

Policy for a Sustainable Future

Federal
environmental
acts: the first
50 years
PAGE 12

Calculating
the social cost
of carbon
PAGE 6

Equity and
California's
clean energy
programs
PAGE 16



Berkeley Rausser

College of Natural Resources

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LETTER FROM THE DEAN

In the 1970s, growing public awareness of environmental degradation prompted the formation of the Environmental Protection Agency, followed by two bedrock pieces of federal environmental legislation: the Clean Air Act and the Clean Water Act. Fifty years later, we acknowledge the progress those laws made possible while also recognizing the gravity of the ongoing climate catastrophe. As a new administration works to deal with this crisis, revitalize our economy through investments in green infrastructure, and address systemic inequities, the history and scholarship of environmental policy offer vital lessons.

This issue of *Breakthroughs* highlights Rausser College of Natural Resources researchers working at the nexus of environmental policy and regulation, climate change, innovation, renewable energy, and environmental justice. “State of Regulation” (page 12) centers on Berkeley faculty who are analyzing the successes and failings of landmark federal statutes like those mentioned above. “Electrifying America” (page 16) features economists who are evaluating real-world outcomes of California energy policy, bringing resulting equity issues to light and informing future policy in the state and across the nation.

We’re delighted to include a Q&A with former California governor Jerry Brown on the policy-research interface and his goals for the California-China Climate Institute. Finally, we profile an alumna who’s advancing equitable, sustainable development through her leadership at the California Strategic Growth Council.

In recognition that global environmental change is a defining challenge of our time, one of the five themes of UC Berkeley’s *Light the Way* campaign is Energy, Climate, and Environment. I’m happy to share that Rausser College—continuing on despite the difficulties created by the pandemic—is leading the charge on this important initiative. We hope you’ll consider supporting our university’s important work to tackle this global challenge and create a more viable future for all people.

I welcome your feedback at dackerly@berkeley.edu.

David D. Ackerly



BREAKTHROUGHS

SPRING 2021 / CONTENT

State of Regulation

Assessing 50 years of foundational environmental policy

Page 12

Electrifying America

California's renewable energy policy offers lessons for the nation

Page 16

2 BRIEFS

Body language | Cooking close-ups | Conservation beyond bounds | Fighting plant pandemics . . . *and more*

3 IN THEIR OWN WORDS

Jonas Meckling on the global green race

4 FIVE KEY LESSONS

Economics of supply chains

6 ON THE GROUND

The social cost of carbon

8 Q&A

Former governor Jerry Brown on optimism for climate action

22 PROFILE

Louise Bedsworth leads the California Strategic Growth Council

24 COLLEGE GIVING

Professor Wayne Getz and his family support transfer students

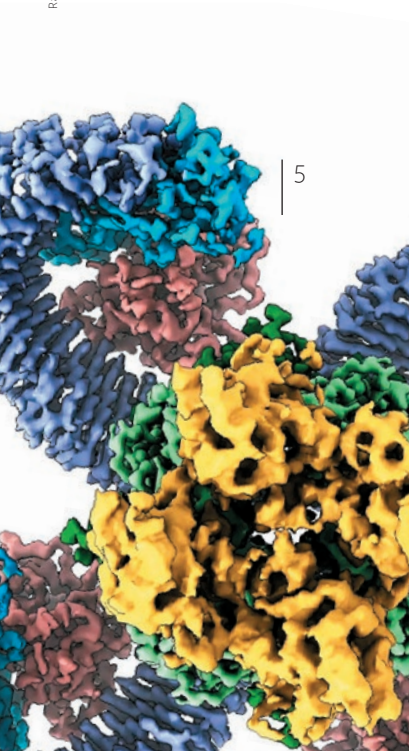
25 THE BIG PICTURE

Frost, frogs, and fungus

ONLINE

Professor **Rachel Morello-Frosch** and alumna **Jane Flegal** are just a few researchers from Rausser College who have joined the Biden administration. Learn more at nature.berkeley.edu/policy.

Raoul Martin (plant pandemics); Tyler Varsell (regulation); Louise Bedsworth (Bedsworth)



5



8



12



22



Body Language

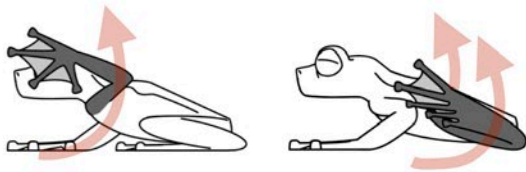
Most frogs emit a characteristic croak to attract the attention of a potential mate. But a few species that call near loud streams—where noise may obscure their calls—also show off with a flap of a hand, a wave of a foot, or a bob of the head. Frogs who “dance” near streams have been documented in the rainforests of India, Borneo, Brazil, and now Ecuador.

Rebecca Brunner, a PhD candidate in the Department of Environmental Science, Policy, and Management (ESPM), has discovered that the glass frog *Sachatamia orejuela* can be added to the list of species that make use of visual cues in response to their acoustic environments. It is the first time a member of the glass frog family has been observed using such visual communication.

Little is known about the mating and breeding behavior of *S. orejuela*. This species is almost exclusively found on rocks and boulders within the spray zones of waterfalls—where rushing water and slippery surfaces likely offer protection against predators. Their green-gray color and semi-transparent skin make them nearly impossible to spot. They’d also never been heard before now.

Brunner was chest-deep in an Ecuadorean rainforest stream recording the call of an *S. orejuela* for the first time when she also observed various visual signaling behaviors and captured them on video. Her discovery was documented in the journal *Behaviour* in December.

“I was already over the moon because I had finally found a calling male after months of searching. Before our publication, there was no official record of this species’ call, and basic information like that is really important for conservation,” Brunner said. “But then I saw it start doing these little waves, and I knew that I was observing something even more special.” — *Kara Manke*



Rebecca Brunner discovered that an elusive glass frog species (*Sachatamia orejuela*) uses both high-pitched calls and visual signaling (shown here) to communicate near loud waterfalls.

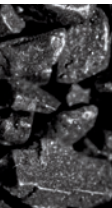


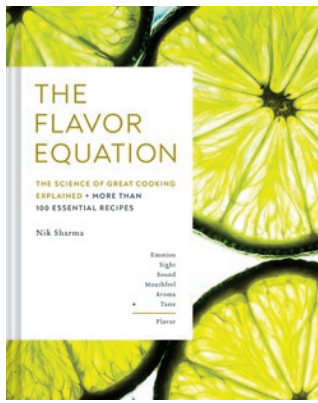
Did you know?

SHYAMALA GOPALAN, THE MOTHER OF VICE PRESIDENT KAMALA HARRIS, EARNED HER PHD FROM UC BERKELEY IN 1964.

In 1958, at the age of 19, she moved from India to enroll in the graduate program in nutrition and endocrinology—which is now a part of the Department of Nutritional Sciences and Toxicology at Rausser College of Natural Resources. Her dissertation, supervised by nutrition professor **Richard L. Lyman**, focused on an inhibitor protein in whole wheat flour. Dr. Gopalan went on to become a leading cancer researcher. She passed away in 2009.

Rebecca Brunner (frog and figure); via Biden for President (Gopalan)

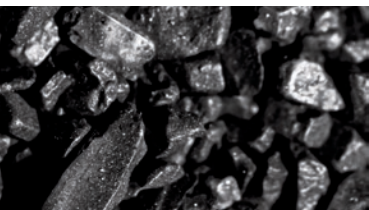




Cooking Close-Ups

As a trained molecular biologist, food writer Nik Sharma has always been interested in the science of food and flavor. In his latest cookbook, *The Flavor Equation: The Science of Great Cooking Explained + More Than 100 Essential Recipes* (Chronicle Books, 2020), Sharma explains various chemical and physical processes that occur in the kitchen. For some of the book's visuals, he used microscopes in Rauser College's Biological Imaging Facility, capturing striking macro images of culinary essentials including salts, sugars, and yeast.

Chronicle Books (book cover), Nik Sharma (food close-ups)



Pictured, from top: Hawaiian black salt, Maldon sea salt, and brown sugar.

In their own words



The Global Green Race

BY JONAS MECKLING

For decades, climate policy was primarily environmental policy. At UN conferences, for example, countries negotiated emissions-reduction targets and timetables. In recent years, another part of climate policy has increasingly gained traction: innovation and industrial policy. As countries seek to develop, manufacture, and deploy low-carbon technologies such as solar photovoltaics (PV), onshore and offshore wind power, electricity storage, electric vehicles (EVs), and hydrogen power, climate policy has come to be about global economic competition—and who will play what role in the green economy of the future.

European economies and China previously led the charge, but now, many more countries are joining the global green race. Economic relief and stimulus packages—in response to the economic crisis resulting from the coronavirus pandemic—contain various allocations for green industries and technologies. In addition, nations are pursuing long-term climate investment agendas, which place green technologies and infrastructure at the center of economic development. These include the E.U.'s Green Deal, South Korea's Green New Deal, and the Biden administration's 10-year \$1.7 trillion climate investment plan.

Global competition in green technologies and industries can lead to a worldwide focus on innovation. For example, California's 2012 Zero-Emission Vehicle standard helped foster the rise of Tesla and the deployment of electric vehicles within the state, but it also pushed most automakers around the world to develop EVs to comply with California's regulation. Later, China adopted an EV mandate. These regulatory moves helped change the technological trajectory of the auto industry, and now a growing number of companies, such as Volkswagen and GM, are shifting toward an electric future.

However, global green competition can also lead to conflicts that stymie decarbonization efforts. A protracted trade dispute between the United States and China increased the cost of solar PV in the U.S. relative to what it would have otherwise been in open markets. Governments engage in geopolitical battles over rare earth minerals that are central to the development of several low-carbon technologies.

