



Union of
Concerned Scientists

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Catalyst

Volume 19, Fall 2019

The Costs of Vehicle Pollution

*Communities of color
bear the brunt*

Updating the US
Electricity Grid

Interview with
Richard Garwin

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The Union of Concerned Scientists puts rigorous, independent science to work to solve our planet's most pressing problems. Joining with people across the country, we combine technical analysis and effective advocacy to create innovative, practical solutions for a healthy, safe, and sustainable future.

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ON THE COVER:
Thousands of residents in Los Angeles—and communities across the country—are exposed to dangerous air pollution as a result of living near busy highways. See p. 8 to learn about which communities are disproportionately affected by vehicle pollution, and how they can play a role in addressing this problem.

Bringing Nuclear Weapons Issues to Voters



By Ken Kimmell



Presidential campaigns provide the public unique access to candidates and an opportunity to raise issues, provoke debate, and sometimes secure the commitments of candidates to a desired action. Taking advantage of these opportunities, UCS has been busy this year working to insert nuclear weapons policy into the presidential campaign.

We have focused particularly on urging candidates to address a policy of “no first use”—meaning the United States would never initiate the use of nuclear weapons, using them only for deterrence and retaliation against a nuclear first strike. The United States currently retains the option to use nuclear weapons first against other nuclear-armed states. Initiating a first strike, however, would almost certainly start a nuclear war and lead

UCS has been actively questioning presidential candidates about a nuclear no-first-use policy.

to devastating attacks on the United States and its allies. The adoption of a no-first-use policy would reduce this risk, demonstrate the US commitment to reducing the role of nuclear weapons, and lower the chance that an erratic president would use his or her sole authority to launch a nuclear strike.

In public forums, UCS and its partners have been actively questioning presidential candidates about a nuclear no-first-use policy. We have questioned 18 of the candidates, several of whom have publicly pledged their support for the policy. In addition, UCS has conducted polling that shows broad public support for a no-first-use policy, and we've published op-eds calling for more debate on nuclear issues in the presidential campaign. At our urging, CNN correspondent Jake Tapper asked a question about candidates' stances on a no-first-use policy at the second Democratic presidential debate in Detroit in July, giving the approximately 9 million viewers an important opportunity to learn about the issue.

This is how democracy should work. I am looking forward to a more robust public debate on US nuclear weapons policy and I am proud UCS is helping to generate it.

WHAT OUR MEMBERS ARE SAYING

Here's a sampling of recent feedback from the UCS Facebook page (www.facebook.com/unionofconcernedscientists) and Twitter feed (www.twitter.com/ucsusa).

ON THE TRUMP ADMINISTRATION WEAKENING THE ENDANGERED SPECIES ACT

f James Greenberg:
Each species loss makes our ecosystems more fragile, and unpleasant consequences more likely.

f Donna Pemmitt:
This was done to allow corporations to drill, frack, cut, or mine regardless of what creatures would be endangered.

f Wayne Gramelspacher:
Short-term corporate profits cannot justify the long-term damage being caused to our world.

t @BSommerkorn:
Can you imagine looking at the world and saying, "We should make reducing biodiversity easier!" And then lobbying for that goal?

ON UCS REPORTING ABOUT THE TRUMP ADMINISTRATION'S EFFORTS TO UNDERMINE SCIENCE

t @LittleIrishNic:
Your organization is on fire! I used to get frustrated that the scientific community didn't do more direct messaging to the public, since most politicians aren't qualified to interpret and communicate data appropriately. But your communications rock—great work.

ON THIS SUMMER'S DEADLY HEAT WAVES

t @SafeH2o4Schools:
Extreme heat contributed to more deaths in metropolitan Phoenix last year than initially thought: 172 deaths.

t @Hardasshelen:
With this admin, all the warnings are falling on deaf ears . . . they're forging ahead with backward policies. We need more scientists running for local offices/Senate.

f Jim Fritz:
My seven great-grandchildren are going to be in survival mode for most of their lives. Hell of a heritage we are creating for them.

ON THE ATTRITION OF USDA SCIENTISTS AFTER FORCED RELOCATION

f Laura Jodice:
It's a sloppy way to reduce government, devoid of structured, informed decisionmaking. It's like saying you are renovating the kitchen by randomly swinging a sledgehammer throughout the house.

f Judith Stanley:
If a major American company did this there would be criticism. Our own government did this to our own people.



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Public Says: Fossil Fuel Firms Should Pay



EVEN RESIDENTS OF STATES DOMINATED BY THE OIL AND GAS INDUSTRY SAY FOSSIL FUEL COMPANIES SHOULD BE HELD LIABLE FOR CLIMATE DAMAGES.

As the costs associated with climate change—related sea level rise and extreme weather increase every year, the Union of Concerned Scientists wanted to find out how the public perceives the problem. So we commissioned the Yale University Program on Climate Change Communication to conduct a nationwide survey, which came up with some encouraging responses.

Just over half of the survey's 5,131 respondents (53 percent) say global warming is already harming their local community either a "moderate amount" or a "great deal." A majority (57 percent) think fossil fuel companies are responsible

for a "moderate amount" or a "great deal" of that damage and should pay for most or all of it. And fully half support lawsuits against fossil fuel companies to hold them liable for the damage.

Since 2017, the state of Rhode Island and 14 cities and counties from New York City to King County, Washington, have sued major fossil fuel companies, seeking billions of dollars for climate change damages. Roughly half of the lawsuits have been filed in California jurisdictions, including the cities of Oakland, Richmond, San Francisco, and Santa Cruz. Here, legal action has particularly strong support from state residents: nearly

two-thirds (65 percent) of the Californians surveyed in the Yale poll think fossil fuel companies—including Chevron, whose headquarters is 24 miles east of San Francisco—should pay for climate change-related damages.

Even residents of states dominated by the oil and gas industry say fossil fuel companies should be held liable. Fifty-one percent of respondents in Louisiana and

56 percent in Texas—where ConocoPhillips, ExxonMobil, and the US subsidiaries of BP and Royal Dutch Shell are headquartered—agree that the companies should pay the tab.

"These poll results show strikingly widespread public support for the principle of 'polluter pays'—that fossil fuel companies should be held responsible to pay for the climate mess they have created," says Peter Frumhoff, director of science and policy at UCS. "For decades, they purposefully misled the public about the climate risks of their products, and now communities across the country are paying the price."

Killer Heat Report Sizzles in the Media

UCS underscored the hottest July on record with the release of our report *Killer Heat* and a suite of materials projecting future heat index (or “feels-like” temperature) values for the contiguous United States. Comprising the report itself, 433 congressional district fact sheets in both English and Spanish, a video, podcast, scholarly article, blog series, and an interactive tool that allows people to see the future of heat in their community, the *Killer Heat* project aimed to draw attention to the

looming threat of extreme heat—and it succeeded.

