

HEALTH EFFECTS INSTITUTE
ANNUAL REPORT 2021

Trusted Science for a Changing World





Fresh Faces, New Vision

A MESSAGE FROM THE CHAIR

It is often said that the only constant in life is change. That maxim is evident in the events of 2021, with a global pandemic driving new attention to public health and a growing focus on climate change as the major challenge facing society. It is therefore appropriate that the theme of this year's annual report is change and how HEI is adapting to it to provide science that meets the evolving needs of society and our sponsors in a changing world.

The climate-driven energy transition is producing profound changes in technology and fuels in transport and other major sectors, with implications for both legacy and emerging technologies and their health and environmental impacts.

While internal combustion engines still power the vast majority of new and in-use vehicles, and will for some time to come, electrification of the light duty fleet is growing rapidly, and a host of new technologies, including hydrogen-fueled vehicles, are competing to power emerging heavy duty fleets. These changes, combined with growing calls to decarbonize all sectors of society, are reshaping energy production and use around the world. The energy transition, particularly at the intersection of transportation and energy production, raises new and important questions about the health and other consequences of new fuels and technologies along their entire production, use, and disposal pathways. This change demands the development of an understanding of those impacts relative to fossil fuel combustion and to each other.

As this annual report illustrates, HEI has been active in producing new research on the health impacts posed by legacy air pollution sources, even as it evolves to understand and address new fuels and technologies. HEI's major new studies on the health effects of extremely low levels of air pollution from all sources are directly relevant to informing regulatory decisions in the United States and Europe. Our research and companion [systematic review of the health impacts of traffic](#) will provide a deeper understanding of the broader health impacts of traffic in all its forms. And our Accountability Program is measuring the health benefits of environmental regulations to help document progress on clean air and identify tested solutions. We continue to pursue this science with the credibility of a trusted bipartisan industry–government partnership, a partnership that is all too rare today.

Change is no stranger to HEI itself as well. After 20 years of outstanding service as Chair of the HEI Board, Dick Celeste has stepped down. We owe Dick a debt of gratitude for his many contributions. I am excited and privileged to take on the responsibility of the Chair and to help lead HEI forward together with its outstanding Board. The Board is also changing to meet future challenges; we are joined by two globally respected new members: Dr. Karen Seto, a leading expert on urbanization, and Dr. Catherine Ross, a widely recognized expert on transport and urban planning.

We also recognize the significant racial and economic inequities that exist in society, inequities that HEI's own research clearly documents. In response, HEI bears an important responsibility to



increase the breadth of diversity, equity, and inclusion across all aspects of the Institute's operation. HEI has taken steps in partnership with our Diversity Task Force to enhance the diversity of our staff, Committees, and Board, as well as the researchers we fund and the speakers in our events. We are also working to ensure a safe and welcoming environment at HEI more broadly and will continue to expand these efforts in the years ahead.

In closing, and not for the last time, I want to thank the many sponsors who make HEI possible.

I look forward to meeting many of you in person in the coming months, and I would be pleased to hear from you at any time as my virtual door at HEI is always open.

Yours,

Richard A. Meserve
Chair, HEI Board of Directors
replies-to-richard-meserve@healtheffects.org



Trusted Science for a Changing World



We are living in a time of extraordinarily fast change. A global pandemic continues to disrupt our lives and our economies. Technology is advancing rapidly in our cities, homes, and workplaces. Industrial development, migration, and demographic shifts are reshaping societies around the world. And the changes in our climate and environment grow more apparent with each passing season.

Changes are driven by choices. To make choices that are guided by the best information available, communities, governments, and businesses need reliable information on what is happening today, what the future may hold, and what decisions are likely to lead to the best outcomes. The best decisions are made when we understand what has worked—and what has not—in the past.

Through our mission to produce high-quality scientific research and data on the most pressing air quality and health questions, HEI informs the critical decisions that will help shape a clean air future.

Pollution and the Pandemic

As we learn more about how the SARS-CoV-2 virus spreads through the air and infects our bodies, scientists and the public have become increasingly aware of the intricate interactions between our environment and our health. Could exposure to air pollution help explain why some individuals are more severely affected by COVID-19 than others? Could the unprecedented policy measures taken to control the pandemic affect air pollution and its health impacts?