The world has entered an era in which global green-technology competition and global climate cooperation coexist. It is essential that policy makers steer the global green race to deepen and broaden international climate cooperation.



Jonas Meckling is an associate professor in ESPM who has written extensively on climate and clean energy policy. He leads the Energy and Environment Policy Lab and previously served as senior adviser to Germany's minister for the environment.

Conservation Beyond Bounds

Though wildlife is a key attraction for visitors to national parks, animals don't often recognize park boundaries. Many species seen in parks range widely into surrounding areas, creating significant management expenses or conservation demands for nearby communities and state and local govern-



Bison roam a Grand Teton National Park hillside. New research explores funding strategies for large-landscape conservation adjacent to both Yellowstone and Grand Teton National Parks.

ments. The expenses include compensating ranchers for livestock depredation by large carnivores, building highway crossings and wildlife-friendly fences for migrating animals, and securing conservation easements on private land.

Using Grand Teton and Yellowstone National Parks as case studies, a recent paper co-authored by Berkeley researchers and their colleagues explores how states, working with national parks, could tap park visitors to fund wildlife conservation beyond park boundaries.

"The Greater Yellowstone is where the concept of managing the larger ecosystems beyond park boundaries was first introduced, yet it's been a largely unfunded mandate for many decades," said **Arthur Middleton**, an assistant professor in the Department of Environmental Science, Policy, and Management and the lead author on the study, which appeared in *Conservation Science and Practice* in December. "The time is overdue for asking park visitors to chip in."

The authors suggest various possible mechanisms for funding, including charging an entrance "conservation fee," which would be earmarked for state wildlife-conservation programs. Another idea involves instituting lodging fees and additional sales taxes applicable only within parks.

For Yellowstone National Park, the researchers estimate that a conservation-fee approach—charging \$1 to \$10 per vehicle—could raise between \$500,000-plus and \$13 million annually. Tax-based approaches could raise anywhere from nearly a million dollars a year from a \$1-a-night lodging fee to \$22 million annually from a 2 percent sales tax increase.

— Emilene Ostlind



Five key lessons

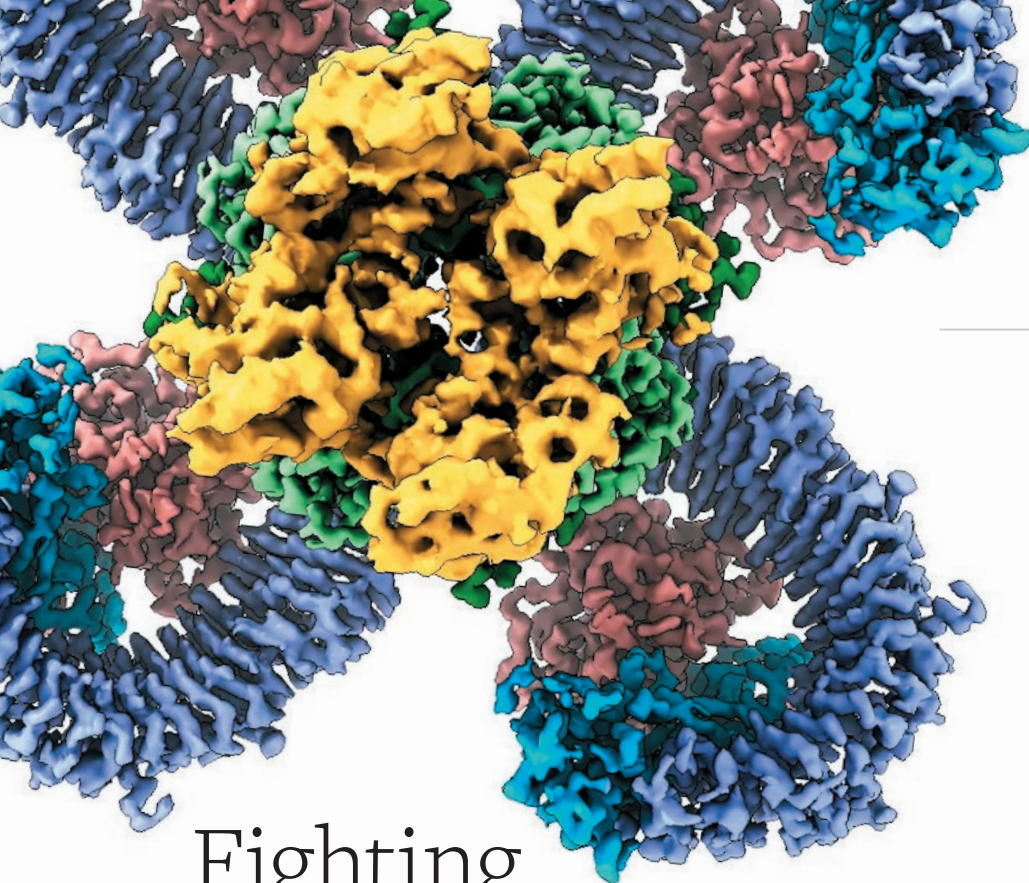
ENVIRONMENTAL ECONOMICS 141

Economics of Supply Chain

At each stage of a supply chain—research, product development, processing, distribution, and retailing to consumers—bringing products to market affects the environment, climate change, food security, and more. Taught by Professor **David Zilberman**, this course offers a background in supply chains using examples from environmental and agrifood sectors.

1 COMMERCIALIZE INNOVATION; ESTABLISH SUPPLY CHAINS

New products disrupt existing supply chains and create new ones. Plant-based meat alternatives, for example, draw on scientific research for product development and require specific ingredients that need to be sourced. As meat alternatives capture more market share, the traditional meat-production industry must adapt to compete.



A rendering of the structure of the resistosome ROQ1. A team led by Professor Brian Staskawicz was the first to image the structure, which offers a road map for engineering plant immunity against deadly diseases.

Fighting Plant Pandemics

What do bananas, wheat, chocolate, and humans have in common? All are in the midst of deadly pandemics. Humans have the tools to fight back; plants need help.

A discovery by plant and microbial biology professor **Brian Staskawicz** and colleagues, published last December in the journal *Science*, is a critical step

toward assisting plants in fighting pathogens without pesticides or other toxins.

Global banana production is seriously threatened by *Fusarium Tropical Race 4* fungus, while a disease called wheat blast endangers the world's wheat supply and overall food security. Cacao swollen shoot virus is spreading in West Africa,

where roughly half of the world's chocolate is grown. According to Staskawicz, who serves as the director of sustainable agriculture at the Innovative Genomics Institute (IGI), the direst predictions foretell an unthinkable future without chocolate in as little as 10 years.

In the study, Staskawicz, researcher **Eva Nogales**, and a team of IGI scientists outline their discovery of the structure and function of a resistosome, a plant immune receptor that recognizes pathogens and activates a strong defense.

Using state-of-the-art cryo-electron microscopes at the Cal-Cryo facility, which Nogales directs, the team captured an image of a resistosome called ROQ1, which helped them understand how ROQ1 uses specific loops of its molecular structure to recognize pathogens. The research could lead to the creation of new resistance genes designed to protect plants from specific diseases and could help explain evolutionary mechanisms behind pathogen resistance.

— Andy Murdock

Raoul Martin

2 CONSUMER DEMAND CAN DRIVE INNOVATION

Whether it be calling for ethical production of palm oil to reduce deforestation or being willing to pay more for sustainably grown produce, buyers who are increasingly concerned about the environment can affect supply chains in big ways.

3 POLICY CAN, TOO

Companies often lack incentives to tackle climate change, but targeted government policy can open up market opportunities. Biofuel mandates led to the development of supply chains for ethanol, and California's high fuel-economy standards stimulated widespread advancements in electric-vehicle technology.

4 PUBLIC-PRIVATE COLLABORATION IS ESSENTIAL

Public research discoveries lead to new product development and industry growth. Society benefits from the engagement of academics in innovation and from resulting career opportunities in agricultural and natural resources sectors.