The report’s findings garnered more than 2,500 stories in outlets including Agencia EFE, the Associated Press, Bloomberg, *CBS This Morning*, CNN, CNN en Español, the *New York Times*, NPR, *PBS Newshour*, Reuters, Telemundo, Univision, *USA Today*, and the *Washington Post*. Online, *Killer Heat*-related content received almost 25,000 pageviews in the first week of its release, and the interactive tool remains one of the



most-visited UCS webpages. Critically, the report—which clearly connects extreme heat and climate change—prompted the media to make the same connection:

according to an analysis by Public Citizen, about 40 percent of the top 50 US newspapers’ stories linking heat to climate change in July referenced *Killer Heat*.

UCS Commits to an Environmental Justice Platform

Tackling climate change is an urgent necessity, and we need to do it in a way that protects the health and well-being of all communities while addressing

longstanding societal inequities. With that in mind, UCS joined with a group of leading environmental justice advocates and national environmental organizations

this summer to advance an Equitable and Just National Climate Platform (for more information go to www.ajustclimate.org). Each of the organizations that signed on to this platform pledged to work toward:

- full participation by environmental justice groups in developing a shared national climate agenda.

Speaking Out for Future Generations on Climate



In September, after Swedish climate activist Greta Thunberg (left) addressed members of Congress, she joined Brenda Ekwurzel (right), director of climate science at UCS, and other experts for a panel discussion about the mounting impacts of climate change and the need for urgent action. Thunberg’s “school strike for climate” movement has sparked climate marches worldwide.

- a healthy climate and air quality for all;
- access to reliable, affordable, and sustainable electricity, water, and transportation for every community;
- an inclusive, just, and pollution-free energy economy with high-quality jobs;
- putting the United States on a pathway to help limit global warming to 1.5°C; and

Rachel Cleetus, policy director of the UCS Climate and Energy Program and the UCS representative in the discussions leading to this agreement, emphasizes that a shared platform should go far to unite the efforts of the various groups advocating for robust, equitable climate solutions. “At UCS our concerns for climate change and the environment go hand in hand with our commitment to environmental justice,” she says. “We are firmly committed to building this ongoing partnership and view this historic document as a moral compass to help guide our work.”

Assessing Climate Impacts on World Heritage Sites



Coastal erosion is damaging a sea wall at Skara Brae, a Stone Age village that is part of the Heart of Neolithic Orkney World Heritage Site in Scotland. It is at high risk of climate change–related damage, according to the Climate Vulnerability Index that UCS is helping to develop.

Many of the world’s most cherished landmarks are threatened by climate change, including places designated as World Heritage sites, which are deemed by the United Nations (UN) to be important for all humanity, and receive special protections under international law. For example: Venice, Italy, faces an imminent threat from rising seas; Yellowstone National Park in the United States is coping with increased wildfire risk; and the Great Barrier Reef is gravely endangered by ocean warming.

As the climate threat grows, so does the need for a means of determining which of these sites are most at risk and

therefore need the most urgent assistance. To that end, Adam Markham, deputy director of the UCS Climate and Energy Program, has been working with a team to develop the Climate Vulnerability Index (CVI), a tool that draws on the expertise of scientists, site managers, and community members to determine how climate change will affect not only the physical sites but also the people who live near them or depend on them.

In April, Markham helped organize a successful field test of this tool at the Heart of Neolithic Orkney, a World Heritage site in Scotland experiencing

damage from coastal erosion. Markham and his colleagues used the CVI to systematically determine the site’s vulnerability by considering several factors including how often the area floods and how able the community is to adapt.

The team shared its findings in a landmark report at the World Heritage Committee’s annual meeting in Azerbaijan in July, with the goal that the CVI will eventually be adopted as the standard tool for climate risk assessment of World Heritage properties. As Markham explains, climate change will force us to make difficult decisions about preservation and site management

priorities, but this kind of standardized tool can help communities and experts make informed, science-based decisions that take a range of local factors into account.

“The CVI has the potential to be a hugely valuable tool to help these sites and their communities accurately understand and plan for the climate risk they face,” he says. “If applied to all World Heritage sites, it could help prioritize action and elevate public understanding of the threats. And that could hopefully spur greater urgency among nations to meet their commitments under the Paris climate agreement.”

Clean Energy Wins in Maine, with Help from UCS



A wind farm on the Maine coast. New legislation passed this year will ramp up the state's renewable energy capacity.

Riding a nationwide wave of clean energy momentum, Maine passed a series of clean energy bills with strong bipartisan support this spring. The new laws will not only help the state achieve significant cuts in global warming emissions but also make it a national leader on clean energy.

Steve Clemmer, director of energy research for the UCS Climate and Energy Program and a Maine resident, worked with coalition partners on this legislation for years. He testified in support of one bill requiring Maine to generate 80 percent

of its electricity from renewable sources by 2030 and 100 percent by 2050, putting the state on track to have the highest renewable energy standard in the country 10 years from now.

Clemmer also provided technical support on a bill that increases opportunities for community solar projects and provides assistance to lower-income households interested in solar power. He calls the bills a “clean energy grand slam.” For more information, see his blog at <http://blog.ucsusa.org/steve-clemmer/maine-hits-clean-energy-grand-slam>.

UCS “Science for Public Good” Grantees Announced

Through our Science for Public Good grants, UCS offers funding to help scientists and other experts bring their communities together to work on local issues. This summer, we received nearly 50 proposals and named six winners:

Olivia Box, graduate student at the University of Vermont, will hold a workshop for researchers who work with indigenous communities; **Noah Weaverdyck** and **Tamara Milton**, PhD candidates at the University of Michigan, are launching a campaign to bring their campus closer to carbon neutrality; **Isatis Cintron**, PhD candidate at Rutgers University, is planning a climate action forum

in Puerto Rico; **Chris Hawn**, assistant professor at the University of Maryland–Baltimore County, convened a three-day conference on homelessness and environmental hazards; **Jean-Philippe Solves** and **Hannah Bercovici**,

graduate students at Arizona State University, are building awareness about the impacts of the proposed Rosemont copper mine; and **Brittany Avin**, PhD candidate at Johns Hopkins University School of Medicine, is holding a

session to introduce fellow STEM students to Baltimore community members.

Learn more about the UCS Science for Public Good Fund, including how to apply for the next round of grants, at www.ucsusa.org/scienceforpublicgoodfund.

