administration*

**Emily Alden**

*Corporate Secretary*

---

**Amy Andreini**

*Science Communications Specialist*

**Ayusha Ariana**

*Research Assistant*

**Hanna Boogaard**

*Consulting Principal Scientist*

**Aaron J. Cohen**

*Consulting Principal Scientist*

**Jacki Collins**

*Senior Accountant*

**Dan Crouse**

*Senior Scientist*

**Gabriela Daza**

*Research Assistant*

**Philip J. DeMarco**

*Compliance Manager*

**Cloelle Danforth**

*Senior Scientist*

**Kristin C. Eckles**

*Senior Editorial Manager*

**Elise G. Elliott**

*Staff Scientist*

**Hope Green**

*Editorial Project Manager*

**Lissa McBurney**

*Senior Science Administrator*

**Janet I. McGovern**

*Executive Assistant*

**Samantha Miller**

*Research Assistant*

**Victor Nthusi**

*Consulting Research Fellow*

**Pallavi Pant**

*Head of Global Health*

**Allison P. Patton**

*Senior Scientist*

**Quoc Pham**

*Science Administrative Assistant*

**Yasmin Romitti**

*Staff Scientist*

**Anna S. Rosofsky**

*Senior Scientist and Environmental Justice Program Lead*

**Abinaya Sekar**

*Consulting Research Fellow*

**Robert A. Shavers**

*Operations Manager*

**Eva Tanner**

*Staff Scientist*

**Alexis Vaskas**

*Digital Communications Manager*

**Ada Wright**

*Research Assistant*

---

**Daniel S. Greenbaum (In Memoriam)**

*President Emeritus*

**Annemoon M. van Erp**

*Deputy Director of Science Emerita*

## BOARD OF DIRECTORS

---

**Richard A. Meserve, Chair**

*Senior of Counsel, Covington & Burling LLP; President Emeritus, Carnegie Institution for Science; former Chair, U.S. Nuclear Regulatory Commission*

**Jo Ivey Boufford**

*Clinical Professor of Global Health and Pediatrics, New York University*

**Homer Boushey**

*Emeritus Professor of Medicine, University of California–San Francisco*

**Jared L. Cohon (In Memoriam)**

*President Emeritus and Professor, Civil and Environmental Engineering and Engineering and Public Policy, Carnegie Mellon University*

**Stephen Corman**

*President, Corman Enterprises*

**Martha J. Crawford**

*Operating Partner, Macquarie Asset Management*

**Ana Diez Roux**

*Dana and David Dornsife Dean and Distinguished University Professor of Epidemiology, Dornsife School of Public Health, Drexel University; Director, Drexel Urban Health Collaborative*

**Michael J. Klag**

*Dean Emeritus and Second Century Distinguished University Professor, Johns Hopkins Bloomberg School of Public Health*

**Alan I. Leshner**

*CEO Emeritus, American Association for the Advancement of Science*

**Catherine L. Ross**

*Regents’ Professor Emerita, City and Regional Planning and Civil and Environmental Engineering, Georgia Institute of Technology; Chairman of the Board of Directors of the Auto Club Group, American Automobile Association*

**Martha Rudolph**

*Environmental Attorney, Former Director of Environmental Programs, Colorado Department of Public Health and Environment*

**Karen C. Seto**

*Frederick Hixon Professor of Geography and Urbanization Science, Yale School of the Environment*

---

**Archibald Cox**

*Founding Chair, 1980–2001*

**Donald Kennedy**

*Vice Chair Emeritus, 1980–2003; Editor-in-Chief Emeritus, Science*

## HEI ENERGY BOARD OF DIRECTORS

---

**Jared L. Cohon, Chair (In Memoriam)**

*Carnegie Mellon University*

**Michael J. Klag**

*Johns Hopkins Bloomberg School of Public Health*

**Martha E. Rudolph**

*Colorado Department of Public Health and Environment*

# HEI

**HEALTH EFFECTS INSTITUTE**

75 Federal Street, Suite 1400

Boston, MA 02110

USA

Phone: 1-617-488-2300

*[www.healtheffects.org](http://www.healtheffects.org)*