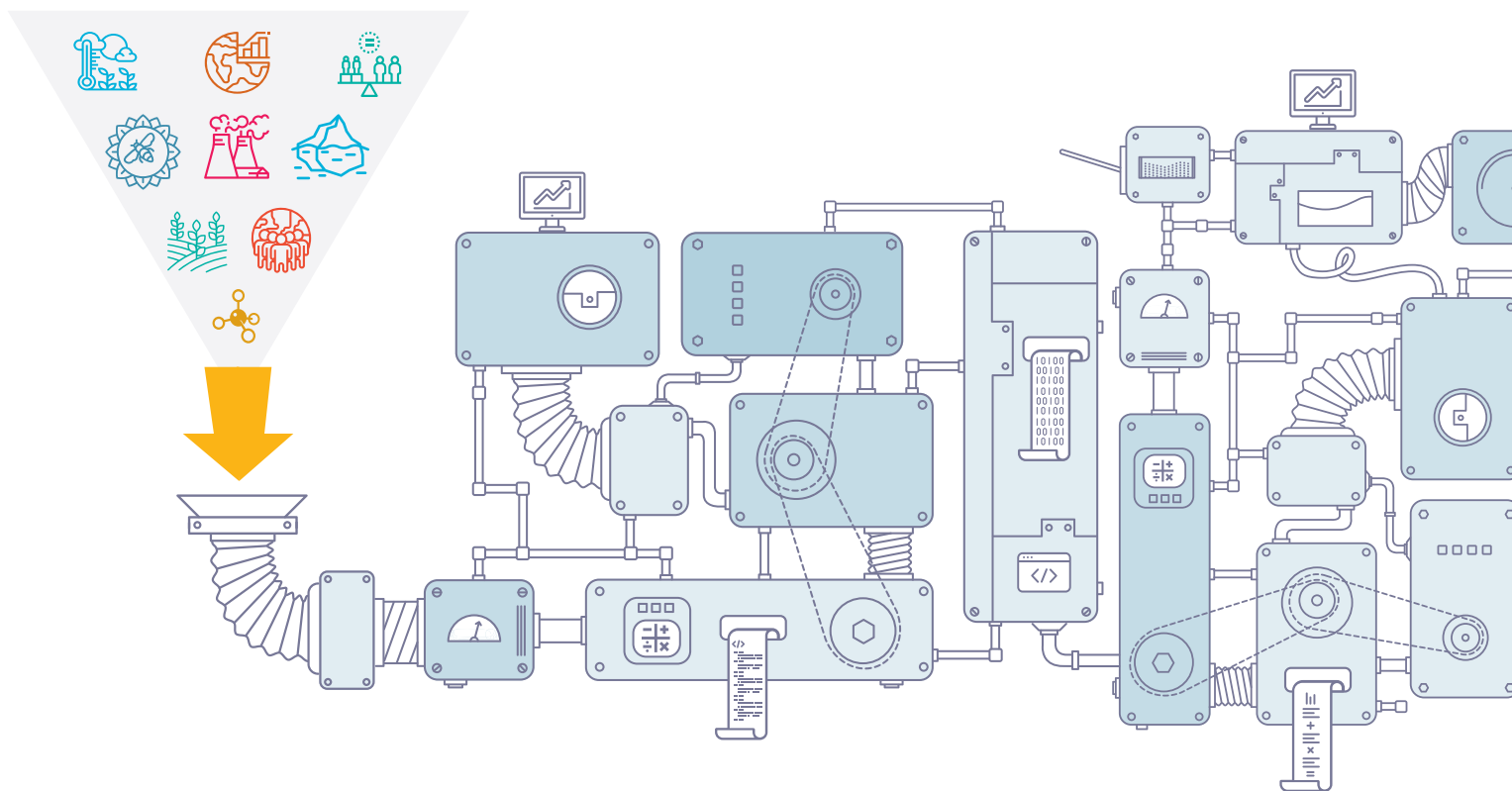
5 SUSTAINABLE DEVELOPMENT IS MORE THAN A TRENDING TERM

For companies aiming to improve human well-being without causing further damage to the natural world, supply chains must actually incorporate environmentally friendly practices. Specific actions include enhancing efficiency in production or adopting more sustainable sourcing.

The Social Cost of Carbon

BY JACOB SHEA

Environmental economists have long sought a single metric to encapsulate the sprawling social, economic, and environmental damages related to greenhouse gas (GHG) emissions. The social cost of carbon (SCC), an estimate of the economic harm caused by each additional ton of carbon dioxide, may well be it. Calculated using computer models that draw on scholarship in climate science, agriculture, demographics, public health, biodiversity, and many other fields, the SCC allows policy makers to evaluate the economic consequences of emissions and make informed legislative decisions about climate change. Read on to learn more about what some consider the most important number you've never heard of.



1 QUEST FOR A SINGLE STANDARD

In the 2000s, government agencies used a wide variety of metrics to evaluate carbon emissions' societal costs. In 2007, the Supreme Court ruled that the Environmental Protection Agency (EPA) must regulate GHGs as pollutants under the Clean Air Act, triggering the agency's mandate to conduct cost-benefit analyses. In 2009, an interagency group representing 11 federal agencies established a single national standard for the SCC.

2 THREE MODELS

Assistant professor of energy and resources **David Anthoff** co-develops the Climate Framework for Uncertainty, Negotiation, and Distribution (FUND), one of three integrated assessment models (IAMs) used by the EPA and other organizations, to calculate the SCC. Such models essentially represent how society and climate interact, by bringing together variables from physics, economics, and numerous other fields. FUND can run game theory investigations into global environmental agreements or complex cost-benefit analyses of GHG policies, among other functions.

3 HOW IAMs WORK

The models act as synthesizing machines, processing enormous amounts of research data related to climate science, biodiversity, economic growth, population forecasts, and other variables. IAMs then predict future emissions and climatic consequences, such as sea level rise, and assess their economic impacts on health, agriculture, energy consumption, and other economic sectors. Finally, IAMs convert predicted damages into the present-day "cost of carbon" for policy makers.

4 BUILDING MIMI.JL

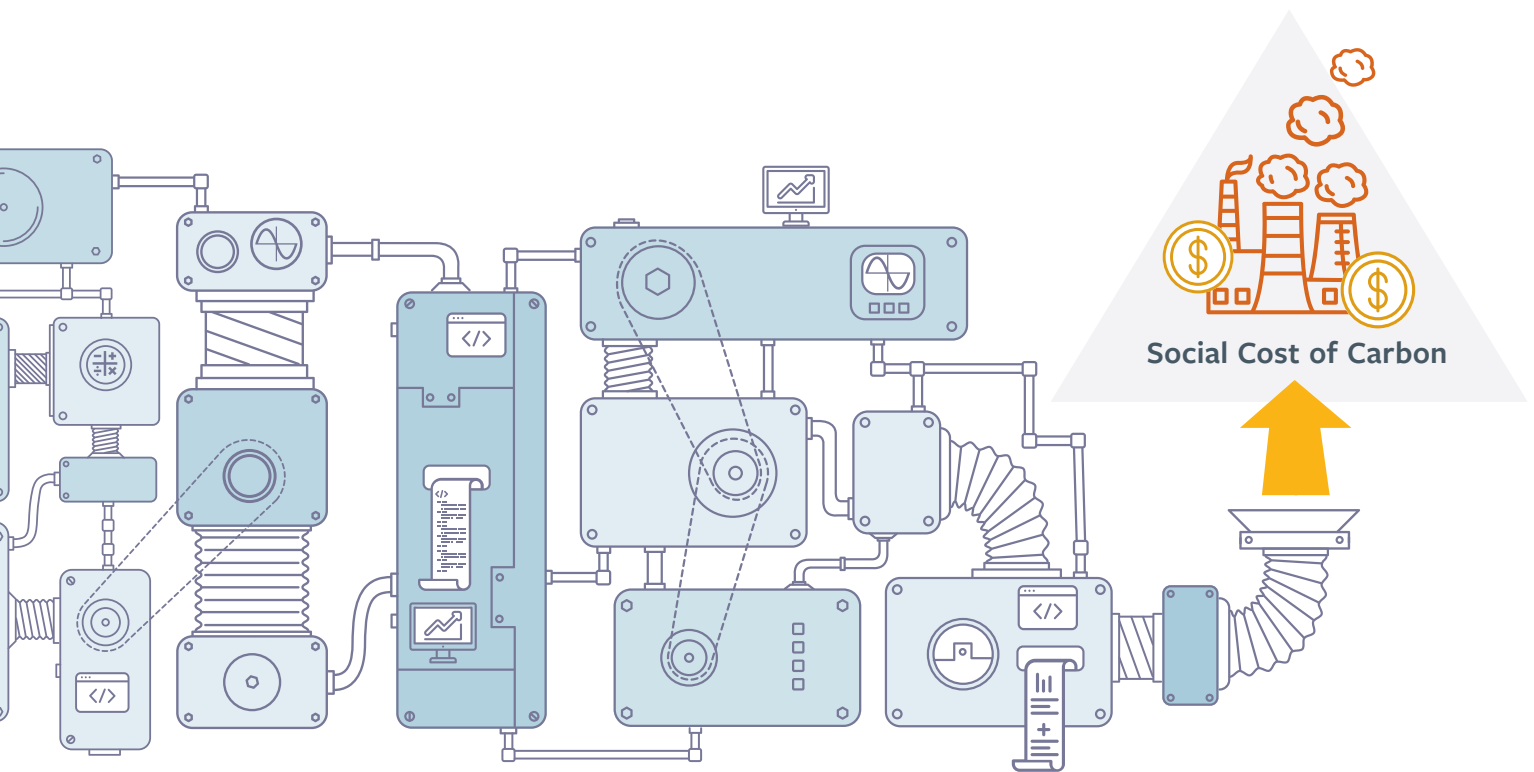
In 2015, Anthoff broke the **FUND** code down into its components to create simpler, more accessible and transparent tools. He built the computational platform **Mimi.jl** to be open-source and free to all. Since no single team can track and update every variable—ranging from water resources to population trends—decentralization is critical. It allows researchers around the world to independently utilize, build on, and iterate on the models.

5 ASK THE EXPERTS

In 2015, the federal government asked the National Academies of Sciences, Engineering, and Medicine (NAS) to review the latest research on SCC models. In response, NAS formed a small expert panel—on which Rausser College of Natural Resources professors **Max Auffhammer** and **Inez Fung** served.

6 DEVIL IN THE DETAILS

Governments set parameters that determine how the SCC is calculated, and even minor changes can influence regulation greatly. For instance, the Trump administration changed two metrics in federal assessments: one change limited the geographic scope to value only climate damages within the U.S., while the other gave an unrealistically low estimate of the costs of climatic disruptions in the distant future. These changes dropped the SCC from \$42 per ton under the Obama administration to \$1 per ton, effectively gutting the economic incentives for policy action.



7 BIDEN AND THE SCC

On day one of his administration, President Joe Biden signed an executive order to reevaluate the SCC and create a new standard. In a February commentary in the journal *Nature*, Anthoff joined other experts to offer SCC recommendations to the Biden administration, including the adoption of the Obama administration-era metrics, an update to forecasts for economic and population growth, and modernized measures for calculating how climate damages affect human welfare.

8 EQUITY OVERSIGHT

Most SCC calculations don't address inequities between communities or ways that climate damages cause greater welfare losses in poorer regions of the world. Anthoff's lab studies approaches for equity weighting, a method of factoring social welfare and equity concerns into cost-benefit analyses and models.