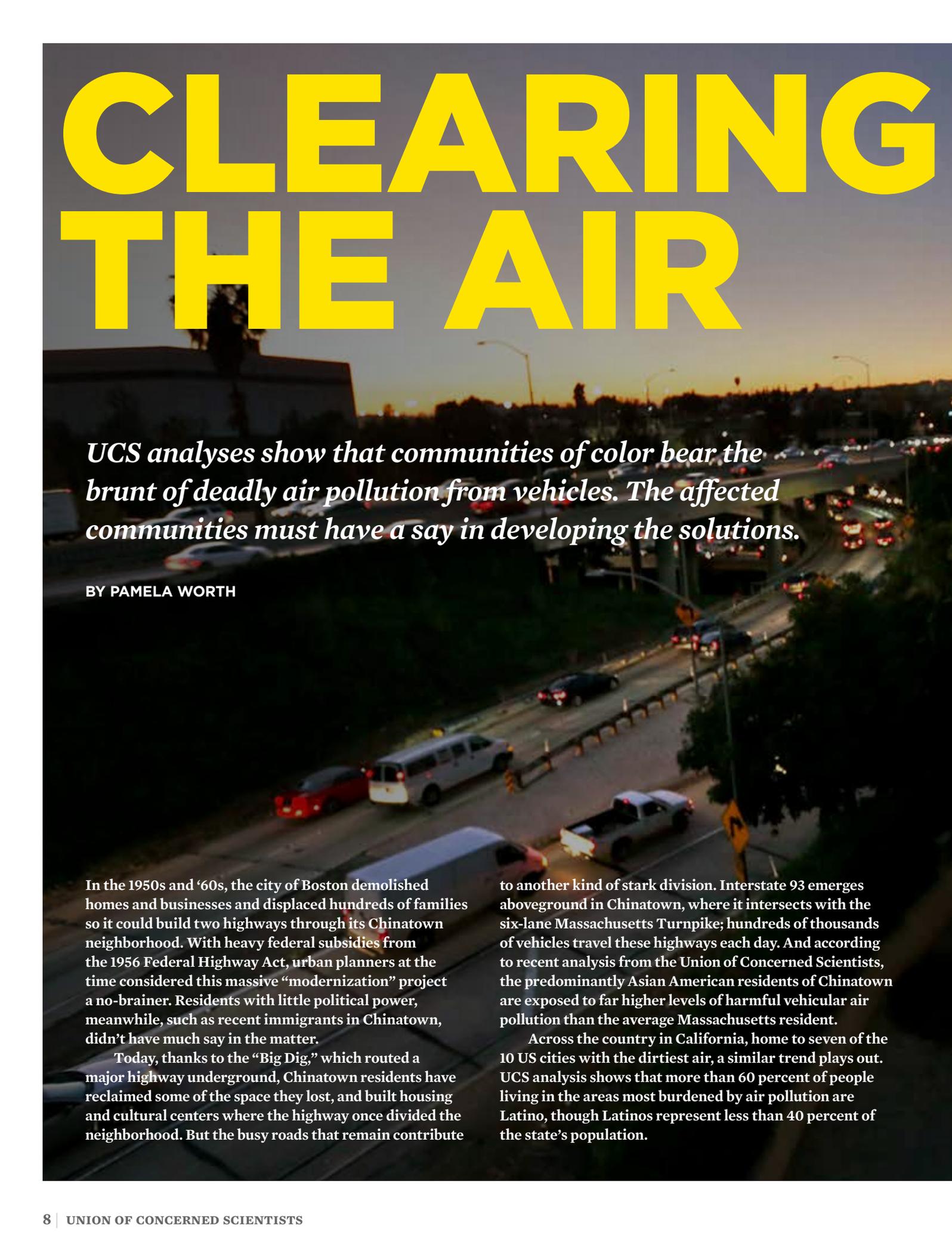
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CLEARING THE AIR



UCS analyses show that communities of color bear the brunt of deadly air pollution from vehicles. The affected communities must have a say in developing the solutions.

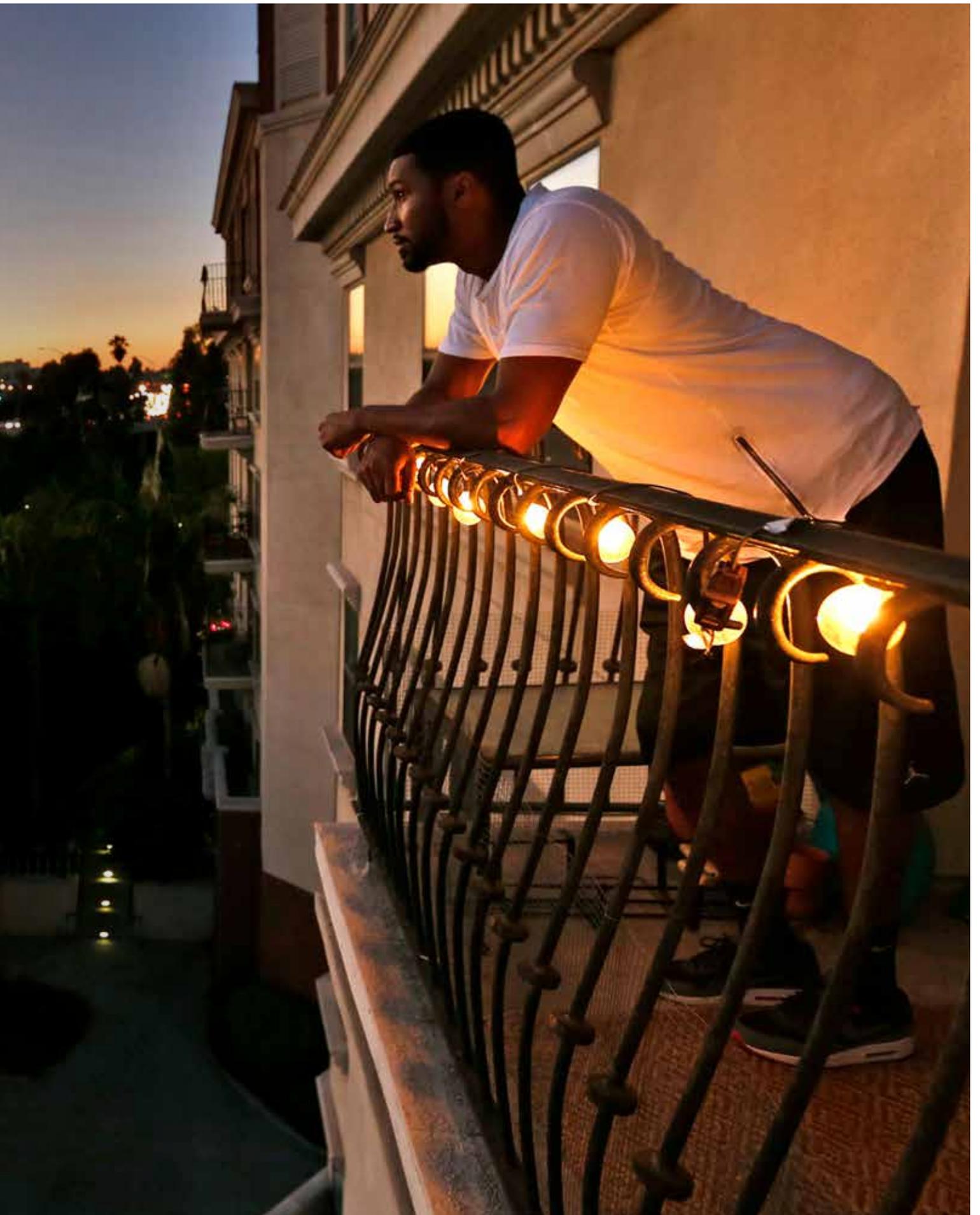
BY PAMELA WORTH

In the 1950s and '60s, the city of Boston demolished homes and businesses and displaced hundreds of families so it could build two highways through its Chinatown neighborhood. With heavy federal subsidies from the 1956 Federal Highway Act, urban planners at the time considered this massive “modernization” project a no-brainer. Residents with little political power, meanwhile, such as recent immigrants in Chinatown, didn’t have much say in the matter.

