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RESOURCES



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Kristin Hayes

In This Issue

Anna Brittain is the manager of RFF's Center for the Management of Ecological Wealth. Previously, she spent several years working as a green business consultant in Northern California and also served as a research fellow with the Institute for Governance and Sustainable Development in Geneva.



Brittain

RFF Senior Fellow **Dallas Burtraw** is one of the nation's foremost experts on environmental regulation in the electricity sector. For two decades, he has worked on creating a more efficient and politically rational method for controlling air pollution. He also studies electricity restructuring, competition, and economic deregulation. He is particularly interested in incentive-based approaches for environmental regulation, the most notable of which is a tradable permit system, and recently has studied ways to introduce greater cost-effectiveness into regulation under the Clean Air Act.



Burtraw

Maureen Cropper, a professor of economics at the University of Maryland and a former lead economist at the World Bank, returned to RFF in 2008 as a senior fellow, a position she held from 1990 to 1993. Her research has focused on valuing environmental amenities, estimating consumer preferences for health and longevity improvements, and the trade-offs implicit in environmental regulations. Previously, at the World Bank, her work focused on improving policy choices in developing countries through studies of deforestation, road safety, urban slums, and health valuation.

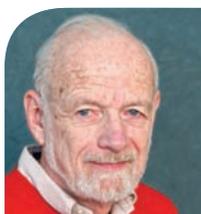


Cropper

Joel Darmstadter is a senior fellow at RFF, which he joined in 1966 following an earlier stint in the corporate sector and several research organizations. Specializing in economic and policy aspects of energy and the environment, he has written, co-authored, and contributed chapters to numerous books and journal articles. He has appeared as an expert witness before congressional committees, been a consultant to several government agencies, and served on a number of National Research Council panels. During 1983–1993, he was a professorial lecturer at the Johns Hopkins University School of Advanced International Studies.



Darmstadter



Fraas

Visiting Scholar **Art Fraas** joined RFF in April 2009 after a distinguished career in senior positions within the federal government. In 2008, he retired after 21 years as chief of the Natural Resources, Energy, and Agriculture Branch at the Office of Information and Regulatory Affairs in the Office of Management and Budget. Much of his work has examined the federal regulatory process, with a particular focus on the impact of environmental regulations.



Hayes

Kristin Hayes is the assistant director of RFF's Center for Energy Economics and Policy and Center for Climate and Electricity Policy. She worked with researchers at RFF and the National Energy Policy Institute to write and produce *Toward a New National Energy Policy: Assessing the Options*.



Shabman

After three decades on the faculty at Virginia Tech, **Leonard (Len) Shabman** joined RFF in 2002 as a resident scholar. His interest is in expanding the contributions of economic analysis to the formation of water and related land resource policy. Shabman's present research is focused on development of evaluation protocols for large-scale ecosystem restoration projects, with special focus on the Everglades and coastal Louisiana.



Walls

Margaret Walls is a research director and senior fellow at RFF. Her current research focuses on issues related to urban land use, ecosystem services, parks, and energy efficiency. She has analyzed transferable development rights programs for managing land use in urban fringe areas, assessed the value of different types of parks and open space, and investigated energy-efficiency issues in buildings.

Managing Risk— and Abundance



One of the themes for RFF's 60th anniversary year is the management of resource scarcity, going back to the issue that prompted RFF's creation. Whether resource constraints place a limit on growth

remains a prime topic of concern.

But from another perspective, we are entering an era of potential resource abundance, thanks to the emergence of new technologies, such as advances in techniques to tap into previously inaccessible hydrocarbon reserves. With a growing global population and the inexorable push for improved living standards across the globe, increased access to resources and the amenities they provide is welcome. But what of the risks?

Humans are making a large impact on the global environment. Our influence is so profound that some argue we are living in a new geological age—the Anthropocene era—characterized by the dominance of our species. To help commemorate our 60th anniversary, Nobel Laureate Kenneth Arrow spoke at RFF about the ethical and analytical implications of human beings' power over the global environment.

The scale of human activity is so great that we are changing the chemistry of the vast oceans and atmosphere, alter-

ing the Earth's climate in the process. The increased availability of fossil fuels, which a few years ago would have been deemed an unambiguously positive development, may be a double-edged sword, delaying a transition to a low-carbon economy. Indeed, how to square these new supplies and the cheaper prices they bring with global greenhouse gas mitigation efforts presents a significant challenge—one that we are examining intently at RFF.

A last-ditch option is geoengineering, an endeavor that would take the Anthropocene era to new heights. Nobel Laureate Thomas Schelling also delivered an address as part of RFF's distinguished 60th anniversary lecture series, discussing questions of strategy and risk management associated with deploying a massive set of unproven technologies that, until recently, many viewed as more relevant to science fiction than international climate policy.

We live in a world filled with risks, and as a species we have proven fallible in understanding and managing them. The implications of the Anthropocene era raise the stakes for intelligently addressing questions at the intersection of human well-being, the fragility of the global environment, and the promise and perils of new technologies. These are important questions—the kind that prompted RFF's creation and that today are setting our agenda.

Phil Sharp, President
sharp@rff.org

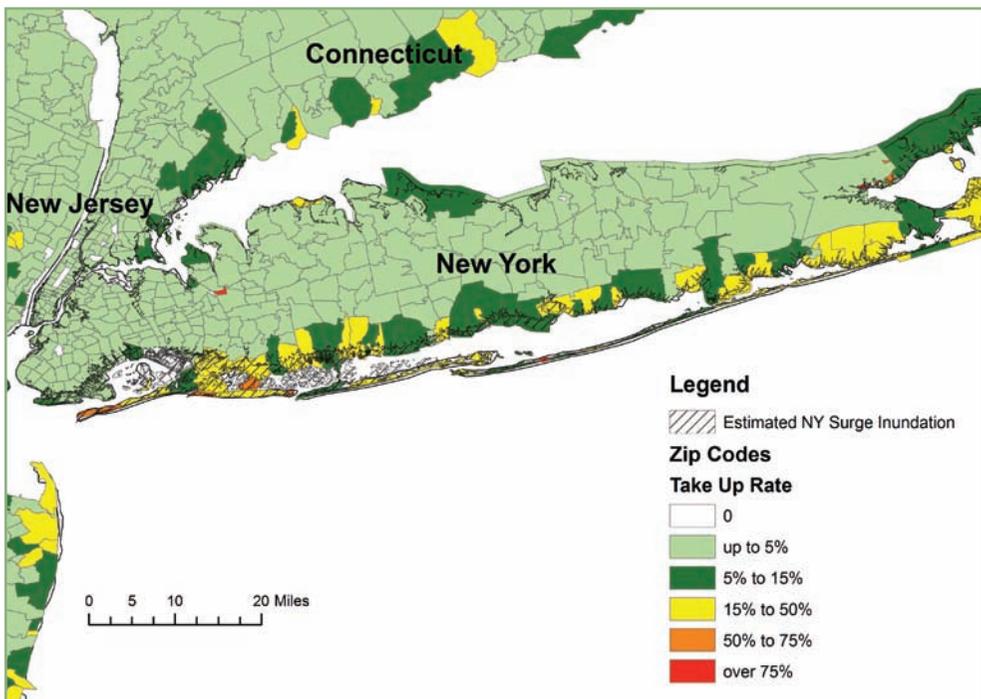
Hurricane Sandy and the National Flood Insurance Program

Following the devastating storm surge and flooding from Hurricane Sandy, and as part of an ongoing research initiative supported by the National Science Foundation, RFF Fellow Carolyn Kousky and her colleague Erwann Michel-Kerjan of the Wharton School of the University of Pennsylvania set out to inform policymakers in their discussions about the status of residential flood insurance, which is primarily provided

through the federal National Flood Insurance Program (NFIP). They wanted to answer the question, what proportion of affected homeowners in New York and New Jersey had federal flood insurance coverage?

They combined preliminary estimates of storm surge inundation from the Federal Emergency Management Agency’s Modeling Task Force with NFIP data to examine the relationship between Sandy’s impact

Figure 1. Residential NFIP Flood Insurance Take-Up Rates by Zip Code in New York in 2010 with Sandy Storm Surge Estimates



Source: Kousky, Carolyn, and Erwann Michel-Kerjan. 2012. Hurricane Sandy, Storm Surge, and the National Flood Insurance Program: A Primer on New York and New Jersey. Issue brief 12-08. Washington, DC: Resources for the Future.