9 THE METHANE PROBLEM

Anthoff has also led groundbreaking research into methane, a potent greenhouse gas with a global warming potential about 34 times higher than CO₂'s. In April, he published a study in *Nature* that evaluates methane's social cost and incorporates equity weighting into the models.

Q&A

Governor Jerry Brown on Climate Action

INTERVIEW BY DAN KAMMEN

Launched in 2019, the California-China Climate Institute (CCCI) is chaired by former California governor **Jerry Brown**, BA '61 Classics, and China's top climate change official, Xie Zhenhua. A partnership between the University of California system and the Institute of Climate Change and Sustainable Development at Tsinghua University, the institute is co-housed in Rausser College of Natural Resources and Berkeley Law. CCCI is focused on joint research, training, and dialogue between the U.S. and China, with the goal of advancing climate action. Professor **Dan Kammen**, a former U.S. State Department science envoy who serves on the academic advisory committee for CCCI, recently sat down with Brown to discuss goals for the institute, how research can affect policy more quickly, and reasons for optimism on climate change.

Kammen: You've had a long and busy career. Why have you chosen to focus your time now on climate change, and why is UC Berkeley the best place to do so?

Brown: There are many important issues, but to me, climate change supersedes them all. As the premier public university globally and in California, which also happens to be close to Sacramento, UC Berkeley was a natural fit for this institute, and we're excited to connect leading researchers here with those in China. Additionally, in China there's a lot of respect for and interest in collaborating with the University of California.

What are your goals for the institute?

Our primary goal is to advance partnerships between the U.S. and China and to encourage dialogue on climate change and all that is entailed in addressing it. So much of the discussion around international affairs is about national security; there's very little talk of common interests or vulnerabilities. A key objective for this institute is to change that. It doesn't have to just be about what's good for California or the United States or what's good for China: our interests are interwoven just as the web of life is interwoven.

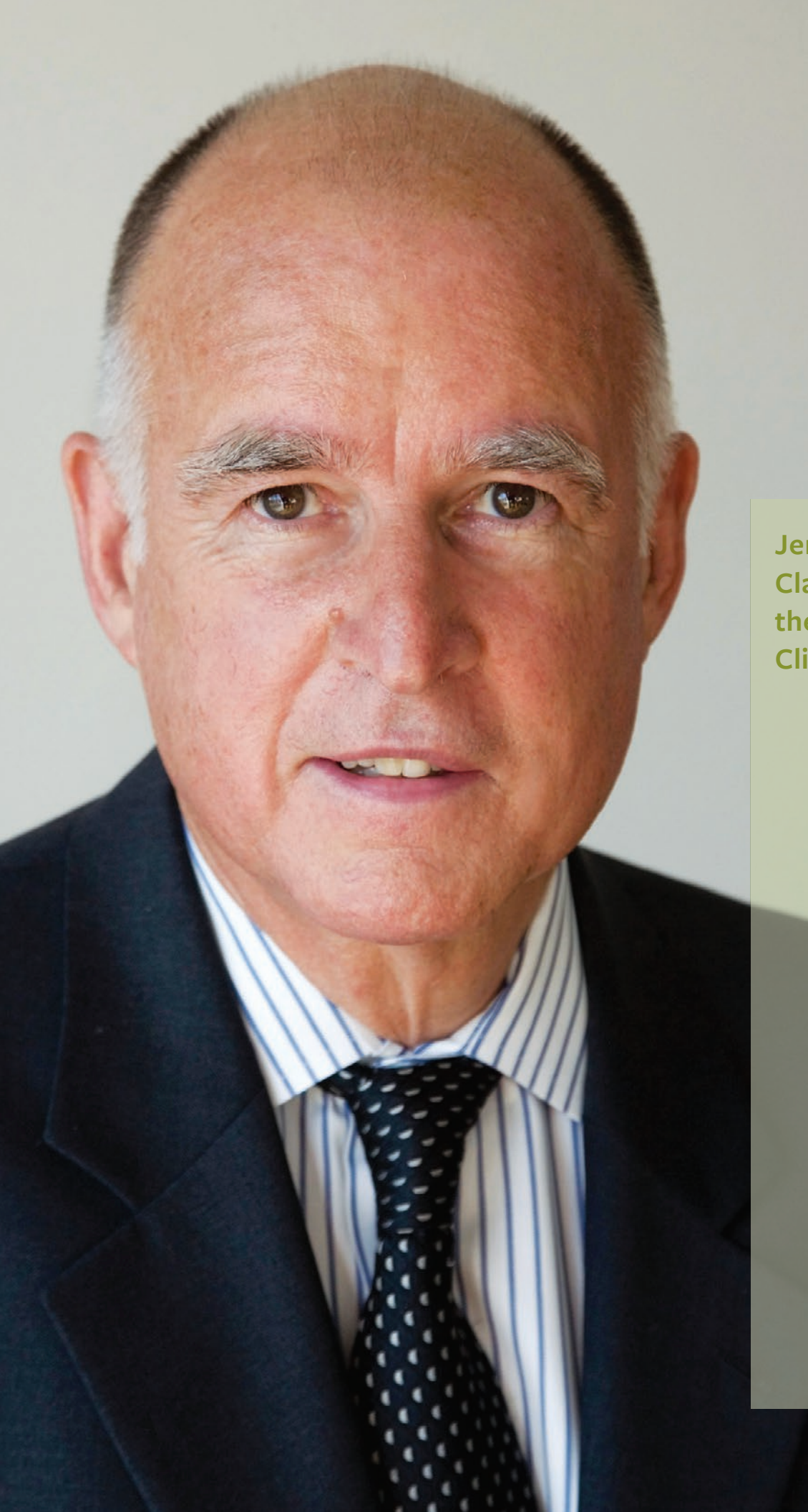
We share membership in the human race, living at a time when technology makes us ever more interdependent. We ought to recognize that and base our actions, thinking, and

research on that fact. Scientists know it, but politicians are almost congenitally incapable of recognizing a common interest.

That concept is critical, and it strikes me that with your involvement—having conversations with leaders in both countries—there's an opportunity for the institute to affect policy quickly. The time to make a difference on climate has shrunk so dramatically. We've got to get the ideas right and get action in place.

Exactly. Researchers from all over the world already work together: that's the hallmark of science. Science leads to technological innovation, and innovation informs government policies. Zero-emission vehicles, carbon pricing, building efficiency, decarbonizing the electric grid—that all has to happen very fast. We must clarify the stakes, elucidate the path forward, explain the economic and social costs, and determine the technological hurdles. We have to move knowledge more quickly from the margins of science and academia into the minds of bureaucrats, policy makers, politicians, and public officials.

I also see the need for more mutual, benign competitiveness, which can motivate and galvanize a greater effort on the part of both the U.S. and China.



**Jerry Brown, BA '61
Classics, co-chairs
the California-China
Climate Institute.**

He served as the 34th and 39th governor of California, from 1975 to 1983 and from 2011 to 2019. While he was governor, California established nation-leading targets to protect the environment and fight climate change, and by 2030 the state will reduce greenhouse gas emissions to 40 percent below 1990 levels, double the rate of energy-efficiency savings in its buildings, and reduce petroleum use in cars and trucks by up to 50 percent, in part by putting five million zero-emission vehicles on California's roads. Under a law and an executive order Brown signed, California will generate 100 percent of its electricity from renewable sources and achieve carbon neutrality by 2045.



Dan Kammen is the director of the Renewable and Appropriate Energy Laboratory.

He has parallel appointments in Rausser College's Energy and Resources Group, the Goldman School of Public Policy, and the Department of Nuclear Engineering. He was appointed the first Environment and Climate Partnership for the Americas Fellow by then-secretary of state Hillary Clinton in April 2010. He shares the 2007 Nobel Peace Prize as a contributor to a report for the Intergovernmental Panel on Climate Change.

So in addition to working on joint solutions, we can encourage friendly competition to see who can accelerate decarbonization more quickly?

Yes. There's so much attention on what we don't like about China, with little attention to what we need to do. Honestly facing our hurdles and roadblocks would give us more empathy and insight into what China is facing and allow for more candor and truth about how both nations can operate at the level of change.

We haven't sufficiently confronted the sheer beast of economic, social, and political inertia in our own country. It's pretty overwhelming, and in fact I often marvel that you appear to be so...I won't say optimistic, but you don't look overwhelmed.

I'm not overwhelmed, and you're partly to thank for that. As governor, you presided over the growth of a solar industry in California that went from passionate but small to now employing more people than all three of our state's utilities. Whether it is solar, battery storage, offshore wind, or integrating food production into urban areas, there are many exciting things that could follow the model that you helped champion.

It starts with someone having a great idea. The institute's role is translating the good thinking of our researchers into digestible policy suggestions. American politicians don't spend much of their time thinking about climate change. So we have to get them thinking about it.

Fortunately, the Biden administration has made climate action and green jobs a priority. Are you hopeful about the role of the United States on climate change going forward?

I think it's very important that America completely move beyond the Trump era and start taking serious actions, and then in that context we can push other major polluters like China and India to do likewise. Federal leadership was on hiatus for four years, but the world has made incredible progress in talking about climate. Now we have to *do* climate. The fact that we have John Kerry as U.S. special presidential envoy for climate and Gina McCarthy as domestic climate czar is promising. Biden's focus on jobs is an integral component of climate action. We need to keep our eye on a path forward, one that will employ billions of people while also avoiding climate disaster.



In 2013, China's top climate change official, Xie Zhenhua (left), and then-governor Jerry Brown signed an agreement to boost cooperation on climate change.

California is trying its best to be on that path of reaching the goals of the Paris Agreement. Are you optimistic about the state and the nation getting there?

We're much further today than I would have envisioned just a few years ago. Now we even have a few oil companies talking about peak oil or net carbon neutrality—that's a sea change. And because of the focus changing at companies here and worldwide, because of the election of Biden and the appointments he's making, I think we can do it.