Today, thanks to the “Big Dig,” which routed a major highway underground, Chinatown residents have reclaimed some of the space they lost, and built housing and cultural centers where the highway once divided the neighborhood. But the busy roads that remain contribute

to another kind of stark division. Interstate 93 emerges aboveground in Chinatown, where it intersects with the six-lane Massachusetts Turnpike; hundreds of thousands of vehicles travel these highways each day. And according to recent analysis from the Union of Concerned Scientists, the predominantly Asian American residents of Chinatown are exposed to far higher levels of harmful vehicular air pollution than the average Massachusetts resident.

Across the country in California, home to seven of the 10 US cities with the dirtiest air, a similar trend plays out. UCS analysis shows that more than 60 percent of people living in the areas most burdened by air pollution are Latino, though Latinos represent less than 40 percent of the state’s population.



UCS analysts are studying data on air pollution and racial demographics across the country, specifically exposure to $PM_{2.5}$, or particulate matter 2.5 microns or smaller in diameter, which is formed in the emissions from cars, trucks, and buses. These so-called fine particulate pollutants are about 30 times smaller than the width of a human hair—tiny enough to travel deep into the lungs when inhaled and even to find their way into the bloodstream.

The team estimated annual average $PM_{2.5}$ levels from vehicles by census tract, using a model to calculate how vehicle tailpipe and refueling emissions lead to ground-level particulate pollution exposure, and comparing the results with racial and other demographic information from each tract. The findings paint a grim picture of the disparate impacts experienced by communities of color.

“Our results aren’t a surprise to anyone who’s been affected by air pollution,” says David Reichmuth, UCS senior engineer and lead analyst for this project. “But we wanted to help quantify what people already knew or suspected in the hopes of helping community groups that have been demanding solutions and justice for years.”



On both coasts, the numbers are stark. In Massachusetts, UCS analysts estimate that Asian American residents are exposed to 36 percent more fine particulate pollution than white residents. African American residents are exposed to 34 percent more; Latino residents are exposed to 26 percent more. However, about 70 percent of white Bay Staters live in areas with concentrations below the state average. In California, on average, African Americans, Latinos, and Asian Americans are exposed to levels of fine particulate pollution that are 43, 39, and 21 percent higher, respectively, than those for white Californians.

“Over and over again, the same results play out. In every area we’ve focused on so far, Asian Americans, Latinos, and African Americans are exposed to higher pollution levels,” Reichmuth says.

“NO SAFE LEVEL”

Fine particulate pollutants, while just one component of overall air pollution, are estimated to be responsible for approximately 95 percent of air pollution’s global public health impacts, says Maria Cecilia Pinto de Moura, a senior vehicles engineer at UCS who collaborated with Reichmuth on the research. In the United States, exposure to fine particulate pollution is believed to be responsible for nearly two-thirds of all deaths from environmental causes. And whether you’re walking through a polluted neighborhood on a day with dangerously bad air quality or you’ve lived there for decades, your proximity to fine particulate pollution is a health risk: both acute and chronic exposure have been linked to illness and death.

In the short term, exposure to elevated levels of fine particulate pollution can exacerbate lung and heart ailments, cause asthma attacks, and lead to both increased hospitalizations and death from cardiovascular disease (including heart attacks and strokes). In the long term, it has been linked to lung cancer,





UCS President Ken Kimmell speaks at a press conference for the release of our report detailing inequitable exposure to vehicle pollution in the Northeast and Mid-Atlantic. UCS found that communities of color are exposed to more particulate pollution in transit corridors (such as the Massachusetts Turnpike in Boston, below left) than white communities.

fertility issues, and even diabetes. For children, exposure has been linked to slowed lung-function growth and the development of asthma, among other negative impacts.

“It’s hard to come up with a definitive answer about whether there’s any amount of PM_{2.5} that’s safe to breathe in,” says Reichmuth, “because there aren’t any people with zero exposure as a control. The data suggest there’s no safe level.”

Burning fossil fuels produces fine particulate pollution directly, and the combustion process in vehicle engines also emits gases that go on to form additional fine particulates through chemical reactions in the atmosphere. There are many other sources of fine particulate pollution, says Reichmuth, but the analyses he and Pinto de Moura have conducted focus solely on vehicle emissions. “We narrowed our focus to make a case to reduce vehicle pollution,” he says, “and alleviate the outsized and unfair burden these particulate emissions place on communities of color.”

“Armed with these data,” says Pinto de Moura, “communities have another tool with which to demand justice.”

FROM DATA TO ACTION

When the two regional analyses were complete, UCS outreach staff took the results to the people and communities who are most affected. In California, our team partnered with The Greenlining Institute to bring together individuals and organizations working for environmental justice. Participants discussed the techniques used in the analysis, how these types of modeling tools could be most useful for communities, and next steps focused on solutions.

“Communities across California are crafting solutions that will help alleviate the inequitable burden of air pollution,” says Coreen Weintraub, Western States senior outreach and campaign coordinator at UCS. “We heard that communities want to be more involved in the development and direction

(continued on p.21)

UNEQUAL LEVELS OF AIR POLLUTION DON'T OCCUR RANDOMLY

The environmental injustice documented in this article is the result of decades of decisions about where to place highways, where to invest in public transportation, and where to build housing.

For many years, codified racism in US housing policies—also known as redlining—made it difficult for people of color to obtain mortgages anywhere but in neighborhoods deemed undesirable by the Federal Housing Administration. The resulting enforced segregation effectively disenfranchised these communities, allowing their voices to be ignored in decisions like the construction of a highway through a neighborhood (as in Boston’s Chinatown in the 1950s and ‘60s).

Although the scope of the analyses referenced here is limited to vehicles and roads, decisionmakers have imposed many other environmental injustices on communities of color, allowing them to be sites for power plants, landfills and toxic waste dumps, and industrial facilities that emit harmful pollutants.

For a more in-depth understanding of how these overlapping decisions and policies (referred to as structural racism) create environmental injustice for people of color in the United States—and for inspiration about how to address these inequities—we recommend the following reading:

“Childhood Asthma: A Lingering Effect of Redlining,” by Kriston Capps (Citylab.com)

“The Case for Reparations,” by Ta-Nehisi Coates (*The Atlantic*)

“Race Best Predicts Whether You Live Near Pollution,” by Bryce Covert (*The Nation*)

“Redlining Was Banned 50 Years Ago. It’s Still Hurting Minorities Today,” by Tracy Jan (*Washington Post*)

“The Racist Housing Policy That Made Your Neighborhood,” by Alexis Madrigal (*The Atlantic*)

The Color of Law: A Forgotten History of How Our Government Segregated America, by Richard Rothstein (Liveright, Inc.)