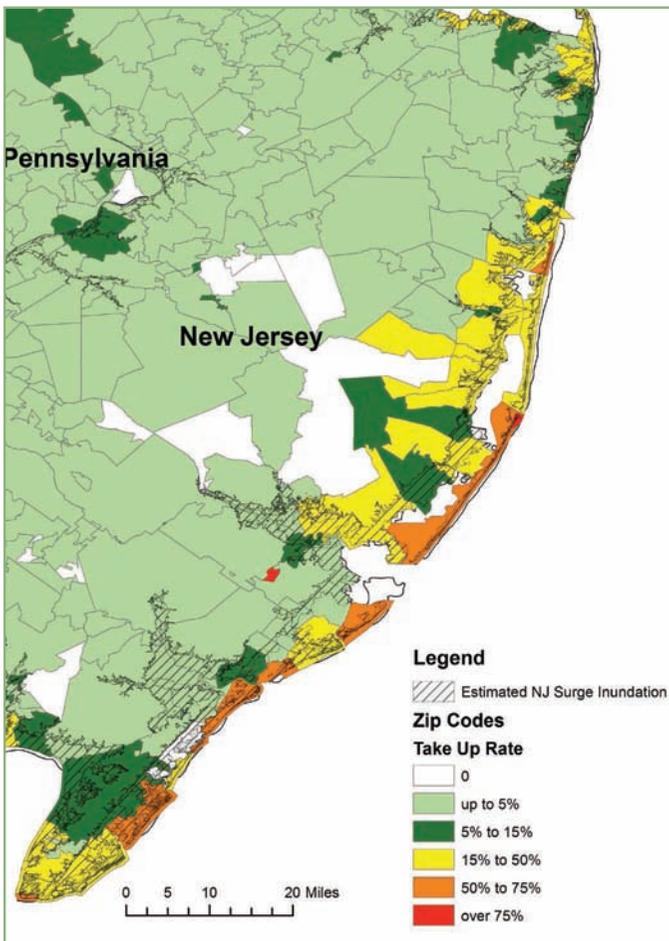
and NFIP “take-up rates”—the percentage of households with an NFIP policy (Figures 1 and 2). **Their analysis shows that many homeowners who sustained flood damage from Sandy did not have flood insurance policies.**

Researchers have identified many reasons for low take-up rates: homeowners dismiss the risk, are overly optimistic in thinking they won’t be victims of a disaster, or drop insurance if they don’t file a claim within a short period of time. Some homeowners

don’t realize their homeowners insurance policy does not cover floods, and others face budget constraints.

Kousky and Michel-Kerjan note that having adequate insurance coverage not only helps prevent financial hardship for individuals when a disaster strikes, but also provides social benefits in terms of greater availability of funds for rebuilding communities and reducing reliance on limited federal aid post-disaster.

Figure 2. Residential NFIP Flood Insurance Take-Up Rates by Zip Code in New Jersey in 2010 with Sandy Storm Surge Estimates



Source: Kousky, Carolyn, and Erwann Michel-Kerjan. 2012. Hurricane Sandy, Storm Surge, and the National Flood Insurance Program: A Primer on New York and New Jersey. Issue brief 12-08. Washington, DC: Resources for the Future.

Highlights of RFF's Recent Contributions to Shaping Environmental Policy

Agricultural Biotechnology

February 19

RFF Visiting Scholar Randall Lutter moderated a panel on agricultural biotechnology and the environment. Panelists focused on concerns over labeling food from genetically modified animals. www.rff.org/agbiotechnology



CONVENING THOUGHT LEADERS

The Anthropocene Era

November 13

RFF hosted a special lecture with Kenneth J. Arrow, 1972 Nobel Laureate in Economic Sciences, titled "The Environment in the Anthropocene Era: Values, Rationality, and Justice." This event was part of RFF's 60th anniversary celebrations. www.rff.org/resources2020

The Future of Fuel

November 28

As part of the First Wednesday Seminar Series, RFF's Center for Energy Economics and Policy hosted a panel discussion on the future of five key fuels over the next decade. www.rff.org/fuel

Environmental Regulation

December 5

RFF experts Sheila Olmstead, Dallas Burtraw, Art Fraas, Margaret Walls, and Leonard Shabman participated in a panel discussion on lessons learned from applications of

market-based policy and its desirability in the future. www.rff.org/markets

Geoengineering

December 13

Thomas C. Schelling, 2005 Nobel Laureate in Economic Sciences, concluded RFF's 60th anniversary Nobel Laureate lecture series with his remarks "Geoengineering: Time for Some Gentle Experimentation." www.rff.org/resources2020

Media, Science, and Cognition

February 6

RFF Visiting Scholar and Co-Director of RFF's Center for the Management of Ecological Wealth Lynn Scarlett moderated a First Wednesday Seminar, "The Media, Science, and Cognition: How We Shape Our Understanding of Environmental Issues." www.rff.org/cognition

Climate Policy and Tax Reform

February 27

The International Monetary Fund's Ian

Parry co-hosted a panel with RFF experts on comprehensive tax reform and climate policy. www.rff.org/taxcode

BUILDING PARTNERSHIPS

Monitoring Carbon from Space

November 7

RFF Vice President for Research and Senior Fellow Molly Macauley presented “NASA’s Carbon Monitoring System and the Social Cost of Carbon” at the NASA Goddard Space Flight Center.

Carbon Tax

November 13

RFF’s Rob Williams, Dick Morgenstern, Karen Palmer, and Molly Macauley participated in a conference, “The Economics of Carbon Taxes,” co-hosted by RFF, the Brookings Institution, the American Enterprise Institute, and the International Monetary Fund.

Water and Shale Gas

November 13–14

On November 13, RFF Fellow Sheila Olmstead shared an overview, “Water Management Concerns for Unconventional Gas Development,” at the In-Depth Workshop on Water Management at the Center for Strategic and International Studies. Olmstead also presented preliminary results from RFF’s shale gas study at the North American Gas Summit on November 14.

Land Conservation

November 30

RFF Senior Fellow Allen Blackman spoke at a luncheon at the World Bank on ecosystem services programs in China, Costa Rica, and Mexico.

Natural Resources

December 10–13

RFF’s Molly Macauley, Becky Epanchin-Niell, Lynn Scarlett, James Boyd, and Leonard

Shabman participated in a conference hosted by A Community on Ecosystem Services, Ecosystem Markets, and Ecosystem Services Partnership, focusing on how to incorporate ecosystem services in natural resource management.

Energy and Environment in the Social Sciences

January 4–6

RFF experts participated in sessions at the Allied Social Science Associations in San Diego. Topics included designing a US carbon tax, forests and agriculture, energy extraction, and transportation economics.

Environmental Stewardship

January 8

RFF’s Lynn Scarlett moderated “The Conservative Voice and Environmental Stewardship” with former US Secretary of the Interior Gale Norton and Ed Schafer, former US secretary of agriculture and former governor of North Dakota, at the inaugural Conservation and Stewardship Conference of the Conservation Leadership Council.

Electricity Technology

January 16–17

RFF Senior Fellow Carolyn Fischer presented “Environmental and Technology Policy Options in the Electricity Sector: Interactions and Outcomes” at the Grantham Research Institute on Climate Change and the Environment at the London School of Economics, as well as at the Swedish Environmental Protection Agency.

Sustainable Conservation

February 28

RFF Senior Fellow and Co-Director of RFF’s Center for the Management of Ecological Wealth James Boyd presented “Making Conservation Sustainable” at the University of Virginia.

The Limits of a Gasoline Tax

During rush hour, busy urban commuters fail to account for the costs they impose on other drivers, leading to excessive amounts of congestion. These costs, in terms of time and extra fuel consumption from sitting in traffic, add up to a significant sum—more than \$100 billion in 2011, according to the Texas Transportation Institute’s annual estimate. In a 2007 article in the *Journal of Economic Literature*, Winston Harrington, Ian Parry, and I concluded that the various externalities associated with gasoline consumption warranted a gasoline tax of \$1.25 per gallon. Forty percent of this tax, we estimated, was attributable to congestion.