To answer these questions, HEI launched [five new studies](#) after a rigorous competi-

tion. In an analysis of trends in the United States, China, Germany, and Italy, Kai Chen of Yale University will evaluate whether pandemic lockdowns have led to improvements in air quality, and whether such changes are linked with lower mortality rates apart from the increased numbers of deaths caused by COVID-19. Four other studies will examine interactions between air pollution exposure and susceptibility to COVID-19 infection and various outcomes. These researchers are focusing on a range of geographic locations, including New York City (Jeanette Stingone, Columbia University), Southern California (Michael Kleeman, University of California, Davis), Denmark (Zorana Anderson, University of Copenhagen), and Catalonia, Spain (Cathryn Tonne, ISGlobal).

A Focus on Fires

In North America and around the world, record-breaking wildfire seasons have brought the dangers of fire to the forefront. Beyond immediate threats from the blazes, soot generated by fires can affect air quality and health hundreds or even thousands of miles away. Two new HEI-funded studies are examining the health effects associated with smoke from wildland fires and agricultural burning.

[Michelle Bell](#) of Yale University will lead a study on the potential relationship between adverse birth outcomes and exposure to particulate matter from Australian wildfires. Bell and colleagues in the United States and Australia plan to assess potential disproportionate effects on sensitive populations. They will also make their emissions inventory and modeling of the wildfire smoke exposures available publicly.

[Mehmet Talat Odman](#) of the Georgia Institute of Technology will examine whether prescribed and agricultural burning in the southeastern United States might be associated with increased emergency department visits related to smoke exposure. The team will test air pollution contributions from intentional burning versus other sources and provide data for comparing agricultural burning effects with effects of wildfire burning being investigated in other studies.

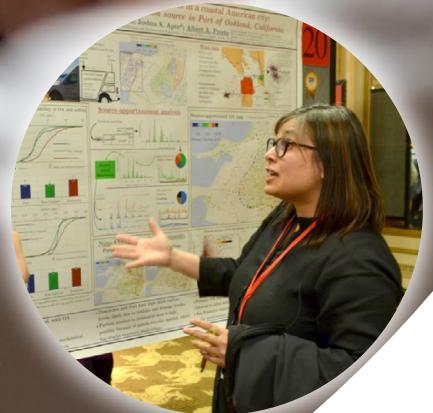
Probing Climate Connections

Climate change is intricately linked to air quality and health. Rising temperatures could, for example, lead to higher ozone concentrations, while drier conditions can increase wildfires that generate particulate matter pollution. At the same time, black carbon particles, ozone, and other air pollutants can exacerbate climate change. In a virtual session conducted as part of HEI's 2021 Annual Conference, leading scientists considered what is known about these important interactions, how regulations that target air pollutants can benefit the climate and vice versa, and the potential for unequal exposures and impacts across communities.

Through our mission to produce high-quality scientific research and data on the most pressing air quality and health questions, HEI informs the critical decisions that will help shape a clean air future.

Presenters reviewed strong evidence that reducing fossil fuel emissions would help counteract the upward trajectory of deaths that can be attributed to air pollution and curb climate change. They also explored extreme heat as a critical nexus between climate and health that disproportionately affects Black and indigenous populations and other people of color. Speakers highlighted methods to assess how the potential health gains of decarbonization strategies stack up against the costs of implementing them. They also discussed how the distribution of costs and benefits could alleviate—or worsen—the impacts of emissions in disadvantaged communities.

Reaching New Audiences in a New Time



Building strong connections between individuals and organizations is integral to HEI's goal of generating trusted information. We bring experts together through rigorous science, we advance research on topics selected based on shared priorities, and we cultivate a robust network of stakeholders dedicated to informing wise decisions about air quality and health.

Perhaps most tangibly, we bring people together through our Annual Conference. This springtime event has long stood as a centerpiece of our role as a convener of colleagues across academia, industry, government, and community groups. Over the years, the conference has grown into a go-to source for the latest scientific insights and stimulating discussions on air pollution, health impacts, and public policy.

Although the COVID-19 pandemic has changed the way we gather, it has also underscored the urgency and importance of coming together to exchange timely information and guide science-based decisions. We remain steadfast in our commitment to continuing and enhancing HEI's service as a convener—whether virtually or in person.