The Bomb and Beyond

INTERVIEW WITH DR. RICHARD GARWIN



Renowned physicist Richard Garwin's expertise across disciplines helped lay the foundation for many of today's indispensable technologies, including GPS, MRI, touchscreens, and laser printers. An inventor with nearly 50 patents, a prolific author of more than 500 papers, and an advisor to multiple US presidents, Dr. Garwin has served on the UCS board of directors for 20 years and worked with IBM's Watson lab for 40 years, and has taught at Harvard, Cornell, Columbia, and the University of Chicago. Among his many honors, Dr. Garwin has received the National Medal of Science and the Presidential Medal of Freedom and is among just a handful of scientists to have been elected to all three US National Academies (Sciences, Medicine, and Engineering). Learn more about his accomplishments on our podcast, at www.ucsusa.org/ep69-garwin.

At 22 years old, you were working at the Los Alamos National Laboratory with prominent physicist Enrico Fermi, creator of the first nuclear reactor. How did you get involved with that work?

RICHARD GARWIN: My involvement with Enrico Fermi started in 1947, when I began my graduate work in physics at the University of Chicago [where Fermi was a professor]. After a few months in graduate school, I got itchy because there was no lab work. I was an experimenter: my father had a shop in the garage, and he did audio and visual work for schools and businesses. I was familiar with using my hands and working with electronics. So I went to Professor Fermi, and he took me on.

I finished my PhD in 1949, and I was appointed to the faculty in physics at the University of Chicago. But they only paid nine months a year. And by then, my wife and I had a six-month-old—and we ate 12 months a year. So when Fermi said, “Perhaps you could come with me and be a consultant to Los Alamos,” I jumped at the chance. We went in 1950 for three months. And in 1951 for four months, and in 1952 for five months.

You began your career by developing the thermonuclear (hydrogen) bomb. Can you describe that experience?

RICHARD GARWIN: Since I was there in Los Alamos at the invitation of Fermi, I had a good deal of access. And so, the first thing I did was to look at testing of nuclear weapons, because I had some new ideas there. When a physicist is introduced to any subject, they tend to have ideas and that's very good for cross-fertilization.

I spent my first summer looking at the program for making thermonuclear weapons, which had been the same

ever since 1942. On my own initiative, I started building an apparatus for doing a precision measurement to lower energies for the thermonuclear reactions. I had to leave in September, and the laboratory director decided they would continue this. Then in 1951, [hydrogen bomb co-creators and physicists] Edward Teller and Stan Ulam had written a paper on a different way of making hydrogen bombs, but they needed me to design an experiment that would leave no doubt that it would work.

I looked at the paper and tried to design a small-scale experiment. Now, for many years it's been an unclassified fact that US hydrogen bombs—and everybody else's—work by radiation implosion by the energy of the fission primary, like the Nagasaki bomb being confined in a radiation case. And the pressure of this confined energy is used to compress a secondary charge of thermonuclear fuel.

So, in 1951, I published a secret paper at Los Alamos: a four-page memo and a big foldout drawing of a hydrogen bomb test [known by the code name “Mike”]. And the laboratory deemed that was the right way to go, and it was built and tested November 1, 1952, less than 16 months after my paper. Full size, 11-megaton yield, almost a thousand times the energy release of the Hiroshima bomb. And so that was the beginning of thermonuclear weapons in the world.

You've spent much of your career since then advocating for nuclear testing bans and nuclear arms reduction measures. How did you shift from working on nuclear weapons to working against nuclear proliferation?

RICHARD GARWIN: Well, in the early 1950s, people still believed that there could be defense against nuclear weapons. I was only 22 when I went to Los Alamos the first time, and 23 when I designed the

“Today, I more deliberately try to encourage other people to help the world. . . . You have to understand how the world is if you’re going to try to do something about it.”

Mike test that became the thermonuclear weapon. I moved to IBM in December 1952, and they asked me to spend a year or two away to look at air defense of the United States against Soviet bombers armed with nuclear weapons. This was not what I was interested in doing. But they were insistent, and I realized that I would be working with totally new people from MIT and Harvard, who were well-connected in Washington.

We would go down and get threat briefings from the intelligence agencies. This was a totally new aspect of my scientific and technical life, and I learned what Soviet nuclear weapons could do against the United States. It made me very fearful. We had bought a house, and I remember walking around the bedroom saying to myself, what do I want to do with my life? What’s most important? Well, it’s family, it’s the environment. It’s the political stability of the government. Because if you don’t have that, you don’t have assured survival of the family and you can’t do anything about the

environment. So I decided I would work to preserve and improve all these things. That’s a lot of the background of my work with UCS over the decades.

Was there a pivotal moment where you felt that you needed to speak out?

RICHARD GARWIN: Probably it was the antiballistic missile controversy of 1968 when I realized that for more than 10 years, we [the Strategic Military Panel of the president’s Science Advisory Committee] had been writing annual reports to the national security advisor and the president saying, “Here is the Army’s current plan for deploying a missile defense of the entire country. And here’s why it won’t work—either because it doesn’t have the capacity to handle the missiles, or it can’t discriminate, or it’s too expensive.” [Around that time] the publisher of *Scientific American* asked us whether we could provide articles on the topic for the magazine. [Cornell physicist] Hans Bethe and I agreed to do so. That

was the time when I really felt that I had to inform Congress and the incoming staff of every presidential administration [about the limitations of the proposed antiballistic missile system].

In your illustrious career, you’ve played a role in so many of today’s technologies, from GPS and magnetic resonance imaging to laser printers. Now, at 91, are you retired and relaxing, or still working in the sciences?

RICHARD GARWIN: Today, I more deliberately try to encourage other people to help the world. Many of them are more talented than I am. They have better people skills, better scientific and technological skills. People who’ve grown up with the technology have a great advantage over those of us who spent \$1,000 for a PC in 1980.

I don’t relax. I watch a lot of C-SPAN, so hearings—which are not all good news. But you have to understand how the world is if you’re going to try to do something about it. {C}

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CLEAN ENERGY BATTERY STORAGE = GAME CHANGER

Bringing the US Electricity Grid into the 21st Century

BY ELLIOTT NEGIN

Despite the Trump administration's continuing attempts to stymie efforts to address climate change, the burgeoning market for renewable energy seems likely to foil its agenda, at least when it comes to generating electricity.

No matter how much President Trump "digs" coal, for instance, it can no longer compete economically. Since 2010, at least 289 coal plants have closed, comprising 40 percent of US coal power capacity, and 50 of those plants have shut down since Trump took office.

Meanwhile, renewable electricity generation has nearly doubled over the last decade, and close to 90 percent of that expansion has come from wind and solar, which jumped more than five-fold. This April, wind, solar, and hydroelectric power produced more electricity than coal for the first time ever.

That's all good news. If wind and solar maintain their exponential growth rate, the United States is on track to get all of its electricity from clean energy sources by 2050. Fulfilling that potential, however, will require two major advances: updating the rickety US electricity grid and implementing energy storage technologies that can enable the grid to incorporate more wind and solar power.