In retrospect, I think we were wrong to attach these congestion costs to gallons of gasoline consumption. The appropriate tax for internalizing congestion costs is not a per-gallon gasoline tax but a fee per mile that varies with the degree of congestion. On congested highways in urban areas during peak commuting periods, the fee might be substantial, but on rural roads and in urban areas during off-peak travel periods, the fee should be zero. A gasoline tax is a blunt instrument for addressing congestion—and it probably would do nothing to solve the serious problems that exist in cities across the country.

This imperfection in the gas tax for addressing congestion problems will worsen in the future. For one thing, the share of the vehicle stock comprised of hybrids, electric vehicles, and other alternative fuel vehicles is steadily rising. The Energy Information Administration forecasts that 12 percent of all cars and light-duty trucks on the road in 2025 will be alternative fuel vehicles, up from only 5 percent in 2010. This increase is partially spurred by new fuel economy stan-

dards, which require new cars to achieve a minimum of approximately 40 miles per gallon by 2017, ratcheting up to 55 miles per gallon by 2025. Light-duty trucks face similar increases. These new standards will make the per-gallon gasoline tax an even less-effective tool to combat urban congestion.

Moreover, the standards will diminish much-needed revenues from a gas tax for our nation’s roads. Virginia’s governor, Bob McDonnell, recognized this in his recent proposal to drastically alter the way the state raises funds for transportation. Governor McDonnell proposed eliminating the state’s 17.5 cents-per-gallon gasoline tax and replacing it with a combination of a general sales tax increase; an increase in motor vehicle registration fees, including a surcharge on alternative fuel vehicles; and a plan to capture more revenue from Internet sales.

In late February, the Virginia legislature adopted most of the governor’s key recommendations—removing the per-gallon gas tax and increasing the sales tax and motor vehicle registration fees. The legislature also added a 3.5 percent wholesale tax on motor fuels. This percentage-based, or *ad valorem*, tax allows revenues to increase as gas prices rise (and decrease as they fall), unlike the traditional per-gallon tax.

A full analysis of the approach in Virginia is a discussion for another day, but some facts are clear. Per-gallon gas taxes can be expected to raise significantly less revenue in the coming years as fuel efficiency and the share of alternative fuel vehicles on the road increase. Increasing gas taxes is extremely difficult politically, which is why we have an 18.4 cents-per-gallon federal





gas tax that hasn't been raised in nearly two decades. At the same time, our nation's road infrastructure is crumbling and badly in need of a cash infusion.

A carbon tax may be the right way to go to address global warming and would lead to a tax on all energy sources (proportional to their carbon content), including gasoline. But for some of the other most pressing transportation problems—congestion externalities and road infrastructure funding shortfalls—perhaps it's time to move beyond the long-standing political stalemate over increasing the gas tax to think creatively about new policy choices and funding approaches. ● —**MARGARET WALLS**

This commentary originally appeared on RFF's blog, *Common Resources*. Read more at www.common-resources.org.

FURTHER READING

- Harrington, Winston, Ian Parry, and Margaret Walls. 2007. Automobile Externalities and Policies. *Journal of Economic Literature* 45: 374–400.
- Schrank, David, Bill Eisele, and Tim Lomax. 2012. *TTI's 2012 Urban Mobility Report*. College Station, TX: Texas A&M Transportation Institute, The Texas A&M University System. <http://mobility.tamu.edu/ums/>.

Connecting International Climate Agreements and Domestic Actions

An Interview with Takashi Hattori



Takashi Hattori spent December 2012 through February 2013 at RFF, in between completing his role as director for climate change at Japan's Ministry of Economy, Trade, and Industry and starting his

new position as head of the Environment and Climate Change Unit at the International Energy Agency (IEA) in March 2013. He sat down with *Resources* as an independent expert to discuss his experiences with climate policy negotiations, both internationally and within Japan.

RESOURCES: Takashi, why did you choose to get involved in the issue of climate change?

TAKASHI HATTORI: When I was an undergraduate, I participated in the 20th anniversary Earth Day event in New York. I knew then that I wanted to do something about this global issue. Since then, within the government of Japan, I've had various opportunities to work on the issue, and I've realized that government cannot do everything. Industries, people, research communities, local governments—they all play a role in this issue.

RESOURCES: You've been part of Japan's team responsible for international climate

negotiations through the UN Framework Convention on Climate Change. What do you think is necessary to move the international negotiations forward?

HATTORI: I first attended the Kyoto Conference (COP3) in 1997, which set the Kyoto Protocol. It was a moment when we internationally agreed to do more to address climate change. Since then, the world has changed rapidly. Many countries—both developed and developing—have made efforts to work on climate change actions. But we need to work further.

Last year we started the Ad Hoc Working Group on the Durban Platform, which is negotiating the future framework beyond 2020. This is a forum for bringing many new ideas, where all countries can work together to further the climate issue. We need creative thinking to develop a new structure and new elements for international climate actions.

RESOURCES: How do you see the interplay between international action on climate change and national or subnational action? Do you think more movement at the national level can create more movement at the international level or—vice versa—can more international action lead to more national action?

HATTORI: The interplay between international and national or regional action

on climate change is a quite important question. In my experience, it's best to see actions on both sides. We want to have international agreements, but in order to agree, each player needs to be comfortable with the outcome—they need to have domestic consent. In this sense, to agree on the outcome of international negotiations, we need to see domestic actions or some trends domestically toward that international agreement.

There are many domestic climate policies in the United States and other countries. I think these are elements for future international agreements. And if we can reach international agreement, this perhaps enhances domestic actions. So it's a circular process. We need both.

RESOURCES: How is Japan handling its own climate policy at the moment?

HATTORI: In Japan in 1973, we faced an energy crisis. Since then we've put a lot of efforts into energy efficiency. When we first encountered the issue of global climate change, we realized we had to change. We thought we should work on this problem both domestically and internationally. That's why we held the Kyoto Conference and tried to lead actions on climate change.

Recently we suffered the Great East Japan Earthquake on March 11, 2011. We lost the lives of many people. We lost nuclear power. We lost supply of electricity. And we now are in a new situation, taking a different approach to meet the goal of energy and climate change.

Before the earthquake, about 30 percent of Japan's electricity was generated by nuclear power. Right after the earthquake, we lost four plants, but then following inspections, all the nuclear plants were shut

COMMON RESOURCES

Visit RFF's blog, *Common Resources*, where experts provide up-to-date commentary on the latest research, analysis, and debates surrounding environmental and natural resource policy issues—in DC and around the world.

Join the discussion at
www.common-resources.org.



down. Now we are trying to review what happened, and only two plants are currently operational.

Because of the loss of nuclear power, Japan increased its imports of natural gas to cover the energy shortage. But at the same time, the Japanese people and Japanese industries made efforts to reduce energy consumption. For example, they tried to limit energy use at peak times—in the hottest days of summer and in the coldest days of winter—to match supply and demand. It was an enormous effort by the Japanese people. So although carbon dioxide (CO₂) emissions increased, hopefully we can still meet the target of the Kyoto Protocol.

RESOURCES: Is the private sector in Japan developing technologies that will help with this transition to a low-carbon future?

HATTORI: Japanese industries are quite keen to work on the climate change problem. For example, they have taken voluntary actions in the 1990s and continue to work on this issue. In terms of technology, Japanese industries are trying to develop environmentally friendly, cutting-edge, low-carbon technologies to deal with climate change. This also may help other countries if those technologies are implemented there as well. Specifically, Japan is using the Bilateral Offset Credit Mechanism to try to promote low-carbon facilities and projects in developing countries. This is where developed and developing countries work together to create new projects that generate a credit or offset that will serve both countries. In 2011 we started working together with developing countries, such as Mongolia, Vietnam, Indonesia, Thailand, Cambodia, Kenya, Ethiopia, and so on.

RESOURCES: Despite the fact that Japan did not sign up to be a part of the second commitment period for the Kyoto Protocol, do you think the treaty is still the right way to move forward in reducing emissions?

HATTORI: When we agreed on the Kyoto Protocol, it covered 59 percent of the world's CO₂ emissions. Today only about 15 percent are covered by the Kyoto Protocol because of the economic growth in developing countries.