Annual Conference Goes Virtual

In 2020, in the early months of the COVID-19 pandemic, the decision became clear: HEI's Annual Conference scheduled for that spring would need to go virtual. HEI staff were already well-practiced at conversing through computer screens, but the conference, which typically involves hundreds of participants, was another

Building a More Diverse and Inclusive HEI

To understand air pollution and its associated health effects requires attention to the fact that pollution exposures and its effects are unequally distributed throughout society. The groups of people who face the highest exposures and the most severe health effects are the same groups who have suffered marginalization and disparities in many other aspects of life.

Addressing these inequities requires science, and it requires action. At HEI, we are renewing our focus on uncovering health disparities and their drivers through our air quality research programs. For example, a recent [study by Ying-Ying Meng](#) of the University of California, Los Angeles, shed much-needed light on the health effects of living near freeways and the potential for reducing exposure. The study cohort included participants in Medi-Cal, California's healthcare program for low-income individuals. Other ongoing studies seek to uncover how different factors influence people's vulnerability to both air pollution and COVID-19, particularly in disadvantaged neighborhoods.

At the same time, we are expanding our ongoing commitment to promote diversity and inclusion within our organization and in the field of environmental health overall. Scientific institutions, including HEI, have contributed, even if unconsciously, to the development and perpetuation of an exclusive environment, and it is imperative that we work proactively to create broader inclusivity. HEI's Diversity, Equity, and Inclusion Task Force works with leadership to implement steps, defined in our [Action Plan to Promote Inclusion](#), to ensure a safe and welcoming environment for all. As part of our commitment, we are further enhancing efforts to diversify our staff, Board of Directors, and expert committees, as well as the researchers we fund and the speakers who participate in our events. We are also investigating ways to support opportunities for career development through travel awards or internships for students in sciences relevant to air pollution and health.

level. Would people attend? Could a virtual platform support the lively discussions our community wants and expects?

Ultimately, the virtual event was a striking success. Organized as a series of webinars, it not only attracted more attendees than any previous HEI conference but also welcomed a greater diversity of participants. The same was true in 2021, when HEI's [second virtual conference](#) drew 1,200 attendees from 76 countries across five continents.

In April and May 2021, the series kicked off with a session on climate change, air quality, and health. More than 550 viewers attended. Later sessions featured community-centered environmental health research, global air quality policy and decision-making, the COVID-19 pandemic as it relates to air

pollution, methods for synthesizing evidence across studies, non-tailpipe emissions, and health effects of low levels of air pollution exposure (at or below current air quality standards in the United States).

The Changing Face of Transportation



Five decades ago, the United States began a process to clean up the air by controlling emissions from motor vehicles. Standards for vehicles and fuels are in large part responsible for the significantly cleaner air we enjoy today. Yet although each vehicle emits less pollution, the number of vehicle miles driven has increased markedly. As a result, vehicles remain key contributors to air pollution and the job of achieving clean transportation is not yet complete.

Recent years have also brought drastic changes in how people move. Although personally owned internal combustion vehicles remain dominant overall, technological advances are enabling a vast array of new options for getting around. Electric vehicles and self-driving technologies are becoming increasingly available, and ride-hailing and ride-sharing services continue to gain popularity. Electric bikes and scooters are available in many cities, which are also incorporating more infrastructure to support pedestrians and cyclists. Mass transit is changing, too, with an increasing emphasis on light rail and electric buses. Despite these trends, however, traffic congestion remains a key issue in many places. A recent increase in last-mile goods delivery has brought more light-duty trucks and vans into urban and residential areas, further exacerbating the challenges.

With all these changes, where is air quality headed? Which changes will stick, and what new trends might emerge? The decisions made in the business world and at local, state, and federal levels of government will have implications many years into the future. Yet uncertainties surrounding consumer acceptance, economic trends, and technology development make it challenging to predict what the future transportation landscape will hold. To help untangle these

complex questions, HEI supports research and convenes stakeholders to advance understanding of the changing face of transportation—and what it means for our air.

A Multifaceted Look at Traffic

Living near a busy roadway can increase a person's risk of premature death, particularly from causes related to heart disease. This connection is supported by initial findings in HEI's forthcoming report, [Systematic Literature Review on the Health Effects of Long-term Exposure to Traffic-Related Air Pollution](#). The review also finds moderate to high confidence in the link between exposure to traffic pollution and lung cancer deaths, new-onset asthma, and acute lower respiratory infections in children. The findings of the review, which will be finalized in mid-2022, underscore the ongoing public health concern posed by air pollution from combustion-engine vehicles.