That's why the Union of Concerned Scientists is focused on making those two critical goals a reality.

UPDATING AN ANTIQUATED SYSTEM

In the early 1990s, UCS launched a campaign to persuade states to increase the amount of electricity they generate from renewable resources over time. Since then, 29 states and the District of Columbia have established mandatory renewable electricity standards; and some, such as California, Hawaii, Maine, Vermont, and the nation's capital, have set targets of 100 percent by mid-century.



Energy storage can be part of new renewable energy projects, such as this solar farm in Australia (left), or built in established communities, such as this facility in Illinois (right).



Renewable electricity standards have proven to be one of the most effective ways to curb US global warming emissions. It would be even more effective to have a national standard, and New Mexico Senator Tom Udall has proposed one of 50 percent by 2035. But ratcheting up renewable electricity requirements can go only so far without modernizing the grid and increasing storage capacity. As Mike Jacobs, a UCS senior energy analyst, puts it: “After our success with renewable electricity standards, and now that wind and solar are becoming cost-competitive, the grid issue looms large.”

While today’s smart mobile phones boast more than 100,000 times the processing power of the computer onboard Apollo 11, most of the power plants, transmission lines, transformers, and poles that comprise the grid are at least 40 to 50 years old, built during the expansion of the electric power sector in the decades following World War II. With its aging equipment, capacity bottlenecks, and vulnerability to climate impacts, today’s grid gets a barely passing grade of D+ from the American Society of Civil Engineers.

And, while the grid was designed to transmit electricity from large, centralized plants, power today flows from many more sources, including solar panels and wind turbines. Rooftop solar panels and other “distributed” generation systems reduce the distance electricity has to travel, potentially increasing efficiency and saving money, but they also increase the complexity of transmitting electricity, and the amount generated from hour to hour varies. Investments in grid infrastructure can help incorporate modern technology that will make the grid more resilient and flexible, better able to integrate variable energy sources and transmit power when and where it’s needed, and capable of providing real-time information to help consumers manage their energy use and reduce costs.

100 PERCENT CLEAN ENERGY IS POSSIBLE—WITH STORAGE

A modernized electricity grid would have the capacity to store large amounts of excess electricity. Today, utilities have to

produce the exact amount of electricity needed at a specific time to meet demand. With advanced storage technology, it doesn’t have to be that way. “Our electricity grid is where our food distribution system was before refrigeration,” says Jacobs. “Up until the 1920s, when the refrigerator became widely available, most people had to eat fresh food right away because they had no good way to keep it cold.”

Having a grid with storage capacity means that if solar panels generate more energy than is needed on a sunny day, consumers can still benefit from it when they turn on their lights at night. One storage technology—pumped hydroelectric—has been around since the 1890s, and there has been increased interest in it in recent years because it can be paired with variable renewable sources. Hydroelectric plants pump water to elevated reservoirs and release it through turbines to generate electricity when demand is high. With 23 gigawatts of capacity, pumped hydro is currently the largest type of energy storage in the United States. That said, it represents less than 2 percent of US generating capacity and is unlikely to grow much more due to the cost of building such large facilities.

The ideal solution would be rechargeable, factory-size batteries that can store massive amounts of energy for days or even weeks. Today’s grid-scale batteries generally lack capacity to store much more than a few hours’ worth of the energy used in a given market. That’s enough to accommodate solar or wind power variability, but not nearly enough to fully switch from fossil fuels to renewables.

While billions of private sector dollars are now pouring into research and development for electric vehicle batteries, they are only trickling in for grid batteries because the market is still in its infancy. That makes funding dependent on the US government, which historically has supported cutting-edge research before the private sector was ready to invest. But federal funding for grid battery R&D has been deficient, and the United States is falling behind China, Japan, and South Korea in the global battery market.

Energy storage does for our electricity grid what refrigeration did for our food distribution system. Just as we now store fresh food to eat later, we can store solar power generated during the day for use at night.

MAKING IT HAPPEN

In March 2018, UCS joined forces with the Bipartisan House Advanced Energy Caucus to cosponsor a conference with top energy experts from around the country to discuss how the federal government can best encourage energy storage innovation. Their recommendations—including expanding public-private partnerships, investing in promising experimental battery technologies, and underwriting demonstration projects—formed the basis for proposed legislation we shared with members of Congress.

As a follow-up to that conference, UCS flew in 25 clean energy advocates, including environmental justice leaders and renewable energy company officials, for three dozen meetings on Capitol Hill this past April to request more federal funding for energy storage and an energy storage tax credit.

The result? At least five bipartisan energy storage bills are now pending in the Senate, and two of them include UCS recommendations. The House, meanwhile, passed an appropriations bill in June that boosts the Energy Department's energy storage budget by nearly 35 percent and its Advanced Research Projects Agency budget by 16 percent, and the House Science Committee is close to finalizing an energy storage R&D package that includes a number of UCS recommendations.

"Energy storage technology was developed right here in the United States, but we are way behind other countries," says Rob Cowin, director of government affairs for the UCS Climate and Energy Program. "Increasing federal funding for energy storage R&D will pay big dividends for the US economy and national security. Taking the right steps now will make our electricity grid cleaner, more reliable, and more affordable." {C}

BUILDING ENERGY STORAGE SOLUTIONS THAT WORK FOR EVERYONE



A wide range of stakeholders from across the country participated in our December 2018 conference to develop a set of principles to ensure equitable deployment of energy storage technologies.

While UCS is pushing hard for a modernized electricity grid that includes new energy storage technologies, the organization is also at the forefront of ensuring that energy storage projects are deployed *equitably*.

"The transition to a clean energy economy must address the needs of disadvantaged 'frontline' communities that have historically borne the brunt of pollution," says Jeremy Richardson, a UCS senior energy analyst (see p. 11 for a discussion of how this

type of inequity occurs). "Energy storage has enormous potential to benefit these communities directly."

In Chicago last December, UCS held a first-of-its-kind conference for renewable energy experts, labor union reps, consumer advocates, faith leaders, and environmental justice organizers to discuss equitable energy storage deployment. The 30 or so participants agreed that energy storage projects should be designed to reduce and ultimately eliminate fossil fuel plant emissions, improve grid and community resilience, promote local economic development, encourage renewable energy, reduce electricity bills, and guarantee community input.

In July, UCS organized meetings between grassroots advocates and congressional staff members on making federal energy infrastructure policies more equitable. The activists met with six House and Senate offices and also briefed House Natural Resources Committee staff.

"Congress hears from fossil fuel industry lobbyists all the time, so it's really important that they hear from clean energy advocates who live outside the Washington bubble," says Richardson. "The message the advocates delivered was clear: Well-planned energy storage policies can help the country meet ambitious climate and energy targets and still put frontline communities first."

The Birth and Growth of a Watchdog for Scientific Integrity

BY SETH SHULMAN

In the summer of 2003, I was working as a freelance journalist reporting on science and technology when I got a call from the Union of Concerned Scientists asking me to attend a meeting to discuss a potential “unusual” assignment.