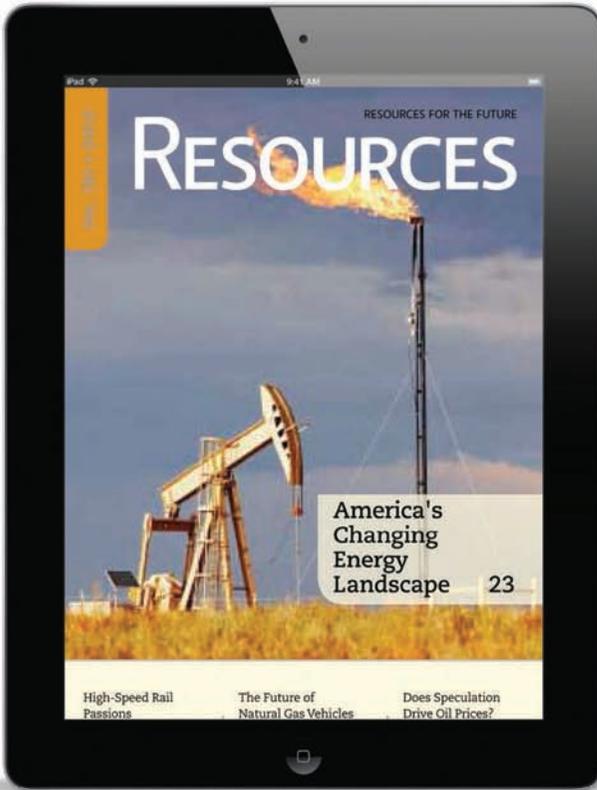
We need wider participation in working to reduce CO₂ emissions, not just by developed countries, but also by developing countries. So the Kyoto Protocol is not the solution, or at least it can only serve as a partial solution. In order to bring others into international negotiations or an international agreement, perhaps we should pursue another way.

In the long run, we will work on extending the international agreement beyond 2020, but while we work toward this, we should also pursue domestic actions and other international actions related to climate change. For example, in Japan we continue to work on energy efficiency, renewable policies, and other energy-related policies. We set a target for the introduction of new renewable energy and recently introduced a feed-in tariff scheme for solar, wind, geothermal, hydro, and biomass. This is a challenge for Japan because we've had to rebuild our energy policy and our climate change approach.

I think domestic actions are key for moving international negotiations forward. There are many new initiatives throughout the world, in the United States, in Europe, and in developing countries, such as China and India, and in Brazil. Those domestic actions will be the foundation for future international regimes. ●

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CROWDSOURCING

Environmental Science and Reporting

Scott Horner, a farmer in western Colorado, awaits the bloom of spring lilacs with anticipation each year. Once the lilacs peak, it's time for Horner to plant potatoes and launch the growing season.

The fragrant bunches have been appearing earlier and earlier in recent years, Horner has noticed.

Earlier lilacs, plants growing out of turn, an extended wildfire season: these are some of the observations and data that are shared in a new science journalism project, iSeeChange, launched at KVNF-TV in Paonia, Colorado. The initiative is designed to bring local farmers, ranchers, and residents into conversation with scientists about environmental issues.

iSeeChange producer Julia Kumari Drapkin described her project at RFF's February 2013 First Wednesday Seminar, "The Media, Science and Cognition: How We Shape Our Understanding of Environmental Issues." The discussion was part of RFF's 60th anniversary event series, *Resources 2020*, a yearlong exploration of how economic inquiry can address future environmental challenges.

Drapkin, along with Barbara Allen, the Ada M. Harrison Distinguished Teaching Professor of the Social Sciences and chair of Women's and Gender Studies at Carleton College in Northfield, Minnesota, led the discussion about how the public understands and shapes its opinions about global warming and other environmental issues.

Drapkin went to Paonia, which last year experienced its worst drought since 1924, to launch iSeeChange as part of Localore, a nationwide project funded primarily by the Corporation for Public Broadcasting to bring public service journalism to local media. Her vision was to turn science reporting upside down by starting with the observations of local residents on changes in climate and bringing scientists into the conversation to discuss how those observations fit and compare with broader scientific research.

At the same time, the observations and data collected and recorded by local farmers and ranchers—many in family diaries that go back decades—may provide a data set useful to climate researchers.

"This is a community that lives outdoors and is built around the land," Drapkin said. "They are farmers, ranchers, hikers, campers. These people are not afraid of science. They are living science every day much more than I do here in Washington, DC."

In addition to producing multimedia news stories, Drapkin created a website that serves as a sort of online almanac where local residents post questions and observations about weather.

An entry from February 19, 2013 reads, "I was wondering why I've had allergic-type sneezing. . . . Juniper pollen, though still low, is already floating in the air, several weeks earlier than 'usual'—ugh!"



Carleton College Professor Barbara Allen (left) discusses the journalism project iSeeChange, produced by Julia Kumari Drapkin (right), at RFF's February First Wednesday Seminar.

Many of the residents in Paonia were noticing changes in weather patterns, Drapkin said. For example, the fire chief said the wildfire season was lasting much longer than the normal two months. She discussed it with a researcher who confirmed that it had lasted 78 days longer than usual in the last couple of years.

Drapkin said most people in Paonia were skeptical that changing weather patterns had anything to do with human activity.

After Drapkin described her real-world experience, Allen put the project into the context of how people understand and make decisions about information they receive. She said most people's attitudes toward climate change are shaped through "hot cognition," a combination of information, personal experience, and emotion related to that information.

Allen said the only way to change these habitual ways of thinking is to be a trusted

source and to create dynamic dialogue, as iSeeChange has done.

Allen drew lessons from the project that other science communicators can learn from. In her news stories about climate and weather, Drapkin interviews local residents about their experiences, placing the stories in the context and language of the community. Drapkin also mediates between the scientific and local communities by introducing scientific terms in the vernacular—what Allen calls the language of experience. The stories include information that doesn't necessarily conform to a preset conclusion. People can add their own observations and data to the iSeeChange almanac. The crowdsourcing builds a resource around which the community is now discussing climate, Allen said. ●

To watch video of the event, visit www.rff.org/cognition. Visit thealmanac.org to find out more about the iSeeChange project.

The Obligations of **ENVIRONMENTAL** *Stewardship*

Humankind is influencing the global environment to such an extent that we are now in what some have identified as a distinct geological age, the Anthropocene era. The human global footprint is undeniable and dates back at least to the Industrial Revolution, if not well before.

In separate lectures, two Nobel Laureates in economics came to RFF and addressed issues central to the Anthropocene era. Kenneth Arrow focused directly on the philosophical and ethical questions associated with humankind's power over the global environment, and Thomas Schelling examined the strategic nuances of geoengineering—the potential use of technology to alter the climate to avoid catastrophic global warming. Their speeches were part of RFF's 60th anniversary activities, which have looked ahead to the critical issues and research needs of the next 10 years and beyond.

Arrow's talk was wide-ranging and learned, referencing figures as diverse as Homer, Hamlet, John Locke, E.O. Wilson, Steven Pinker, and T.S. Eliot. He explored two linked questions. First, what is it about human beings that has enabled them to gain such power? And second, what, if any, obligations come with that power?

He discussed several unique human attributes, notably language and empathy, that have fostered the development of complex

human societal interaction, learning, and moral reasoning. Noting that many people now have concern for the welfare of other species, Arrow argued that “the breadth of our sympathies is related to the fact that we are so powerful.”

Arrow has been active on the issue of climate change, recently participating in an RFF project on how to appropriately discount impacts over long time horizons, such as those associated with global warming. But he elaborated in the question-and-answer period that although climate change is a profound issue, he believes the greatest threat facing the world remains nuclear weapons.

Thomas Schelling has spent a good portion of his career wrestling with the nuclear threat—and, like Professor Arrow, he has been a prominent figure in the climate change debate since chairing a commission on global warming in 1980 for President Jimmy Carter.

The prospect of geoengineering—for example, using particles to screen out some of the sun's radiation in a process called solar radiation management—is something that Schelling has been thinking and talking about for the past 20 years. “And for the first 10 years, half of my audience thought I was crazy and the other half thought I was dangerous,” he said.

Recently, however, geoengineering



Nobel Laureates Kenneth Arrow (left) and Thomas Schelling (right) delivered distinguished lectures at RFF as part of its 60th anniversary celebrations.

has emerged as a topic for discussion in respectable company, both because it is a potential backstop against severe climate change and because it is increasingly feasible.