Scientists and policy makers are also increasingly aware that the health effects of traffic extend far beyond tailpipe emissions. Three ongoing HEI-funded studies are investigating factors such as noise, stress, socioeconomic status, and green space in addition to common traffic-related air pollutants. The studies focus on children's health in Southern California ([Meredith Franklin](#), University of Southern California), pregnancy outcomes in Spain ([Payam Davdand and Jordi Sunyer](#), IS-Global), and health outcomes among Danish adults ([Ole Raaschou-Nielsen](#), Danish Cancer Society Research Center).

Understanding Policy Impacts

Accountability studies are crucial for understanding which policies are most effective for achieving intended improvements in air quality and health outcomes. In [HEI Research Report 205](#), released in 2021, researcher Ying-Ying Meng and colleagues at the University of California, Los Angeles, examined the effects of a series of actions aimed at reducing air pollution from the



movement of goods in Southern California. Their results provide evidence that regulatory actions to decrease emissions from goods movement around major ports and freeways might bring health benefits for disadvantaged communities nearby.

A new study launched this year will explore the effects of policies targeting motor vehicle emissions and electricity generation in Atlanta, New York City, and Los Angeles. Researchers Stefanie Ebelt, Emory University, and David Rich, University of Rochester Medical Center, will lead the study to assess impacts of policies on particulate matter pollution and health in those cities, which have different air pollution contributions from the traffic and energy sectors.

Convening Across Disciplines

Transportation is a topic that spans multiple disciplines and many sectors of society. As a result, collaboration is essential to understanding trends and informing decisions. To support a productive dialogue, HEI President Dan Greenbaum served as chair for the organizing committee of a workshop of the National Academies of Sciences, Engineering, and Medicine that brought together stakeholders from academia, industry, and government. The workshop, "How We Move Matters: Exploring the Connections between New Transportation and Mobility Options and Environmental Health," offered a provocative look at critical issues at the intersection of transportation and health and provided a forum for envisioning future directions.

Global Health Is Public Health

Pollution Is Personal

Air pollution exposure affects our health even before we take our first breath. In its 2020 assessment of global pollution burdens, the State of Global Air project presented the first-ever comprehensive estimates of the link between air pollution and pregnancy outcomes and health of newborns. The report found that nearly 500,000 newborns died in 2019 as a result of air pollution exposure, with household air pollution accounting for most of these worldwide deaths. A [video](#) released alongside the report puts into stark relief the toll on air pollution's youngest victims.

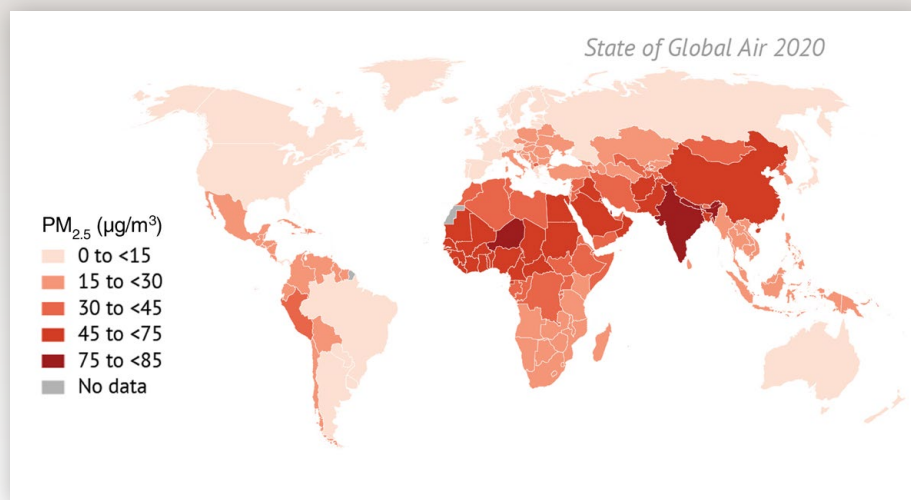


From the tiny infant issuing a first cry to a world leader crafting a vision for the future, we all breathe the same air. In our increasingly connected world, global health is public health, and the actions we take as individuals and nations can have far-reaching effects. HEI plays a leading role in improving knowledge and capacity to address pressing air quality issues around the world.