The organization’s president and many of its senior scientists and policy analysts were in attendance, and their sense of alarm was palpable. They said reports were coming in from across the federal government of a then-unprecedented level of political interference and manipulation of science in the George W. Bush administration.

UCS wanted to independently corroborate the trend, but this type of work was a bit out of its comfort zone. Though the organization had a well-earned reputation as a highly effective and independent advocate for specific science-based policies, the staff worried that wading into this overtly political morass might seem partisan.

Little did any of us know how consequential this meeting would turn out to be.

PUTTING SCIENTIFIC INTEGRITY ON THE MAP

Upon investigation, I quickly confirmed that the problem was serious and widespread. Top-notch scientists on advisory panels had been subjected to political litmus tests and some had been replaced by ideologues with dubious credentials. Many government scientists reported confidentially that their work was being censored or even distorted.

The evidence was stark and, in early 2004, UCS released its findings in a report titled *Scientific Integrity in Policymaking*. In



In the 15 years since UCS put scientific integrity on the map with its report *Scientific Integrity in Policymaking*, we have been examining and exposing government efforts to sideline science from decisions that affect our health and safety.

MORE THAN
10,000 EXPERTS
SIGNED THE 2004 STATEMENT
CALLING FOR
SCIENTIFIC INTEGRITY
IN POLICYMAKING.

a wise move, UCS paired the report with a statement signed by more than 60 of the nation’s most eminent scientists, including Nobel laureates, National Medal of Science recipients, and members of the National Academy of Sciences. The signatories were too distinguished and diverse to be dismissed as a partisan attack, and their numbers eventually swelled to more than 10,000.

The statement caused an enormous stir, making *Scientific Integrity in Policymaking* one of the organization’s most widely publicized reports. It drew a point-by-point rebuttal from the White House and, importantly, elevated the issue onto the public agenda. In the process, UCS established itself as a watchdog defending the right of government scientists to conduct their work free from political interference—a bold step that eventually spawned a new division within UCS.

A POWERHOUSE IS BORN

In the ensuing years, UCS saw the potential to play a larger and more sustained role as a guardian of scientific integrity, and raised funds to expand what had been a small team monitoring the issue since 2004 into the Center for Science and Democracy at UCS in 2012.

Of course, at the time, no one could foresee the even more brazen assault on science the Trump administration would mount. But, as a testament to the commitment UCS leadership made when reflecting on the critical role science plays in our democracy, the Center for Science and Democracy now sits at the frontline of the organization’s efforts to defend government science—and scientists—from attack.

TODAY, MORE THAN
26,000 SCIENTISTS
AND
OTHER EXPERTS
ARE MEMBERS
OF THE
UCS SCIENCE NETWORK.

Today, with a staff of nearly two dozen, the Center has grown into a powerhouse with a national reputation, working to both monitor and blunt attacks on science, pushing for electoral and governmental reforms that will restore science-based policymaking, and building systems to engage the US scientific community in critical policy debates—both today and well beyond the Trump administration.

Over the past seven years, the Center has built an impressive track record of pushing back against efforts at the Environmental Protection Agency and many other federal agencies to undermine science, both in the studies they use to make policy and in the makeup of their scientific advisory committees. The Center has undertaken a series of large-scale surveys of government agencies to hear how science is being conducted and communicated directly from the scientists and analysts themselves. And it has worked to grow the UCS Science Network that now comprises some 26,000 individual scientists around the country who are committed to sharing their expertise and standing up for science.

In testimony before the House Natural Resources Committee earlier this year, Center for Science and Democracy Director Andrew Rosenberg said, “The erosion



Michael Halpern (left), deputy director of the Center for Science and Democracy at UCS, spoke at a July congressional hearing to support bipartisan legislation to protect scientific integrity at federal agencies.

of scientific integrity in government has hit a fever pitch in the last two years. Barely a week goes by without hearing of scientists who are prevented from sharing their expertise with the public, or analytic work that is censored, or experts who are prevented from communicating with Congress, or data that is made less accessible through websites, or science that is misrepresented.”

Thankfully, the Center is there to lend its voice to those whose words are being suppressed, and to build support among UCS members and the public. As Rosenberg told the committee, “When science is sidelined from public policy or scientific integrity is compromised, public health, safety, and our environment are undermined. Simply put, we cannot make good policy in the public interest unless we fairly consider the weight of scientific information.” {C}

A TRIBUTE TO SOMEONE SPECIAL: A GIFT SUPPORTING SCIENCE

Consider making a gift in the name of someone in your life who would be proud to support UCS.

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To learn more, visit
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Or call (800) 666-8276 for assistance.



Poetry to Inspire Hope: Elizabeth J. Coleman



In late 2016, as the incoming Trump administration began signaling its intent to reverse years of progress on climate change, Elizabeth J. Coleman felt despair. To replenish her hope, Coleman—a poet, public interest attorney, environmental activist, and mindfulness teacher—turned to reading poetry.

“Poetry expresses both our grief about what we’ve done and what has befallen us, and the possibility of doing things differently,” she says. “It makes me feel engaged, like there’s a way forward.”

As she read, inspiration struck: what if she could channel her dread, and her need to do something, into a collection of poems

that might inspire readers around the world to address our environmental crisis?

“I felt a deep call to do whatever I could,” she says, “both for our Earth itself, and for marginalized communities who suffer most immediately from the climate crisis.”

So Coleman got to work.

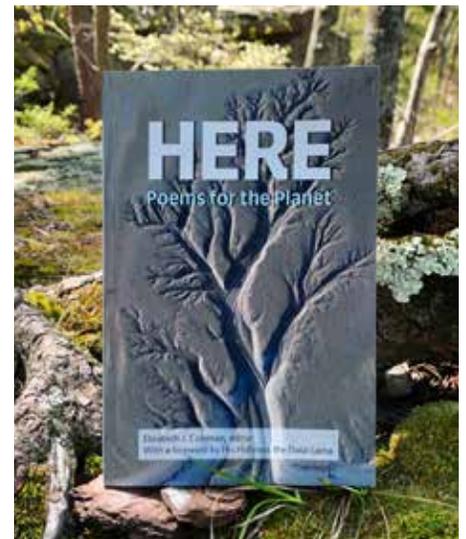
“I’ve been all in from day one on this project,” she says of her collection *Here: Poems for the Planet*, published by Copper Canyon Press this past Earth Day. With poems from 128 diverse and celebrated poets (including Pulitzer Prize winners and US poet laureates), a foreword from His Holiness the Dalai Lama, and a guide to activism from UCS, the book is already in its second print run, with thousands of copies sold and full-to-capacity book release events.

A UCS member for more than 15 years, Coleman decided to donate the book’s proceeds to the organization. She says it was an obvious choice.

“As a lawyer, I’m a true believer in evidence and science,” she says. “I felt confident in the rigor of UCS, that I’d be dealing with an organization that is solid and based in science. And as a poet, part of what I love about UCS is that science is so poetic. There’s a glorious connection.”