We need to keep up the momentum. Governor [Gavin] Newsom has set a target of achieving only zero-emission vehicles in California that's earlier than the target I had previously set. Good—he's raising the bar. Let's do more.

Here at Berkeley, our biggest source of renewable energy isn't solar or wind; it's excited young people. What would you say to our students who are embarking on careers and hope to address the climate crisis?

Ask yourself, What's my life all about? What is meaningful? When we talk about something as big as climate change and how it will affect lives in California and around the world, it's...not quite theological but of a similar universal dimension. It's not about making a little more money or having a better house: it's about how life is going to be structured going forward. How much can we reduce future suffering by dealing with climate change? Whether you are in biology, political science, chemistry, this is motivating.

When they were building Chartres Cathedral centuries ago, the people doing the work were never going to see the finished structure. But there was a worldview of a divine order, which they were honoring each day by the contribution they were making. Here we are honoring the earth, the atmosphere, and life itself. The humble choice of your major connects to something much bigger that will endure beyond

your own lifetime. That, to me, gives the dimension that people desperately need. Climate change is an issue of such transcendent importance and value that you can give your life to it, and it's worth it. This is big stuff. It doesn't get any bigger!

Indeed. I'll close with a lighthearted one. What's your favorite place on the Berkeley campus?

It's hard to pick a favorite, but I'll always remember, when I was here as a student in 1960, from the eighth floor of the International House you could look out a window and see the sun setting beyond the Golden Gate Bridge and Mount Tamalpais. What a view.

This interview was lightly edited and condensed.

Leadership for Change

In February, the California-China Climate Institute announced that longtime global climate leader and former chair of the California Air Resources Board (CARB)

Mary Nichols will join the institute as vice chair.

Nichols has served on CARB under three governors and as California's secretary for natural resources. When not working for the State of California, she has been a senior staff attorney at the Natural Resources Defense Council and an assistant administrator in the U.S. Environmental Protection Agency's Office of Air and Regulation. She also headed the Institute of the Environment and Sustainability at UCLA.

"The California-China Climate Institute has created a platform for top leaders in California, the U.S., and China to share and advance climate policy at a time when doors have slammed shut elsewhere," says Nichols. "Our climate emergency demands that we continue to push for collective solutions backed by thoughtful, actionable research and analysis."



State of

Landmark U.S. environmental policies are 50 years old. Where do we go from here?

BY ANDREW FAUGHT

ILLUSTRATION BY TYLER VARSELL

When the Environmental Protection Agency (EPA) was created in 1970, it arrived amid a roiling public movement protesting the ill effects of air pollution and toxic-waste disposal into the nation's waterways. Tens of thousands of Americans, in an enthusiastic show of stewardship, flooded the nascent organization with résumés.

The EPA got its regulatory teeth shortly thereafter, when Congress passed two landmark pieces of legislation: the Clean Air Act of 1970, which targeted pollutants contributing to acid rain and smog, and the Clean Water Act of 1972, responsible for slashing the amount of polluted runoff in rivers, lakes, and streams.

"The policies were overwhelmingly popular," says **Joe Shapiro**, an associate professor in the Department of Agricultural and Resource Economics (ARE). "It was vastly



Regulation

different than the more partisan environmental politics of today.”

Over the past 50 years, policy makers have extended and built on the Clean Air and Clean Water Acts as well as other environmental regulations of the 1970s, including the Safe Drinking Water Act and the National Environmental Policy Act. Half a century after those foundational laws were passed, Shapiro and other Berkeley researchers are taking stock of the United States’ environmental regulatory past and generating groundbreaking research that could help plot the country’s economic, social, and political future.

HOW MUCH IS TOO MUCH REGULATION?

The Clean Air Act and the Clean Water Act are roundly regarded as important successes, and their impacts are remarkable. Since the Clean Air Act went into effect,

ambient concentrations of air pollutants, such as soot, have fallen by more than 90 percent, resulting in vast public health benefits including greatly reduced rates of respiratory illness, heart disease, and premature birth. The Clean Water Act, meanwhile, is credited with significantly reducing pollution runoff from factories and wastewater treatment plants.

But Shapiro warns against complacency. “It’s easy to take what we’ve done for granted and pat ourselves on the back for such incredible decreases in pollution over the years,” he says. “We must continue to use evidence and research to determine where additional policy is valuable.”

His research is surfacing new evidence that suggests that even more regulations would benefit society. In a working paper published last December, Shapiro and **Reed Walker**, an associate professor of business and public policy, present a novel approach to measuring the



costs of additional regulation under the Clean Air Act for industrial air pollution sources.

The social costs of producing goods for society include both the private costs incurred by manufacturers—for things like labor and materials—and the external costs that are passed on to society, such as health impacts from pollution, the destruction of wildlife habitat, the reduction of recreational areas, and so on.

Economists generally agree that environmental policy should continue to reduce pollution until the costs of additional pollution reductions exceed the benefits to society, and that cleaning up pollution usually becomes more expensive with each additional unit of pollution reduction. “Over the last half century, there’s been much debate about the magnitude of the costs and benefits of additional air pollution regulation,” says Shapiro. “Our recent paper speaks to this debate.”

In the study, he and Walker asked whether, given past progress, regulations adopted since the Clean Air Act’s enactment have pushed too far or not far enough.

Their study focused on what are known as offset markets, a Clean Air Act provision that allows industrial polluters to buy and sell rights to emit air pollution. After analyzing data on offset transactions from 16 states that collectively represent 60 percent of economic activity in all U.S. air pollution offset markets, Shapiro and Walker concluded that though additional air pollution regulation would have large economic costs, it would create even greater economic and social benefits—about 10 times larger on average.

“Our research suggests, from the standpoint of economic theory, that regulation is too lenient and that society could benefit tremendously from tightening the standards even further,” says Walker.

What is true of air quality regulation also applies to federal drinking water rules. In a study published in the *Journal of Economic Perspectives* in 2019, Shapiro and co-author David A. Kaiser assessed the history, effectiveness, and efficiency of the Clean Water Act and the Safe Drinking Water Act. They found that overall investments in providing clean drinking water under those laws—while not cheap, at about 0.8 percent of the annual U.S. gross domestic product—create “substantial health benefits that exceed their estimated costs.”

By providing nuanced considerations of the real costs and benefits of air and water policy, these studies can guide policy makers seeking to improve regulations by maximizing societal benefits. “The challenge now is to address environmental problems not addressed or skipped by environmental policies in the last half century,” Shapiro says.

POLICY FOR EQUITY

For its part, California is attempting to build on federal successes while also making up for shortfalls. In addition to



The Cuyahoga River on fire, Cleveland, 1952. Intermittent pollution fires on the river finally sparked public outrage in the 1960s and became a rallying point for environmental action.

establishing trailblazing policies to tackle local air pollution and global greenhouse gas emissions, the state is addressing state and federal legislative deficiencies related to issues of environmental justice.

A working paper Walker co-authored in October with ARE associate professor **Meredith Fowlie** and Goldman School of Public Policy visiting professor **David Wooley** explores the linkages between U.S. and California climate policy, environmental justice, and local air pollution. “The goals of making air regulations cost-effective and equitable are often in tension with one another,” says Walker.

In 2006, California passed the Global Warming Solutions Act (Assembly Bill 32), which at the time was the most significant climate change law in the country. One challenge with the legislation, says Fowlie, is that it targeted “two fundamentally different problems”—climate change and local air pollution—under the same regulatory framework.

Fowlie says that dealing with local air pollution can indeed play an important role in building support for domestic action on climate change, since greenhouse gas emissions are often co-emitted with other pollutants that affect local air quality. But there’s no guarantee that policies designed to efficiently reduce greenhouse gas emissions will deliver local air pollution improvements to communities living in proximity to pollution sources like refineries, congested highways, and hazardous-waste sites.

California has been working to address these and other important environmental concerns with policies that explicitly target these issues. One important example is the Community Air Protection Program (AB 617), which was signed into law in 2017. In short, it requires the California Air Resources Board and regional air districts to create additional emissions reporting, monitoring, and reduction plans in communities most affected by local air pollutants.

To work to improve air quality for the most polluted communities, says Fowlie, the state must first be able to accu-



President Richard Nixon signed the Clean Air Act in 1970 with vast public support and bipartisan backing in Congress. The same year, the EPA was established and the first Earth Day took place.



Earth Day at the U.S. Capitol, 1990. The annual event has remained an important gathering to urge lawmakers to pass environmental legislation.



Youth Climate Strike demonstrators in Washington, D.C., 2019. As part of an ongoing global movement, activists call for meaningful political action on climate change.

rately pinpoint where those communities are. Until recently, it has been difficult to measure disparities in pollution exposure, owing to a lack of regulatory-grade devices for monitoring airborne particulates. Fortunately, Fowlie says, advances in low-cost air quality monitors and remote sensing—such as the use of satellite imagery—are making it easier to understand such disparities across the country and in real time.

Another benefit of AB 617 is that it leverages community input to address the inequities that local pollution creates. The policy provides “unprecedented levels of support for public engagement in the development of comprehensive, community-level emission reduction plans,” write Fowlie, Walker, and Wooley.

“The jury is still out on whether AB 617 is having the desired impact,” Fowlie comments. “I have high hopes because it recognizes the importance of empowering communities and bringing them into a political process that they feel marginalized from. I think that is exactly what we should be trying to do.”

THE CHALLENGE AHEAD

Predicting the future of environmental policy is no sure thing. Legislation is often born of “a confluence of social awareness,” says **Ted Grantham**, a Cooperative Extension specialist in the Department of Environmental Science, Policy, and Management who studies state and federal waterway policies.