A Global View

Having global-scale insights on pollution sources, exposures, and health effects is vital to informing priorities and guiding effective responses. The [State of Global Air](#), a collaboration between HEI and the Institute for Health Metrics and Evaluation with expert input from the University of British Columbia, offers an annual snapshot of pollution and health trends around the world, based on data from the [Global Burden of Disease](#) (GBD) study. *The State of Global Air 2020* report provided key findings on the toll of ambient particulate matter, ozone, and household air pollution, attracting widespread interest and media coverage.

To dig deeper into the evolving sources of air pollution worldwide, HEI supported a project in 195 countries and territories to estimate the contributions of various source sectors (such as coal and traffic) to the global disease burden from exposure to ambient particulate matter from those sources. Researchers Erin McDuffie and Randall Martin of Washington University in St. Louis, Missouri, Michael Brauer at The University of British Columbia, Canada, and their colleagues conducted the research as part of the GBD Major Air Pollution Sources (GBD MAPS) project. A [new HEI report](#) presents their results, which are informing



[Interactive State of Global Air map](#) shows population-weighted annual average PM_{2.5} concentrations in 2019.

work at the United Nations Environment Program, the Clean Cooking Alliance, and governments around the world.

HEI is also supporting work by George Washington University's [Susan Anenberg](#) to improve methods for estimating global nitrogen dioxide emissions and exposures, and document effects on asthma in children for inclusion in the upcoming release of Global Burden of Disease results.

Strengthening Capacity in Asia

HEI is dedicated to leveraging its decades of experience leading impactful science to build research capacity in regions around the world. HEI has made important strides in Asia, which sees some of the world's highest air pollution burdens. In 2021, the Collaborative for Air Pollution and Health Effects Research (CAPHER-India), based at the All-India Institute of Medical Sciences in New Delhi, got underway with leadership from Randeep Guleria. HEI was instrumental in CAPHER-India's establishment and has now launched a search for qualified investigators with the goal of funding research studies in India.

HEI staff members have also continued to contribute to meetings and events across South Asia. HEI scientists Pallavi Pant and Katy Walker developed a commentary for a policy brief by the Collaborative Clean Air

Policy Centre that examined strategies to communicate information about a possible link between air pollution and susceptibility to COVID-19 in India. Pant, along with HEI President Dan Greenbaum, also spoke at the [India Clean Air Summit 2021](#), and Greenbaum spoke at a [WWF-India webinar](#) on air pollution and climate change.

State of the Science in Southeast Europe

Despite substantial progress in curbing air pollution in Western Europe, particulate matter pollution is consistently higher in Southeast Europe. HEI is working with local experts to review current evidence on the health effects of this pollution and how it links to ongoing policy debates in this region. Also, HEI held a [workshop](#) where participants examined health effects of ambient air pollution in the region, progress in research methods, and the best ways to use data to inform policy making. The workshop was co-hosted with the International Society for Environmental Epidemiology–Europe, the European Respiratory Society, and the Medical University of Plovdiv, Bulgaria.

Committees

Current as of December 31, 2021

RESEARCH COMMITTEE

David A. Savitz, *Chair*

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

Jeffrey R. Brook

Senior Research Scientist, Air Quality Research Division, Environment Canada, and Assistant Professor, University of Toronto, Canada

Amy H. Herring

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

Barbara Hoffmann

Professor of Environmental Epidemiology, Institute of Occupational, Social, and Environmental Medicine, University of Düsseldorf, Germany

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

Ivan Rusyn

Professor, Department of Veterinary Integrative Biosciences, Texas A&M University

Evangelia (Evi) Samoli

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

Gregory Wellenius

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

New Research Committee Members



Heather Holmes



Evi Samoli



Gregory Wellenius

The HEI Board of Directors recently appointed three new members to the Research Committee: Heather A. Holmes, associate professor, Department of Chemical Engineering, University of Utah; Evangelia (Evi)

Samoli, associate professor of epidemiology and medical statistics, Medical School of the National and Kapodistrian University of Athens, Greece; and Gregory Wellenius, professor of environmental health, Boston University School of Public Health.