Coleman’s book is organized thematically, with odes and elegies to Earth and its inhabitants, poems to inspire action, and young people’s voices on the future. The concluding UCS activist guide provides practical tips for readers seeking ways to contribute to the fight against climate change. It can be purchased at <http://store.ucsusa.org>.

“This book has given me hope,” Coleman says. “In speaking to our hearts, and not just our minds, poetry can lead to action as well as hope.” {C}



MAXIMIZE YOUR IMPACT: GIVE A GIFT OF STOCK

By making a gift of stock to UCS, you could earn significant tax savings on capital gains—while standing up for science.

IT'S A SMART WAY TO GIVE.

For more information on making a gift of stock, visit www.ucsusa.org/stockgifts or call (800) 666-8276.

Clearing the Air

(continued from p.11)



Decades of misguided policies on housing and transit have resulted in urban communities suffering the health impacts of vehicle pollution on congested roadways. Investing in public transit, affordable housing near transit, biking and walking paths, and more efficient vehicles can help reverse this trend.

of research like this, and that solutions to these problems exist at both the state and local levels. The connections we made will help inform our future work on how solutions like electrification will affect both emissions and equity.”

On the opposite coast, our analysis drew attention both from the media and local officials. In Chinatown, on the open-air basketball court of a school located near the confluence of I-93 and the Massachusetts Turnpike, UCS Northeast Campaign Coordinator Paulina Muratore organized a press conference with state legislators, city councilors, and local media to announce the Massachusetts results. After the event, state officials used UCS-created maps to identify the most overburdened cities and towns, pledging to host solutions-focused workshops in those communities.

Reichmuth, Pinto de Moura, and their team are now compiling estimates of fine particulate exposure from vehicles among racial and ethnic groups across the entire country. Pinto de Moura, specifically, is pushing for better policies by studying the impact of vehicle pollution in the 12 states and Washington, DC, that are currently partners in the Transportation and Climate Initiative (TCI), a regional collaboration to reduce emissions from transportation and invest in clean solutions.

“There’s so much opportunity with the TCI to achieve significant emissions reductions,” Pinto de Moura says. “The data we are compiling can be used as evidence of the need for clean, modern transportation—which means better public transit so people can leave their cars at home more often, use more efficient cars that burn less gasoline per mile, or even better, switch to electric cars, trucks, and buses that have no tailpipe emissions at all.”

However, she cautions, decisions should not be made *for* communities of color, but *by* communities of color. “Efforts to reduce air pollution are not meaningful without the inclusion and active participation of the people most affected by it,” she says.

Reichmuth agrees. “Policymakers and high-exposure communities can use this information to decide how to right these wrongs,” he says. “Ignoring the voices of people of color is how we got here. The remedy is community-based and -sourced decisionmaking.”

CONCRETE SOLUTIONS

Reichmuth and Pinto de Moura’s thorough analyses include many concrete steps policymakers can take to lessen exposure to fine particulate pollution in communities of color. Pinto de Moura says legislators should subsidize the cost of electric cars for low-income residents, invest in charging infrastructure, provide incentives to electrify trucks and buses, improve public transit, build affordable housing near transit, build better sidewalks and bike paths, and guide the development of urban spaces to minimize the distances people need to travel, among other efforts.

Reichmuth stresses that because the imbalance in pollution exposure is systemic in nature, caused by racist policies (see the sidebar on p. 11), correcting it will require systemic action.

“This is definitely not about personal choices,” he says. “We can choose whether we own a car, or what kind of car we buy. But we can’t choose whether an electric or diesel bus picks us up at the bus stop, or whether the delivery trucks going through our neighborhoods are emitting fine particulate pollution that we breathe in. These are policy decisions, and we need to make sure they are fair for all of us.”

Reichmuth, Pinto de Moura, and their team are working to release countrywide analyses, along with additional research into how the widespread adoption of electric vehicles would help lessen exposure to fine particulate pollution in the most affected communities. Find the current analyses in English and Spanish at www.ucsusa.org/CA-air-quality-equity and www.ucsusa.org/northeast-air-quality-equity. {C}

Questions for 2020 Presidential Candidates



The stakes could not be much higher in the coming election, given that the next president must contend with two issues that threaten the very existence of humanity: nuclear weapons and global warming. One can kill quickly on a vast scale, the other could lead to gradual extinctions. At the same time, a relentless assault on science, truth, and justice is under way, with its own serious consequences for our health, our safety, and our democracy. Here are some key questions you can ask during the 2020 campaign season to ensure candidates stand up for science—and do so on the record.

Note: as a 501(c)(3) organization, UCS does not support any candidate for office.

NUCLEAR WEAPONS

The United States currently has roughly 4,600 nuclear weapons in its arsenal, with many of them set to launch at a moment's notice. Just one could kill

hundreds of thousands of people if detonated above a major city.

What is your plan to reform US nuclear weapons policy, reduce the size of the world's nuclear arsenals, and work with other nations to reduce the risks nuclear weapons pose?

Specifically, what's your position on adopting a policy stating that the United States will never use nuclear weapons first in a conflict?

CLIMATE CHANGE

The Intergovernmental Panel on Climate Change says we have 12 years to make drastic cuts in global warming emissions if we are to avoid the worst impacts.

Will climate action be a top priority once you take office?

What is your plan to keep people safe from a changing climate?

How do you plan to accelerate the deployment of renewable energy and the modernization of our outdated electricity grid to accommodate renewable energy?

In addition, we now know that major fossil fuel companies have long been aware of the threat posed by climate change, yet they funded misinformation designed to confuse the public about climate science and block needed climate action.

Will you defend the right of communities, states, and other industries to sue the fossil fuel companies in order to make them pay for their share of the damages caused by climate change?

TRANSPORTATION

This sector is now the largest source of global warming emissions in the United States, and transportation-related air pollution disproportionately affects vulnerable communities.

What will you do to put us on a path to electrify cars and trucks, make our fuels cleaner, and make vehicles go farther on a gallon of gas?

ATTACKS ON SCIENCE

The actions of the Trump administration and its corporate and political allies threaten everything from the safety of our food to the quality of the air we breathe and the water we drink.

How will you safeguard scientific integrity and ensure federal agencies don't sideline science from decisions that affect public health, safety, and the environment?

BE ONE OF 500 FOR THE FUTURE

For our 50th anniversary, UCS is looking for 500 people to step forward with a legacy gift to strengthen our future.

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UCS can be named in your will or trust as the beneficiary of a set dollar amount, percentage, or specific assets. You can also leave a gift to UCS through your retirement, life insurance, or other financial account after your lifetime. Please reference our tax ID #: 04-2535767.

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If you have already left a gift to UCS in your will or other estate plan, please let us know so that we can thank you and welcome you to the Kurt Gottfried Society, our honorary legacy society.

CONTACT US

For more information, please contact the Planned Giving Team at (617) 301-8095 or email plannedgiving@ucsusa.org. Or visit www.ucsusa.org/legacy.



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