“There were events in the ’60s, like the fire on the Cuyahoga River in Cleveland, where people really became aware of the environmental damage that was occurring around them,” he says. “It takes a remarkable alignment of

social and political forces to pass legislation. It’s difficult to imagine passing a law like the Clean Air Act now.”

During his term, former president Donald Trump withdrew the U.S. from the Paris Agreement and reversed, revoked, or rolled back nearly 100 environmental rules established by his predecessors. The rollbacks included canceling a requirement for oil and gas companies to report methane emissions and rescinding water pollution regulations for fracking on federal and Native American lands.

Still, there may be room for optimism. During his first weeks in office, President Joe Biden affirmed that environmental equity and fighting climate change are key priorities for his administration. He immediately signed a slate of environmental executive orders undoing most of Trump’s actions and renewing the country’s commitment to the Paris Agreement. The administra-

tion also quickly reversed the expansion of offshore oil drilling—criticized for releasing toxins into the air and water—and halted construction of the Keystone XL Pipeline, a proposed 2,600-mile oil pipeline that is said to threaten adjacent waterways and animal habitats.

As the nation and the world continue to battle the effects of environmental degradation and climate change, Shapiro expresses guarded optimism.

“Environmental policy will advance, but I’m uncertain how far and how quickly,” he says. “While the Clean Air Act was complex, it didn’t require the U.S., the E.U., China, India, Brazil, and other countries to negotiate what the law would look like. For climate policy, coordination across countries is important.” ■

“The challenge now is to address environmental problems not addressed or skipped by environmental policies in the last half century.”

— JOE SHAPIRO

Electrifying America

California's high energy prices offer lessons for the nation's renewables-focused energy policy

BY ANN BRODY GUY

PHOTOGRAPHY BY ELENA ZHUKOVA

California electricity rates just went up—again. The latest Pacific Gas & Electric residential rate hike, which took effect January 1, is part of a steady climb in electricity prices—up more than 30 percent since 2009, according to the California Public Utility Commission. The utility, the state's largest, attributes this increase to rising wildfire-mitigation costs, including clearing vegetation around power lines and replacing outdated grid equipment.

Until just a few years ago, most PG&E customers could count on some relief from high bills during periods of low usage, which often occur when seasonal heating and cooling needs plummet. Now, some average-sized households can pay over \$100 a month even when consumption is at its lowest. How did California electricity prices get so high?

The West's more severe fire seasons, driven by record heat and prolonged periods of drought, are just part of the problem. "As the climate changes, we're coming to terms with what it costs to run power lines through dry forests in hot weather," says **Meredith Fowlie**, an associate professor of agricultural and resource economics (ARE) who holds the UC Berkeley Class of 1935 Distinguished Professorship in Energy. "Adaptation is requiring big investments, and that's showing up on your electricity bill."

The costs of adapting to increasingly intense fire seasons may be a climate change problem. But zoom out, Fowlie explains, and it gets more complicated. Rising electricity prices are also, in part, an unwelcome consequence of some forward-thinking climate change solutions. Since 2006, when the California Global Warming Solutions Act laid out ambitious

carbon-reduction targets, state agencies have responded with new policies meant to lower greenhouse gas emissions and drive down the costs of clean, renewable energy sources like solar and wind.

In many respects, these policies add up to a success story. The state met its 2020 target two years early, getting more than 33 percent of its electricity from renewable sources in 2018, according to the California Energy Commission. But some actions have had unintended impacts, like higher prices. High prices hurt consumers, but on a larger scale, they upset the energy market's complex balance of pricing, incentives, and investments. Fowlie says that getting that balance right is essential to a fair and equitable energy transition. "California is on the bleeding edge of these concerns," she says.

Rausser College of Natural Resources economists are unpacking real-world policy outcomes at this edge, and their insights are helping shape the frontier of renewable energy policy.

Those insights could not be timelier. California's next target is reaching 44 percent renewable energy by 2024.



A portrait of Meredith Fowlie, a woman with long dark hair, wearing a red top and a black blazer. She is smiling slightly and looking towards the camera. The background is a blue-toned architectural structure with a grid pattern on the right side.

“It’s one thing to theorize about how climate policy can work in principle. It’s another thing to implement these policies in the messy real world.”

— MEREDITH FOWLIE

President Joe Biden has signaled assertive climate leadership with many of his cabinet choices—including public policy professor **Jennifer Granholm**, an expert on clean energy policy, for energy secretary—and a commitment to decarbonizing the U.S. power sector by 2035.

Fowlie—who is also a research associate at the nonpartisan National Bureau of Economic Research and co-directs, with business administration and public policy professor **Severin Borenstein**, the Energy Institute at Haas—believes these targets are achievable. “There is now a viable path to deep greenhouse gas reductions,” she says.

That path runs through the power sector. The idea, Fowlie says, is to decarbonize electricity production through investments in clean technology, then electrify almost everything—homes, the commercial sector, transportation.

But, she cautions, technologies that “green the grid” need the policy infrastructure to evolve along with them. “There’s a tendency to focus on the technology solutions—the wind and the solar and the batteries—but those aren’t going to work on their own,” she says. “The policy incentives and the markets we design will determine how well that technology works and who pays for it.”

OVER-REIMBURSING SOLAR

California’s rooftop-solar incentive program illustrates how well-intentioned policy can drive up prices. As part of the state’s 2009 Net Energy Metering program, households with solar arrays get reimbursed for every kilowatt-hour they generate for the grid. This sounds like a reasonable way to encourage rooftop-solar adoption, until you consider how the state prices electricity.

“Pricing should be as simple as ‘I use a kilowatt-hour, I pay a kilowatt-hour,’ but that’s not how it works in California,” says ARE associate professor **James Sallee**, who with Fowlie and Borenstein published an Energy Institute working paper this spring that charts 10 years of rising electric bills in the state. The kilowatt-hour price on your bill is a retail rate that’s much higher than the cost of delivering that power to you, explains Sallee. That’s because fixed system costs, including wildfire mitigation and infrastructure maintenance and improvement, are loaded into that hourly charge.

“I’m going to pay 27 cents for one kilowatt-hour of electricity at my house,” Sallee estimates, “whereas it only costs about 9 or 10 cents to generate and deliver that unit of electricity.” That 9 or 10 cents accounts for both utility costs and the social costs of pollution, an important measure of actual cost, he says (see also “The Social Cost of Carbon,” page 6). So rooftop-solar customers get reimbursed for the power they generate, and they also avoid paying the system costs loaded into the kilowatt-hour price. Meanwhile, the rising per-kilowatt-hour price sends everyone else’s bills ever higher, even if usage stays steady.



“We can get big efficiency improvements, and we don’t have to sacrifice equity to do it.”

— JAMES SALLEE



Utilities absolutely need to recover fixed costs in order to supply electricity, the economists stress. “When you turn off your lights, we don’t avoid those costs,” Fowlie says.

But why use such an inefficient pricing scheme?

Political expediency is partly to blame. Compared with trying to get voters to pass a parcel or sales tax, it can be quicker and easier to put those costs into electricity rates, which are regulated by the California Public Utilities Commission. “They are legitimate costs, so the CPUC approves them, and the utilities pass it on,” Fowlie says.

THE “UTILITY DEATH SPIRAL”

Over-reimbursing for rooftop solar creates some nasty ripple effects. “When a solar customer cuts their bill by \$300, PG&E’s costs only go down by \$100, so there’s another \$200 they’ve got to recover from everybody else,” Sallee explains. “We have a colorful term for this: the utility death spiral.”

Basically, the system’s fixed costs just shift onto non-adopters. And that pool keeps shrinking because, he says, “as more people adopt rooftop solar, you have to keep ramping up the price. And that makes the incentive for the next person to get solar panels stronger and stronger.”

This combination has the unintended consequence of moving fixed costs onto people for whom investing in rooftop solar is not a viable option—typically renters and lower-income households.

The equity implications run deep. A 2019 study published in *Nature Sustainability*, led by Tufts professor **Deborah Sunter** while she was an Energy and Resources Group (ERG) postdoctoral scholar, found that Black and Brown communities have significantly lower solar adoption rates—even after adjusting for median income and home ownership. Study co-author **Dan Kammen**, an ERG professor and the group’s chair, says

that’s due to insufficient government solar investments in poorer communities, especially a failure to “seed” a few solar projects among a community’s minority businesses—a practice, the researchers note, that makes adoption rates soar.

This imbalance is beginning to shift as technology prices decline and solar programs that invest in low-income communities grow. But such entrenched challenges help explain why Sallee, Fowlie, and Borenstein, rather than trying to fix the rooftop-solar incentive, are working on the bigger question of recovering system-wide costs in a way that’s both efficient and equitable. For example, if utilities charged everyone a fixed fee for system costs, perhaps \$50 or \$60 per month, then kilowatt-hour charges would



reflect the cost that a household's consumption actually entails. Other tweaks, such as rebates to adjust for household income, could make this scheme even fairer, the Energy Institute working paper suggests.

The larger lesson is to avoid policies that may be inefficient in the long run, Sallee says, because it's hard to roll them back later. The Net Energy Metering program met its objective of jump-starting an industry. "But now there's an industry, and there are millions of homeowners with solar who won't let you claw back their incentives," he says.

Another key takeaway from the rooftop-solar incentive is that it returns too much money to consumers for the benefits that the technology—distributed solar—provides to the grid, given that the most efficient path to electrification is utility-scale projects, the economists say. "It's always going to be better to have one giant facility rather than solar spread across 1,000 rooftops," says Sallee.

THE WIND-POWER FEEDBACK LOOP

Stephen Jarvis, PhD '20 ERG, says that the same is true for the utility-scale wind projects he studies. "With larger projects, you can spread out a lot of the costs," he says. "There are all these economies of scale that kick in."