The emergence of the geoengineering option raises troubling questions. First, as Schelling observed, "It looks phenomenally cheap. Compared with the arms race that we've had ever since the end of World War II, this is small stuff. This is likely to be within the individual capacities of maybe 20 different countries if they really wanted to do it."

Additionally, much remains unknown about the physics of geoengineering and its possible unintended consequences. And if for some reason it was deemed necessary to discontinue the solar radiation management strategy, for example, the atmosphere will have accumulated the capacity for a very sudden large increase in temperature.

For these reasons, Schelling recommended moving beyond laboratory experiments to "gentle experimentation" in the atmosphere, "because if geoengineering is a very bad idea, the sooner we know, the sooner

we can stop counting on it." Such testing of solar radiation management, in particular, would be designed to answer the following questions, among others:

- » How are the particles distributed?
- » Do they concentrate more toward the equator or more toward the poles?
- » How long does it take them to distribute throughout the atmosphere?
- » Is it a ragged or uniform distribution?
- » Do the particles dissipate in six months? A year? Eighteen months or longer?

He walked the audience through a masterful analysis of the motivations of different political actors and concluded that the United States was in the best position to take the lead. Whoever initiates geoengineering experimentation is setting the framework for future efforts, noted Schelling, "and I trust the United States, not to do that especially well, but to do it probably better than anybody else." ●

Visit www.rff.org/resources2020 to watch the Nobel Laureate lectures.

green INFRASTRUCTURE

Investing in Nature to Build Safer Communities

By Anna Brittain

Floods accounted for more lives lost and more property damage than any other form of natural disaster in the United States during the twentieth century. And the wreckage continues: In 2012, Hurricane Sandy killed more than 100 people and inflicted billions of dollars in infrastructure damage. In 2008, Hurricane Ike killed dozens of people and flooded more than 100,000 homes along the eastern coast of Texas. In Wisconsin that same year, heavy rainfall caused record-setting flooding, with 31 counties declared federal disaster areas.

According to the US Environmental Protection Agency, bolstering US public water systems in the face of climate change and land development will require more than \$330 billion over the next 20 years, including investments of more than \$50 billion for dam safety and community resilience in particular. As governments weigh their options, “green” infrastructure is gaining recognition as a cost-effective substitute for or complement to the “gray” infrastructure—pipes, dams, levees, and the like—traditionally used to control flooding, store water, and reduce urban stormwater overflows.

Green infrastructure refers to natural systems that absorb and filter pollutants from the air and water, protect communities from flooding and storm surges, reduce erosion, and enhance both community and environmental well-being. Floodplains and wetlands can provide buffers against flood risks, for example, and public parks and other permeable urban surfaces can naturally slow and filter polluted runoff.

Green infrastructure investments will often require new kinds of economic and environmental analyses, as well as negotiations and collaboration among numerous stakeholders. But state and local governments often lack the resources and data necessary to evaluate green infrastructure technologies and their benefits. What tools can communities use to target ecosystem investments?

One strategy that has emerged from research by experts at RFF’s Center for the Management of Ecological Wealth is the carefully targeted preservation of high-benefit, low-cost land parcels. RFF researchers Carolyn Kousky, Sheila Olmstead, Margaret Walls, Adam Stern, and Molly

Macauley find that limiting development on land that fits specific criteria related to flooding potential and cost can economically provide flood protection and build resilience to climate change in Wisconsin's Fox River Basin. Walls and Kousky are conducting a similar study in St. Louis County, Missouri, a community that is located in the triangle formed by the Missouri, Mississippi, and Meramec Rivers.

Floodplains and wetlands can provide buffers against flood risks, and public parks can naturally slow and filter polluted runoff.

RFF Visiting Scholar and Co-Director of RFF's Center for the Management of Ecological Wealth Lynn Scarlett serves on a steering committee that is championing a "soft" infrastructure strategy to restore and build resilience along the Texas Gulf Coast in the wake of Hurricane Ike: the creation of the Lone Star Coastal National Recreation Area, which would protect hundreds of thousands of acres of coastal marsh, wetlands, and the estuary and bay through joint management by regional partners and the National Park Service. Underpinning this work is an economic assessment of the value of preserving these lands for both storm protection and recreation, which span four counties along the Upper Texas Coast where Ike and other hurricanes have made landfall.

Another approach is to pay landowners for water management services. The Florida Everglades are under threat from agricultural and urban land development that is fragmenting lands, destroying species habitat, and dramatically changing traditional water drainage and flow patterns. RFF Resident Scholar Leonard Shabman helped to create the Florida Ranchlands Environmental Services Project to address this problem. Based on its success, the South Florida

Water Management District worked with other state agencies to create the Northern Everglades—Payment for Environmental Services program. This innovative program pays cattle ranchers to implement water management strategies that increase water retention on their lands and reduce nutrient runoff, lessening the need for new investments in hard infrastructure, like levees and water treatment plants.

In some cases, investing in green infrastructure may be worthwhile, even if more costly than traditional approaches, because the social and environmental benefits may exceed the additional costs. Cape May, New Jersey, provides a powerful example. As Mark Tercek, an RFF board member, president and chief executive of The Nature Conservancy, and coauthor of *Nature's Fortunes: How Business and Society Thrive by Investing in Nature*, recently told the *New York Times*, the city "had the foresight to restore its dunes and wetlands to provide storm protection and wildlife habitat" and was spared the damage that devastated neighboring towns. ●

FURTHER READING

- Archie, Michele L., and Howard D. Terry. 2011. *Opportunity Knocks: How the Proposed Lone Star National Recreation Area Could Attract Visitors, Boost Business, and Create Jobs*. Washington, DC: National Parks Conservation Association.
- Kousky, Carolyn, Sheila Olmstead, Margaret Walls, Adam Stern, and Molly Macauley. 2011. *The Role of Land Use in Adaptation to Increased Precipitation and Flooding: A Case Study in Wisconsin's Lower Fox River Basin*. Washington, DC: Resources for the Future.
- Lynch, Sarah, and Len Shabman. 2007. The Florida Ranchlands Environmental Services Project: Field Testing a Pay-for-Environmental-Services Program. *Resources* 165: 17–19.
- Tercek, Mark R., and Jonathan S. Adams. 2013. *Nature's Fortunes: How Business and Society Thrive by Investing in Nature*. New York: Basic Books.





The Controversy over US Coal Exports

Industry proposals to increase exports of American coal provoke fierce efforts to forestall that prospect.

Joel Darmstadter weighs in on the economic rationale favoring exports and the environmental and political arguments against them.

In international trade, a gap between theory and practice has always existed. Theory stresses, as an underlying ideal, the economic benefits of trade based on comparative advantage. In practice, and for a variety of reasons—institutional constraints, political factors, ambiguity of legal doctrine, bilateral or multilateral treaty obligations—the ideal intermittently bows to reality, whether in the form of explicit protectionism or other barriers.

A prominent and highly disputed example concerns the prospective US exports of liquefied natural gas (LNG). A less publicized—but similarly instructive—case involves expanded exports of US coal. Foreign market conditions would appear to represent ideal opportunities for US coal exports. Whereas coal's role in the US economy has receded markedly and is projected to continue shrinking, its use in Asia—notably China and India—is expected to maintain its robust demand growth for at least the next 25 years. Competitively priced, efficiently mined, and backstopped by large

reserves, American coal's prospective stake in that market is solid, notwithstanding the environmental burden that unconstrained combustion practices may inflict. Yet the fuel is embroiled in controversy—political and environmental—over plans to serve these foreign markets.

An Industry under Threat

Even to hold its own, much less contemplate a rebound, coal in the United States seems to have a moribund future. After all, it is an industry that, between 1990 and 2010, saw its workforce fall from around 130,000 to 86,000. Although advances in productivity contributed to this change, a flat level of production (at a bit over a billion tons yearly) throughout this two-decade period, an uneven and sluggish trend in exports (which are only now slowly rising), and—especially painful—a dramatic loss to natural gas in new electric power plants all add up to a somber prospect of stagnation. Projections by both the US Department of Energy's Energy Information Administra-

Oregonians rally on the steps of the State Capitol in Salem against a coal export project that would transport 8 million metric tons of coal annually to Asia.