New Review Committee Members



Sara Adar



Eric Tchetgen Tchetgen

The HEI Review Committee welcomed two new members appointed by the Board of Directors: Sara D. Adar, associate professor and associate chair of epidemiology, University of Michigan School of Public Health, and Eric J. Tchetgen Tchetgen, Luddy Family President's Distinguished Professor and a professor of statistics and data science, Wharton School, University of Pennsylvania.

REVIEW COMMITTEE

Melissa Perry, *Chair*

Professor and Chair, Department of Environmental and Occupational Health, George Washington University Milken Institute School of Public Health

Sara D. Adar

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

Kiros Berhane

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

Michael Jerrett

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

Frank Kelly

Henry Battcock Chair of Environment and Health and Director of the Environmental Research Group, Imperial College London School of Public Health, United Kingdom

Jana B. Milford

Professor, Department of Mechanical Engineering and Environmental Engineering Program, University of Colorado–Boulder

Jennifer L. Peel

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

Eric J. Tchetgen Tchetgen

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

Sponsors

Funding HEI Programs During 2021



Tim Wallington of Ford Motor Company (center) and others representing HEI sponsors at a meeting with the HEI Research Committee and staff.

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

Stellantis

Ford Motor Company

General Motors Corporation

Hino Motors, Ltd.

American Honda Motor Company, Inc.

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Isuzu Motors, Ltd.

Jaguar Land Rover North America, LLC

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Mazda Motor Corporation

Mitsubishi Motors Corporation

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Volvo Powertrain North America

OTHER SPONSORS

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Clean Air Fund

ExxonMobil



Carol Henry, Cummins Inc.



Sherri Hunt, U.S. EPA

Photos by Melissa Ostrow

Ongoing Studies and Reports under Review and in Press 2020–2021

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 Ebel, 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*

*Susceptibility to multiple air pollutants in cardiovascular disease. *Jane Clougherty, Drexel University*

* Report in the HEI review process as of June 30, 2021

** Under negotiation as of June 30, 2021

*Air Pollution, Autism spectrum disorders, and brain imaging amongst CHildren in Europe — the APACHE project. *Mònica Guxens, Barcelona Institute for Global Health (ISGlobal), Spain*

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 STUDIES

Long-term exposure to air pollution and COVID-19 mortality and morbidity in Denmark: Who is most susceptible? (AIRCODEN). *Zorana Andersen, University of Copenhagen, Denmark*

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*

*Characterizing the determinants of vehicle traffic emissions exposure: Measurement and modeling of land-use, traffic, transformation, and transport. *Christopher Frey, North Carolina State University*

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, 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*

EPIDEMIOLOGY AT LOW EXPOSURES

*Identifying the shape of the association between long-term exposure to low levels of ambient air pollution and the risk of mortality: An extension of the Canadian Census Health and Environment Cohort using innovative data linkage and exposure methodology. Phase 2. *Michael Brauer, University of British Columbia, Canada*

*Mortality and morbidity effects of long-term exposure to low-level PM_{2.5}, black carbon, NO₂, and O₃: An analysis of European cohorts. *Bert Brunekreef, Utrecht University, Netherlands*

*Assessing adverse health effects of long-term exposure to low levels of ambient pollution. Phase 2. *Francesca Dominici, Harvard University*

(Continued on next page)

Publications 2020–2021

Ongoing Studies

(Continued from previous page)

GLOBAL HEALTH

Integrating satellites, ground monitoring, and modeling to estimate long-term NO₂ exposures and associated pediatric asthma impacts. *Susan Anenberg, George Washington University*

*Global Burden of Disease—Major Air Pollution Sources a GLOBAL approach. *Michael Brauer, University of British Columbia, Canada; and Randall Martin, Institute for Health Metrics and Evaluation and Washington University*

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*

Formation of reactive oxygen species by organic aerosols and transition metals in epithelial lining fluid. *Manabu Shiraiwa, University of California, Irvine*

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*

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*

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*

Research Report 201

JULY 2020

Understanding the Functional Impact of VOC–Ozone Mixtures on the Chemistry of RNA in Epithelial Lung Cells
Lydia Contreras, University of Texas, Austin

Research Report 204

MARCH 2021

Novel Mechanisms of Ozone-Induced Pulmonary Inflammation and Resolution, and the Potential Protective Role of Scavenger Receptor B1