But large projects aren't immune to equity and efficiency issues, Jarvis found in an Energy Institute working paper on the impacts of the NIMBY (or "not in my backyard") problem—when people who may support projects in concept resist efforts to build them in their own neighborhoods.

Jarvis, now a postdoctoral scholar in the Department of Economics at the University of Mannheim in Germany, analyzed planning-process permit documents in the United Kingdom and found that homeowners in affluent, largely politically conservative areas were most likely to oppose large wind projects—often successfully. Wind turbines change the visual landscape. "People with nice views they paid a lot of money for have a vested self-interest in preserving those views," he says, whereas people in lower-income areas may not have such "visual amenities" to preserve. And, he posits, people with more money likely also have the time and resources to put up a fight.

The result is a bias for developing wind projects in more remote areas, further away from residential neighborhoods, Jarvis found. While avoiding NIMBY fights is just one of the reasons the U.K. has invested in a lot of offshore wind, he notes, "definitely one reason is that local residents get less annoyed. If turbines are 30 miles out in the ocean, they're not ruining someone's backyard, so they're a lot easier to approve."

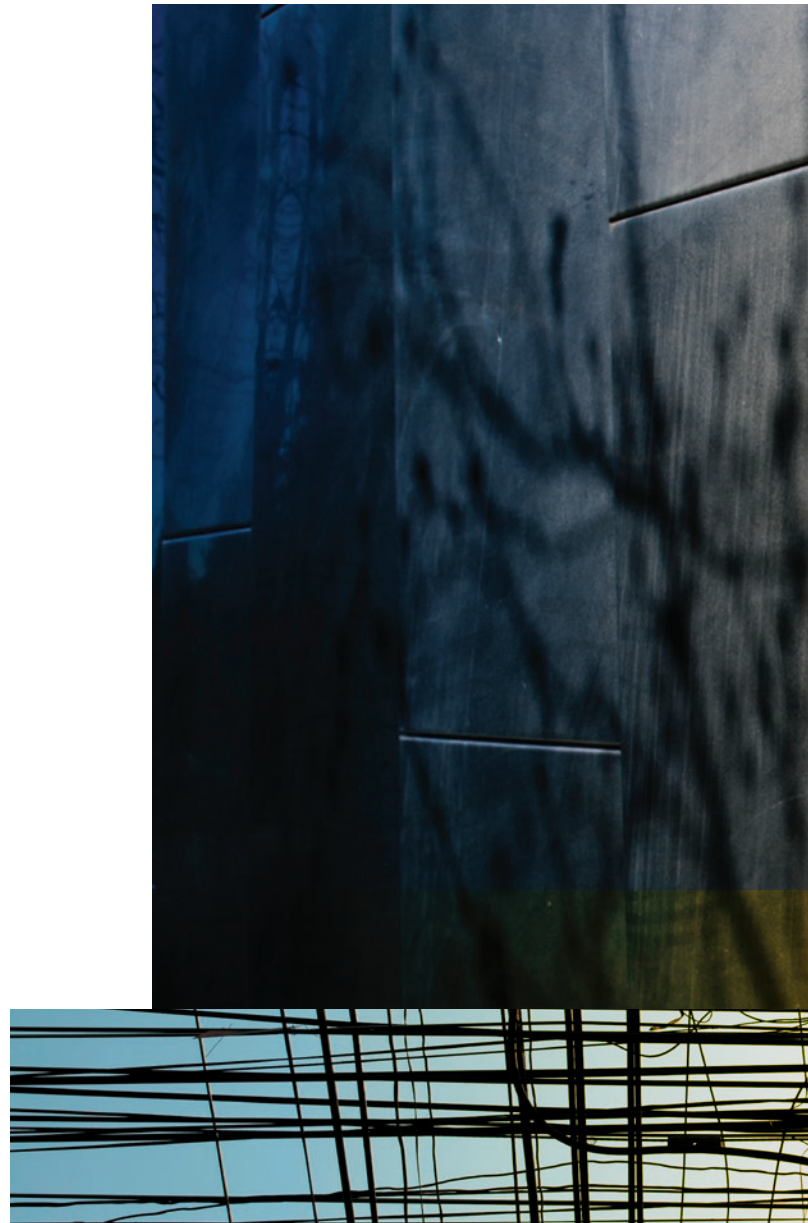
But, Jarvis points out, there's a cost: "Those projects are more expensive to build because you have to send the power over longer distances to get it back to where people live." The problem doesn't have a dramatic nickname like utility death spiral, but it's a similar negative-feedback loop. Satisfying local concerns, however reasonable, "can end up increasing the cost

of meeting larger climate commitments because you're forcing developers to build these more expensive projects," he says. As his paper neatly sums up, "the key here is that what may be optimal for a given local area may in aggregate create harmful outcomes for society as a whole."

Solutions have been uneven, with each community fending for itself. That's why Jarvis's next question is what a standardized approach might look like. That could help address inequity and get more beneficial projects approved, he says.

MARRYING EFFICIENCY AND EQUITY

One standardized approach to reducing greenhouse gas emissions seems to be working relatively well. California's Renewable Portfolio Standard requires utilities to generate a prescribed portion of their energy from clean sources. Utilities' costs to meet these thresholds continue to be "passed through to customers in the form of higher electricity rates," Fowlie writes in a recent analysis. However, as renewable energy prices have declined, the bit that shows up on individual energy bills has also gotten smaller, her analysis



finds. And the program supports utility-scale projects, so consumers are paying the least amount for the most efficient technology. That's good news for ratepayers—and the climate.

Rising prices aren't necessarily a bad outcome. Consumer prices should increase, Fowlie stresses, when they don't reflect the full cost of consumption, including social costs such as pollution and environmental harm.

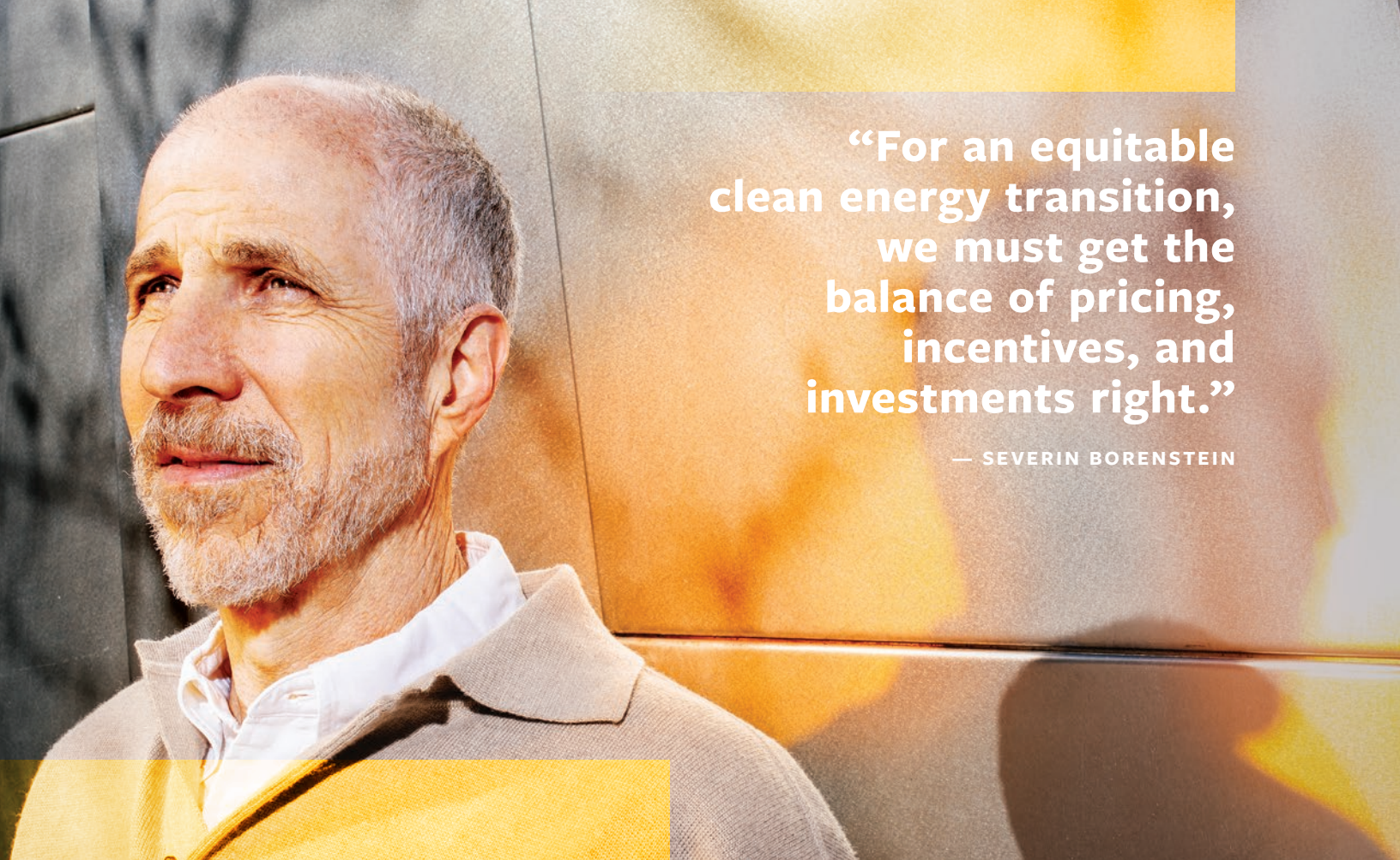
Unpacking complex implementation lessons, both successes and failures, is building critical new knowledge. "It's one thing to theorize about how climate policy can work in principle. It's another thing to implement these policies in the messy real world," Fowlie notes. If the nation can learn from California's tangling with these difficult problems, the U.S. might even play

a comparable leadership role internationally, she says.