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tion (EIA) and the International Energy Agency offer little hope for a rebound: US coal production by 2025 is expected to barely exceed that recorded in 2000. With a sustained preference for natural gas, coal's use in electric generation—53 percent in

cause, to serve the key Asian Pacific market using Rocky Mountain surface deposits, more dedicated long-haul rail capacity and expanded terminal facilities—logistically favoring Washington and Oregon—would be needed.

The prospect of US coal exports helping to meet foreign demand would be one of the few lifelines left for the American industry to survive on, and then only modestly.

2000 and 48 percent in 2010—would fall to around 37 percent, because its principal customers would be existing coal-fueled plants rather than new ones coming online.

Elsewhere in the world, demand for coal, itself showing appreciably slower growth than during the last decade, would nonetheless continue expanding, with India and China at the forefront of that expansion. (Some two-thirds of China's electric generation is expected to remain coal-fueled in 2035.) Clearly, the prospect of US exports helping to meet that demand would be one of the few lifelines left for the American industry to survive on, and then only modestly. To be sure, fundamental breakthroughs in carbon capture and containment could alter that picture, but that and other as-yet remote technological changes are not considered here.

Recent US coal exports stood at about 110 million tons a year—about 10 percent of total production. Some 90 percent of these exports exit at six major ports, all on the East or Gulf Coast, the most important of which are Baltimore, Norfolk, and New Orleans. To facilitate even moderate export growth—EIA's baseline projection for 2025 is 115 million tons—it is widely accepted that new transportation capacity, both inland and coastal, is imperative. That's be-

The Contending Issues

Notwithstanding expressions of such expansion needs by the coal industry, the last couple of years have seen both protests and legal efforts to forestall that prospect. Though primarily nongovernmental, the opposition also has prompted some expressions of concern by officials at various levels of government. These efforts have little to do with market impacts or statutes explicitly germane to the coal industry. They have everything to do with the programmatic thrust or interpretation of the National Environmental Policy Act (NEPA) or project-specific provisions of such federal statutes as the Clean Air Act. In either case, the filing of environmental impact statements (EIS), where statutorily required, constitutes a core vehicle for the opposition movement.

It's worth mentioning as well that opposition arguments sometimes have included the point that US coal exports encourage rising worldwide carbon dioxide (CO₂) emissions. The US Environmental Protection Agency (EPA) appears to harbor such concerns, as noted later. However, it is almost certain that US exports merely displace Colombian, Australian, Indonesian, or other coal supplies that would fill the breach created by US export restrictions. In any case, I see no merit in debating in





this article how US trade policy should be framed in the light of foreign greenhouse gas policy because such policy questions deserve to be part of a broader analysis and focus on global warming imperatives. Such a wide geographic focus would also need to address the effect of US natural gas exports, which would shift at least some foreign energy use away from coal—never mind that such salutary effects are curiously overlooked in some environmentalist opposition to LNG exports.

If, on purely economic grounds, the case favoring the benefits to both industry and the nation is largely unambiguous, what is one to make of the dissenting—largely, though not exclusively, environmental—position?

On the environmental front, several sources of concern are apparent: the impact of expanded mining; issues like air pollution and increased traffic associated with long-haul rail transport from coal fields to port areas; the disruptive consequences to the communities closest to the to-be-constructed port facilities; and, not least, the extent to which, singly or in combination, these might add more than trivially to US greenhouse gas emissions. In one way or another, each of these aspects is bound to involve regulatory hurdles by federal, state, and perhaps local authorities. It is within the framework of such regulatory oversight that opposition to the coal expansion plans is being waged.

I amplify this development with a couple of specific examples:

» As reported in the *Seattle Times*, two years ago, the firm SSA Marine applied for federal and state permits—triggering a formal environmental review—to construct a \$500 million export facility (maximum capacity: 54 million tons) at the Gateway

Pacific Terminal near Ferndale, Washington, with plans to launch operations by 2015.

» Subsequently, a proposal by a subsidiary of Arch Coal for a coal port instigated a joint environmental review by Washington State's Department of Ecology, Cowlitz County, and the US Army Corps of Engineers. The Corps, which has jurisdiction over regional waterways, including the Columbia River, has been advised by EPA to also consider the full range of environmental impacts, from coal mining in Montana and Wyoming to increased coal demand in Asia. In EPA's words, what it seeks from the Corps is the preparation of "an adequate NEPA review, as governed by the Agency's responsibilities under provisions of NEPA and the Clean Air Act."

The impacts explicitly, if illustratively, singled out by EPA for consideration by the Corps are neither general nor few in number. They include such factors as local haze, endangered aquatic species, tribal cultural resources, and incursion into scenic areas. Significantly, EPA also ponders "the cumulative impacts to human health and environment from increases in greenhouse gas emissions . . . from Asia to the United States." To adequately analyze such far-reaching impacts and still allow permitting decisions to be rendered in a timely fashion could prove to be a formidable challenge. After all, even a near doubling of annual US coal exports (to, say, 200 million tons) has to be judged in the context of foreign consumption of approximately 1.7 billion tons. Whether, with such magnitudes, it is reasonable to expect the US Army Corps of Engineers to make a credible determination of CO₂ impacts seems open to question.

Opposition to, or questions raised about, these export plans go beyond comments by regulatory agencies and legally framed

Coal is readied for export at a facility in Newport News, Virginia.

filings by a number of environmental nongovernmental organizations. Dissenting views have also been expressed by several members of Congress, including Senator Ron Wyden (D-OR) and Representative Edward Markey (D-MA). In a May 2012 letter to President Obama, the two legislators expressed their concern that “unrestricted” exports of US coal, petroleum products, natural gas, and chemical feedstocks would undermine the benefits of these resources to the domestic economy. Claiming presidential authority under the Energy Policy and Conservation Act of 1975, they urged Mr. Obama to “address this problem” and ensure that exports “proceed only to the extent that they are in both the short- and long-term national interest.” However that contention may play out, it seems a bit selective to cite the “long-term national

interest” when that objective may be constructively addressed as well—or perhaps more effectively—by measures more likely to reduce worldwide recourse to, and emissions from, coal combustion.

Concluding Thoughts

The economic rationale for coal export plans seems unassailable, given the industry’s domestic stagnation and continued demand growth abroad. Even if foreign coal combustion signifies rising greenhouse gas emissions, the United States has, at best, limited ability to control that outcome because the import needs of China, India, and other countries can be satisfied by suppliers outside of the United States.

I leave it to legal scholars to parse federal statutes invoked to allow a presidential restriction on energy exports. The tempta-

A cargo ship is docked near the shore of a coal-exporting facility in Newport News, Virginia.



tion to exploit the elasticity of the concept of “national interest” is understandable. But it may be risky if that policy route is seen as mainly providing cover in its deference to domestic stakeholders, never mind that it may violate the spirit, if not the letter, of our obligations under World Trade Organization rules. Recall how, a few years ago, Vladimir Putin disrupted westward-bound pipeline gas exports, apparently with the dual purpose of settling political scores with Ukraine and keeping prices low for Russian consumers. A disrupted energy sector in several European countries was an additional consequence. More recently, as recounted in an RFF report by Jhih-Shyang Shih and colleagues, China used its global monopoly position in certain rare-earth commodities to benefit its domestic firms by manipulating exports. Heavy-handed meddling in foreign trade is surely a direction in which the United States would not wish to head.