Kymerly Gowdy, East Carolina University

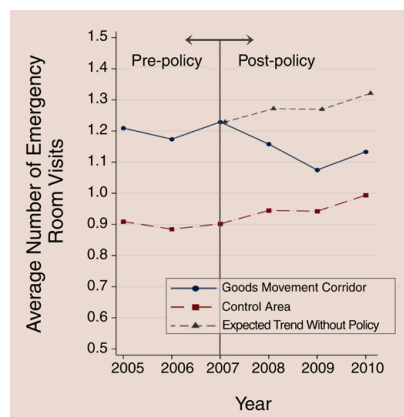


Figure adapted from [Research Report 205](#) shows the average number of emergency room visits among Medi-Cal beneficiaries with asthma before and after implementation of California’s Emission Reduction Plan for Ports and Goods Movement.

Research Report 205

MAY 2021

Improvements in Air Quality and Health Outcomes Among California Medicaid Enrollees Due to Goods Movement Actions
Ying-Ying Meng, University of California, Los Angeles

Special Report

OCTOBER 2020

State of Global Air 2020: A Special Report on Global Exposure to Air Pollution and Its Health Impacts
Health Effects Institute

HEI’s New Investigator Awards for 2020



Heresh Amini



Joseph Antonelli



Raphael Arku

The Walter A. Rosenblith New Investigator Award brings new, creative investigators into active research on the health effects of air pollution.

It provides three years of funding for a small project relevant to HEI’s research interests to a new investigator with outstanding promise at the assistant professor or equivalent level. Three Rosenblith award recipients began their funded work in the past year: **Heresh Amini**, University of Copenhagen, Denmark; **Joseph Antonelli**, University of Florida; and **Raphael Arku**, University of Massachusetts, Amherst.

Financial Summary 2020–2021

HEI made significant progress in fiscal year 2021 toward the objectives of the Health Effects of Air Pollution program with ongoing 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 in 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. The significant balance in Temporarily Restricted Net Assets ensures we will have funds to continue and expand our current targeted research initiatives in future years.

STATEMENTS OF FINANCIAL POSITION

	June 30	
	2021	2020
Assets		
Cash and cash equivalents	\$6,089,019	\$6,984,309
Restricted cash	147,962	147,838
Contributions receivable	1,645,968	1,125,904
Unbilled incurred costs on grants	4,504,834	1,369,180
Prepaid expenses	84,841	126,131
Office equipment, office furniture and fixtures, and leasehold improvements, net	54,097	73,097
	<hr/>	<hr/>
Total assets	\$12,526,721	\$9,826,459
Liabilities and Net Assets		
Liabilities:		
Contracted research payables	\$447,471	\$322,063
Accrued contracted research	1,934,203	1,493,603
Deferred rent payable	51,185	59,084
Other accounts payable and accruals	1,070,663	637,240
	<hr/>	<hr/>
Total liabilities	3,503,522	2,511,990
Net Assets:		
Without donor restrictions	656,243	616,506
With donor restrictions	8,366,956	6,697,963
	<hr/>	<hr/>
Total net assets	9,023,199	7,314,469
	<hr/>	<hr/>
Total liabilities and net assets	\$12,526,721	\$9,826,459
	<hr/>	<hr/>

The HEI Financial Statement and the Mayer Hoffman McCann P.C. Auditors' Report may be obtained by contacting Jacqueline C. Rutledge at jrutledge@healtheffects.org.

STATEMENTS OF ACTIVITIES

	Years Ended June 30	
	2021	2020
Revenues and support:		
EPA grants for the Health Effects of Air Pollution Program	\$5,950,844	\$2,953,933
EPA contracts for Energy Research	\$651,100	\$537,944
Other industry contributions	5,161,046	5,327,001
Other non-federal grant and contract revenue	678,918	740,126
Other revenues	39,737	241
Total revenues and support	12,481,645	9,559,245
Expenses:		
Research programs:		
Research studies	4,687,594	3,504,941
Research planning and study selection	618,614	497,873
Scientific study management	276,929	198,562
Scientific study review	285,174	261,988
Scientific publication and communication	858,358	983,426
	6,726,669	5,446,790
Special Scientific projects:		
Energy research	655,620	777,527
Traffic studies review	459,428	427,040
Global health science	992,904	941,744
	2,107,952	2,146,311
Total research and scientific expense	8,834,621	7,593,101
Administration	1,938,294	1,747,055
Total expenses	10,772,915	9,340,156
Net increase in net assets	1,708,730	219,089
Net assets at beginning of year	7,314,469	7,095,380
Net assets at end of year	\$9,023,199	\$7,314,469