"Decarbonization through electrification is not a crazy idea," Fowlie says, "given how far storage and renewable energy costs have fallen. You can set an aggressive target for renewable energy investment." But, she adds, "the policies you put in place to meet those targets—those choices really matter in terms of who ends up paying."

Misaligned incentives and issues like NIMBYism are cautionary tales that show how failure to create affordable, equal access to clean energy undermines the larger climate goals the policies are meant to achieve.

"It doesn't have to be like that," Sallee says. "We can get big efficiency improvements, and we don't have to sacrifice equity to do it. That's what we're trying to push." **BI**



“For an equitable clean energy transition, we must get the balance of pricing, incentives, and investments right.”

— SEVERIN BORENSTEIN



Career in Clean California

LOUISE BEDSWORTH, PHD 2002 ENERGY AND RESOURCES

BY JACOB SHEA

For Louise Bedsworth, no two workdays are alike. One day, she directs investments that connect affordable housing and public transit, in an effort to advance equitable community development and reduce greenhouse gas emissions. Another day, she meets with an organizer who establishes urban gardens, to expand access to nutritious, affordable food while revitalizing green spaces.

Bedsworth is the executive director of the California Strategic Growth Council (SGC), a cabinet-level state organization formed in 2008 to foster and fund community-driven projects that strengthen local economies, ensure social equity, and enhance environmental stewardship. SGC's guiding principle is that sustainability, equity, economic prosperity, and quality of life are intrinsically linked—and call for comprehensive approaches.

“If we were looking to maximize any single goal—such as emissions reduction, affordable housing production, or community development—our programs would look different,” says Bedsworth. “We’re trying to demonstrate how we can bring all the pieces together.”

For nearly 20 years, she has worked in fields related to California environmental and climate policy. If her career has a unifying thread, it's been a deep interdisciplinarity and the steady integration of cutting-edge research into policy and action.

THE SCIENCE-POLICY NEXUS

Bedsworth earned her undergraduate degree in earth sciences at MIT before coming to Berkeley to study environmental engineering. Focusing on nuclear energy and risk analysis, she explored coursework on the interface between technology and policy, but eventually decided to





Louise Bedsworth (third from right) participates in a groundbreaking ceremony for the Yosemite Village Permaculture Farm.

redirect her specialization toward environmental regulation. “Most engineers at that time were modeling and measuring, but I was interested in interviewing regulators to understand how modeling information was used,” she remembers.

After obtaining her master’s, Bedsworth joined the Energy and Resources Group (ERG) to conduct doctoral research with a committee that included Professor **Gene Rochlin**. She was enthralled by ERG’s interdisciplinarity and tight-knit community, and she spent hours reading past students’ dissertations. In her free time, she played ultimate frisbee with the ERG intramural team.

Bedsworth focused her dissertation on California’s smog-inspection system. At the time, the U.S. government was amending Clean Air Act regulations, but the state—which had long been more progressive than the federal government on environmental policy—took its own strong regulatory approach.

The topic suited Bedsworth’s interdisciplinary leanings.

“Smog regulation involves some very technical questions around engineering and testing methodology, but it’s also wrapped up in complex questions about human behavior,” she says. “How are regulators managing the system to make it effective but also politically acceptable? How do you keep people from cheating?”

In addition to coursework, Bedsworth pursued other opportunities. One summer, she traveled to Vienna to work with the International Institute of Applied Systems Analysis, a think tank focused on global-scale challenges, where she did comparative analyses of European and U.S. vehicle-emissions regulation. She also held an Environmental Protection Agency fellowship and interned at Redefining Progress, a nonprofit focused on ecological footprints founded by an ERG alum.

STATEWIDE STRATEGIES

Upon finishing her dissertation, Bedsworth became an advocate for the Union of Concerned Scientists, working on California’s greenhouse gas emissions standards for passenger vehicles. A particularly proud moment came when, in a 2015 speech, President Barack Obama praised California’s strong leadership on emissions regulation. “The victory that we all felt—finally having the state leadership and federal partnership to really push forward—was incredible,” she says.

After working as a researcher at the Public Policy Institute of California and at UC Davis, Bedsworth transitioned into state government in 2011. At the Office of Planning and Research in Governor Jerry Brown’s administration, she led various collaborative research initiatives and climate change adaptation and

resilience programs. One of her first projects was a long-term environmental-goals report for the entire state.

“Working in the governor’s office was at first daunting but also demystifying,” she recalls. “I saw a huge opportunity to move from this outside space into understanding the political process, designing and implementing policies, and putting solutions in place.”

Bedsworth crafted strategies to coordinate climate-related activities at the state, regional, and local levels. She helped develop the Integrated Climate Adaptation and Resiliency Program, a comprehensive statewide response to the impacts of climate change, and she worked to advance social equity in distributing a \$70 million grant from the National Disaster Resilience Competition. She also collaborated with researchers at Rauser College of Natural Resources and other scientific institutions in co-authoring the biannual statewide Climate Change Assessment in 2018.

At SGC, Bedsworth has led a vast spectrum of projects. For example, she currently oversees a program called Transformative Climate

Communities. Through that initiative, SGC awarded a \$66.5 million grant to the City of Fresno that will connect three underserved neighborhoods there with new affordable housing, public transit infrastructure, green spaces and community gardens, and other improvements. As with so many SGC-funded projects, this one centers primarily on communities historically most affected by pollution and poverty.

Bedsworth’s favorite part of her job is meeting with stakeholders in communities and learning about a town’s vision for an ambitious project. “Our organization combines top-down goals with community-led, ground-up sets of priorities,” she says. “We need all Californians to be part of the climate solution, and we can only address climate change if we address equity across the state.”

“I feel really lucky,” Bedsworth adds. “I’m doing what I’ve always wanted to do.”

“We can only address climate change if we address equity across the state.”

— LOUISE BEDSWORTH



The Getz and Kertsman families at a recent gathering.

Kertsman, and Trevor’s wife, Jessica Getz—came together to establish the Getz-Kertsman Family Scholarship, an endowed fund for undergraduate students in Rausser College of Natural Resources. In particular, the fund targets transfer students, who are often constrained by financial obstacles that make attend-

Equity in Education

GETZ FAMILY ESTABLISHES SCHOLARSHIP SUPPORTING TRANSFER STUDENTS

BY JACOB SHEA

Before **Wayne Getz** emigrated from South Africa in 1979, he witnessed firsthand the brutal, race-based discrimination of apartheid. Seeking political stability and research opportunities, he and his family moved to Berkeley, where Getz joined the faculty in the Department of Entomological Sciences—now within the Department of Environmental Science, Policy, and Management.

Even after living under apartheid, Getz was shocked by the racism he saw in the United States. “As a society, the country still hasn’t come to terms with it,” says Getz, who taught disease ecology, wildlife conservation, and resource management on campus for 39 years and is widely recognized as a leading researcher in population modeling and epidemiology.

Getz and his wife, Jennifer, also an educator, have made equity a priority in their lives. Jennifer had a long career in California K–12 and professional schools, where she worked to expand opportunities for students from diverse backgrounds. Their two children, **Stacey Kertsman** (BA ’95 English and Sociology, MA ’00 Education) and **Trevor Getz** (BA ’95 Anthropology and History), have carried the cause forward. As a professor of history at San Francisco State University, Trevor researches the intersection of gender, colonialism, and slavery in Africa. Stacey, a former dean of equity education and social impact at the Castilleja School in Palo Alto, now consults on education equity.

In 2018, the family—including Stacey’s husband, Robert

ing a four-year university seem untenable.

According to university data, Berkeley transfer students predominantly come from California community colleges, and 42 percent are from families making less than \$50,000 annually. Transfer students are more than twice as likely to be first-generation college graduates and are more likely to be members of a group historically underrepresented in higher education.

Currently, 12.8 percent of Rausser undergrads are transfer students. Getz notes that helping these students succeed creates other societal benefits, since many of the College’s multi-disciplinary programs prepare students for careers in tackling inequity itself, particularly as it relates to natural resources and wealth distribution. “I’ve seen so many talented students graduate from our College ready to become future leaders in these areas,” says Getz. “We hope our gift expands access of marginalized and underrepresented students to tertiary education as part of building a more inclusive society.”

The Getz and Kertsman families also hope this endowment will instill a sense of public service in future generations of their family. “We’re committing together across generations,” says Stacey, “so that our children understand the importance of their contributions to a more equitable and just collective future, and this scholarship is one vehicle for that commitment.”

The families’ gift has been amplified through the Berner Matching Program for Endowed Scholarship Funds, made possible by a generous bequest from Raymond H. Berner. Another current program that doubles gifts to Rausser College is the FTG Berkeley Undergraduate Scholarship Matching Program.

Endowed needs-based scholarships, which require an initial \$100,000 gift, are essential to Berkeley’s ability to attract and support talented scholars.

For information on increasing your impact through a philanthropic matching program or supporting our equity and inclusion efforts, contact Dave Tozer (dtozer@berkeley.edu) or Andrew Judd (judd@berkeley.edu) in the Rausser College development office.



Frost, Frogs, and Fungus

PHOTOGRAPH BY
EMMA STEIGERWALD

The glaciers of Peru's Cordillera Vilcanota mountain range are rapidly shrinking, causing significant changes to the landscape and its ecosystems. These changes affect biodiversity, as species faced with shifting conditions must move, adapt, or die. **Emma Steigerwald**, a PhD candidate in the Department of Environmental Science, Policy, and Management, studies how marbled four-eyed frogs, warty toads, and marbled water frogs in the Cordillera Vilcanota are responding to climate change. In addition to analyzing the impact of the chytrid fungal pathogen on these amphibian populations, her team assesses how introduced North American rainbow trout affect assemblages of native amphibians and other aquatic invertebrates. Shown here, field technician Anton Sorokin filters environmental DNA out of the water at a research site more than three miles above sea level.

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