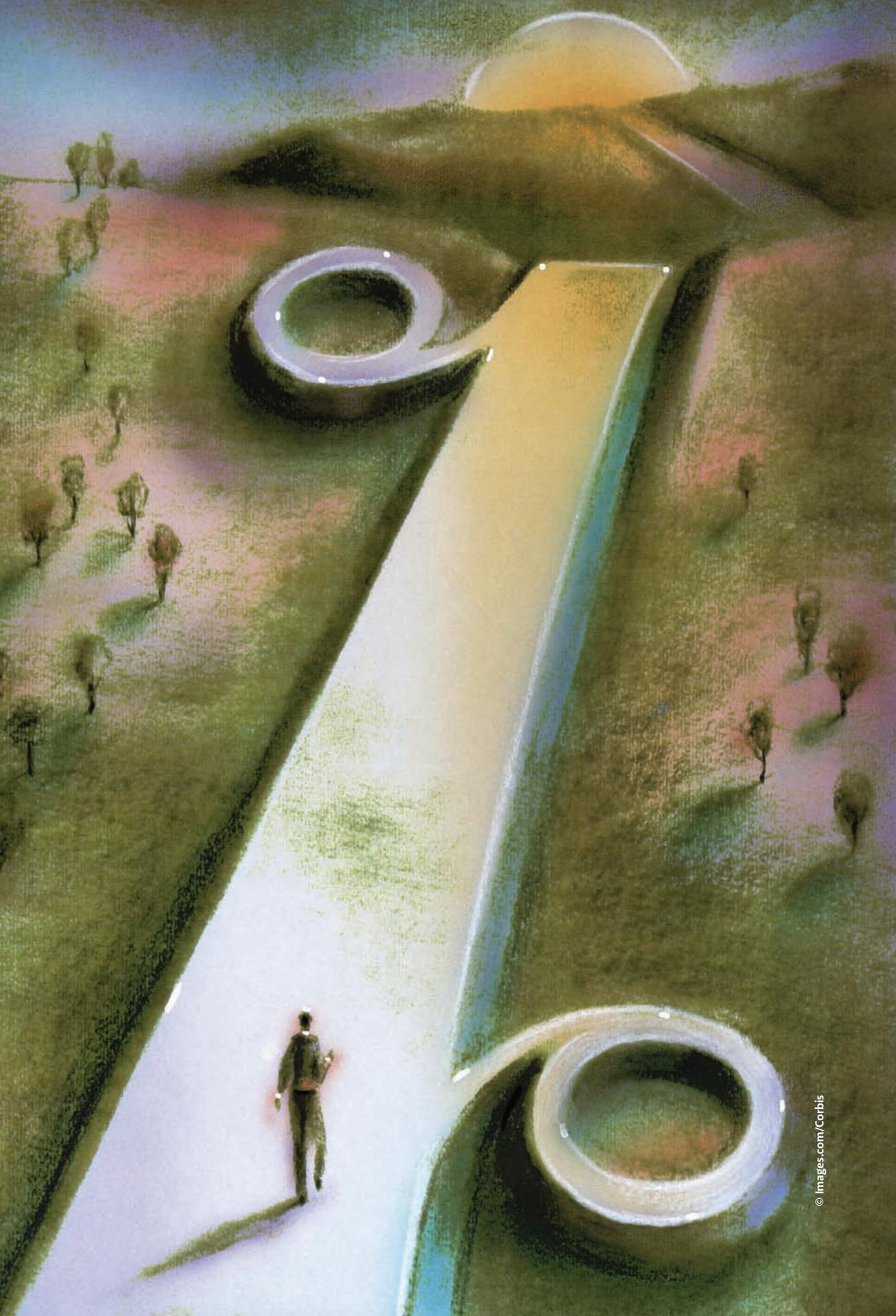
Environmental issues remain unsettled and deserve attention as part of the broad export debate. Both magnitudes and logistical factors—increased western surface mining, multiple train loads heading to Pacific export terminals, congestion in Oregon and Washington urban areas—constitute developments that, even if not unprecedented, are significant enough to trigger the purview of NEPA, as well as programmatic or project EIS oversight along various links in this lengthy and intricate supply chain.

Ultimately, society’s coal dilemma transcends the US coal dispute. As these observations are written (in early 2013), a new study by the International Monetary Fund spotlights the scope and distorting impact of subsidies in the global energy system. The report distinguishes between two subsidy components: one part calculates the extent to which prices to energy users are set below supply and distribution costs; the other part, much more difficult to estimate,

and therefore controversial, primarily addresses the magnitude of “spillover” effects, such as CO₂ emissions. While coal accounts for a minimal fraction of the first component—dominated by petroleum-product, electricity, and natural gas subsidies—it is a major factor in the spillover component. Its estimated annual magnitude of some \$530 billion in that category is exceeded only by oil-product subsidies of \$670 billion. Managing that prospective longer-run and significant environmental impact of global coal combustion doesn’t obviate the importance of dealing sensibly with the export issue, but it is the perspective to which our and the world’s sights need to be concurrently directed. ●

FURTHER READING

- Darmstadter, Joel. 2013. *The Controversy over US Coal and Natural Gas Exports*. Issue brief 13-01. Washington, DC: Resources for the Future.
- International Energy Agency. 2011. *International Energy Outlook 2011*. Paris: Organisation for Economic Co-operation and Development/International Energy Agency.
- International Monetary Fund. *Energy Subsidy Reform: Lessons and Implications*. Washington, DC. <http://www.imf.org/external/np/pp/eng/2013/012813.pdf>.
- Seattle Times*. 2011. Bulk Cargo Terminal Planned in Washington State. March 1.
- Shih, Jhih-Shyang, Joshua Linn, Timothy J. Brennan, Joel Darmstadter, Molly K. Macauley, and Louis Preonas. 2012. *The Supply Chain and Industrial Organization of Rare Earth Metals: Implications for the US Wind Energy Sector*. Washington, DC: Resources for the Future.
- US Energy Information Administration. 2011. *International Energy Outlook 2011*. Washington, DC: US Department of Energy.
- . 2012. *Annual Coal Report 2011*. Washington, DC: US Department of Energy.
- US Environmental Protection Agency. 2012. Letter from USA EPA Region 10 (signed by Kate Kelly, director, Office of Ecosystem, Tribal and Public Affairs), Seattle, WA, to Steve Gagnon, project manager, US Army Corps of Engineers, Portland, OR. April 5.
- Wyden, Ron, and Edward J. Markey. 2012. Letter to President Obama. May 31.



How Should

BENEFITS & COSTS

*Be Discounted in an
Intergenerational
Context?*

*Twelve prominent economists convened at RFF to advise the US government on the vital challenge of evaluating the costs and benefits of environmental policies affecting generations to come. Moderator **Maureen Cropper** reports.*

Because the benefits of reduced greenhouse gas emissions last for centuries while many mitigation costs are borne today, climate change has presented a very difficult political economy challenge. But issues with very long horizons do not just raise political questions; they pose thorny analytical questions as well. After all, deciding how quickly and aggressively to respond depends on how much we think a

given amount spent on mitigation today will benefit future generations.

Converting future costs and benefits into today's currency requires the process of discounting, a calculation that accounts for the fact that people value present costs and benefits more than future costs and benefits. The US Environmental Protection Agency and Office of Management and Budget have clear-cut discounting guide-

lines when it comes to assessing the costs and benefits of environmental policies that have effects lasting a few decades, but those lines blur in the case of climate change, which will affect future generations. Yet in benefit–cost analysis, the rate at which future benefits and costs are discounted can have enormous implications for policy prescription. For example, the central issue separating the aggressive policy recommendations advocated in Nicholas Stern’s 2007 report on climate change from US agency estimates of the damages associated with climate change is Stern’s controversial decision to discount future damages at a much lower rate.

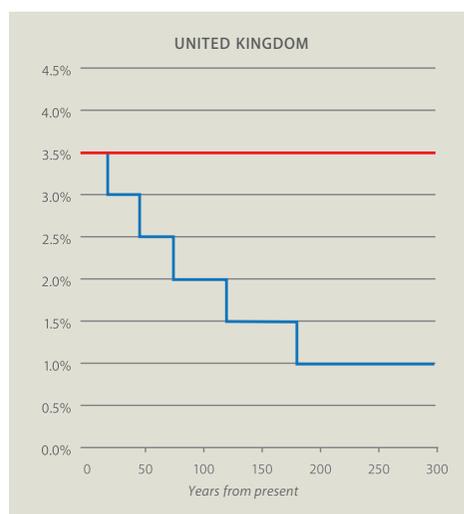
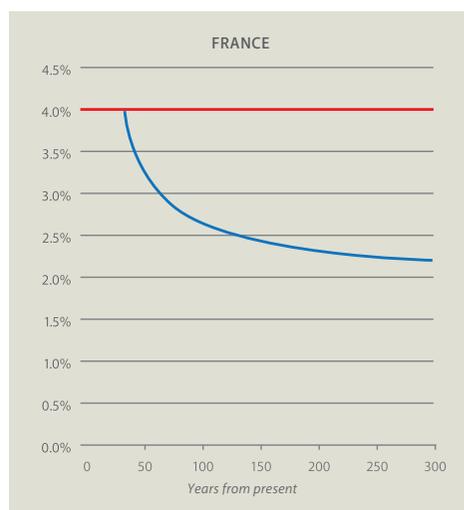
Besides the choice of how high or low to set the rate, there is also the question of whether and how it might change over time. In evaluating public projects, France and the United Kingdom use discount rate schedules in which the discount rate applied to benefits and costs in future years declines over time. As shown in Figure 1, the discount rate in year 200 is lower than the discount rate in year 100 in both countries. This is clearly more future-oriented than applying a constant discount rate (shown by the red line) to benefits in all years.