REPORT CREDITS

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Project Management and Editing

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Printing

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HEI Energy

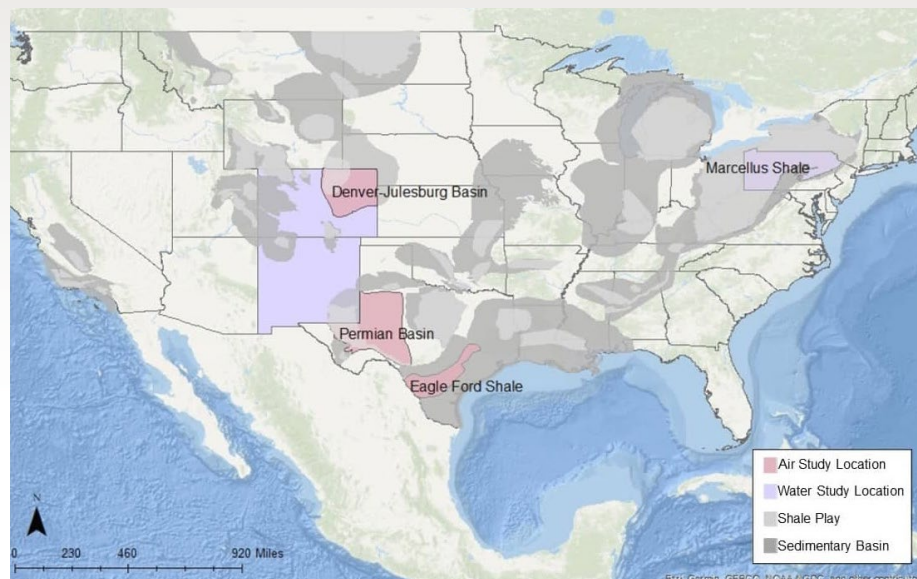
H [EI Energy](#) works to advance knowledge on potential exposures and health effects associated with unconventional oil and gas development. The organization—funded by [sponsors](#) in government and industry with additional support from private foundations—ramped up its activities this past year, marking several key milestones in implementing its research and outreach program.

Bringing Research and Researchers Together

To support its goal of making the latest science accessible to all, HEI Energy manages three key [resources](#):

- a curated literature citation database, updated weekly, which compiles scientific literature on unconventional oil and gas development
- a spatial bibliography, updated monthly, that allows users to explore research specific to particular areas of the United States
- Research Briefs, a series of periodic summaries of literature on selected topics

The organization also brings people together to exchange the latest research insights and provide a forum for discussion on critical issues at the interface of energy and environmental health. Throughout 2021, HEI Energy hosted a series of webinars examining specific unconventional oil and gas development activities and their potential impacts on air, water, and noise in nearby communities. The events summarized current knowledge and generated discussion to inform policymakers, communities, and others who need to make health-based decisions related to these activities. HEI Energy staff also delivered presentations to colleagues at the International Society of Exposure Science,



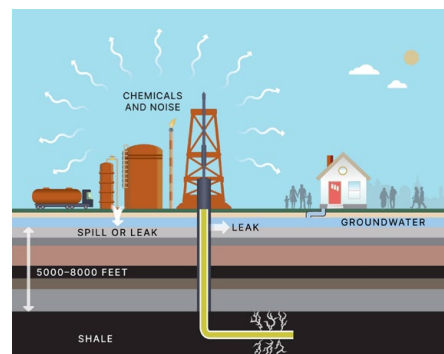
Study locations.

the Shale Network, the Colombian Society of Occupational Medicine, and the American Geophysical Union.

Establishing Guiding Principles and Launching Research

To ensure that HEI Energy’s research activities align with best practices and make meaningful contributions to the field, staff and advisors collaborated to develop a set of [guiding principles](#) for the organization’s funded research. The principles emphasize the key role of community engagement in informing research priorities, conducting studies, and communicating the results.

The HEI Energy Research Committee has selected an initial program of research about air quality, water quality, and noise effects. The investigators are slated to begin their work in early 2022, and progress will be reported at <http://heienenergy.org/research>.



Potential community exposures to be studied in this initial program of research.

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