In the United States, the Office of Management and Budget recommends that project costs and benefits be discounted at a constant rate, although this rate may be lower for projects that affect future generations. This raises a familiar, but difficult, question: how should governments discount the costs and benefits of public projects, especially projects whose costs or benefits extend beyond the current generation?

Twelve prominent economists were asked to address this question at a workshop held at RFF in September 2011. Specifically, they were asked what prin-

ciples the US government should follow in estimating the discount rate to be applied in cost–benefit analyses involving future generations—and whether the discount rate should decline over time. Although panelists disagreed about the empirical approach that should be taken in estimating the discount rate, there was strong agreement about the rationale for using a discount rate that declines over time.

Figure 1. Declining Discount Rates in France and the United Kingdom



Source: Damon, Mohlin, and Sterner 2013.

How, Empirically, Should the Discount Rate Be Determined?

There are two rationales for discounting future benefits—one based on consumption and the other on investment. The consumption rate of discount reflects the rate at which society is willing to trade consumption in the future for consumption today. Basically, we discount the consumption of future generations at a higher rate because we assume future generations will be wealthier than we are and that the utility people receive from consumption declines as their level of consumption increases. To illustrate, if per capita consumption grows at 1.3 percent per year, in 200 years it will be over 13 times higher than today. So it makes sense to discount an extra dollar of consumption received 200 years in the future.

The investment approach says that, as long as the rate of return to investment is positive, we need to invest less than a dollar today to obtain a dollar of benefits in the future. Under the investment approach, the discount rate is the rate of return on investment. If there were no distortions or inefficiencies in markets, the consumption rate of discount would equal the rate of

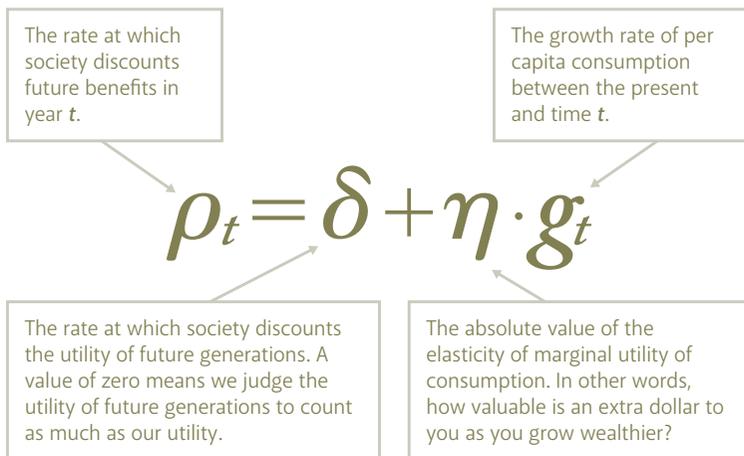
return on investment. There are, however, many reasons why the two may differ. This implies that using a consumption versus an investment approach will often lead to very different discount rates.

The Consumption Approach to Discounting: The Ramsey Formula

The consumption-based, or “prescriptive,” approach to discounting can be traced back to Frank Ramsey (1903–1930), a mathematician at Cambridge University who made fundamental contributions to economics. What has become known as the “Ramsey formula” says that the rate at which one should discount an increase in consumption that occurs in the future depends on three key factors, elaborated upon below: our pure rate of time preference, our expectations about future growth rates, and our judgment about whether and how fast the marginal utility of consumption declines as we grow wealthier (see Figure 2).

» In an intergenerational context, a positive pure rate of time preference (δ) implies that we judge the contribution of future generations to social welfare to be less than ours. Ramsey believed, on ethical grounds, that δ should be zero.

Figure 2. The Ramsey Formula



» The absolute value of the marginal utility of consumption (η) determines how rapidly the marginal utility of consumption changes as consumption increases, and thus affects the discount rate. In an intragenerational context, η can be viewed as a measure of inequality aversion: higher values of η imply that wealthier people should be asked to forgo more income to make poorer people better off.

» The rate of per capita consumption growth is given by g .

Specifying values of the parameters δ and η and forecasting the rate of growth in consumption are something of a challenge. For example, economists have inferred the value of η implied by income tax schedules in different countries and the percent of GDP donated in the form of foreign aid. It is also possible to elicit values of η and δ using stated preference methods, for example, by asking members of the public to make trade-offs between consuming today and saving to make future generations better off.

Practical difficulties in measuring the parameters of the Ramsey formula led some panelists to suggest that the rate of return on investment—which is, in principle, observable—should be used as a check on the discount rate that emerges from the Ramsey formula. The investment, or “descriptive,” approach to discounting suggests that η and δ should be estimated based on behavior in financial markets. One drawback is that behavior in financial markets is likely to reflect short-term rather than intergenerational preferences. And taxes on capital and frictions in financial markets may cause the rate of return on investment to deviate from the consumption rate of discount. The return on risk-free investments, however, is often used to approximate the consumption rate of discount due to difficulties in estimating the latter.

Should the Discount Rate Decline over Time?

Our expectation about future growth rates (g) does not depend on the same type of social and ethical judgments as the other two elements of the Ramsey formula but is equally difficult to predict. Future discount rates are inherently uncertain, due to uncertainty in the rate of growth in consumption (under the consumption-based approach) and the rate of return to investment (under the investment-based approach). But uncertainty about future growth translates into uncertainty about future discount rates. And this uncertainty may give rise to a declining discount rate schedule.

To illustrate this point, consider the simple case where we know that future discount rates will be constant, but we are uncertain about the correct rate to use. Table 1 contrasts the present value of \$1,000 received at various future dates using a constant discount rate of 4 percent versus a constant but uncertain discount rate that equals 1 percent and 7 percent with equal probability. When the discount rate is uncertain, governments should use the expected present value (the average of columns 3 and 4, shown in column 5). The present value computed using the mean discount rate of 4 percent is always smaller than when the discount rate is uncertain. This effect is magnified over time. When the discount rate is uncertain, a certainty-equivalent discount rate will yield the present values in column 5. As shown in column 6, this certainty-equivalent discount rate declines over time.

Using a declining discount rate schedule makes a considerable difference to estimates of the social cost of carbon, compared to using a constant discount rate. The range of estimates produced by some of the 12 panelists at the workshop provides a case in point. Using a constant rate of 4 percent and damage estimates

Table 1. Present Value of \$1,000 Received after t Years

(1)	(2)	(3)	(4)	(5)	(6)
<i>t</i>	Discount rate = 4%	Discount rate = 1%	Discount rate = 7%	Present value when discount rate is uncertain*	Certainty-equivalent discount rate
1	960.7894	990.0498	932.3938	961.2218	0.0394
10	670.3200	904.8374	496.5853	700.7114	0.0313
100	18.3156	367.8794	0.9119	184.3957	0.0102
200	0.3355	135.3353	0.0008	67.6681	0.0101

* average of columns 3 and 4

from panelist Bill Nordhaus, the present discounted value of global damages from emitting a ton of carbon in 2000 is \$5.30 (1989 US\$). It is \$10.00 (1989 US\$) per ton using the declining discount rate schedule estimated by Richard Newell and Billy Pizer, and \$14.00 (1989 US\$) per ton of carbon using the model estimated by Ben Groom and colleagues.

Conclusions

Among economists, the principles underlying intergenerational discounting are to a large degree uncontroversial. The 12 economists at RFF’s discounting workshop agree that there are compelling arguments for using a declining discount rate schedule in the face of uncertainty. Setting the schedule empirically is clearly a difficult task, but so is the task of setting constant discount rates for public projects.

The panelists also agree that the Ramsey formula provides a useful framework for thinking about intergenerational discounting—but they disagree as to how the parameters of the Ramsey formula might be determined empirically. In many ways, the discussion about how to parameterize the formula revisits a long-standing debate about the “descriptive” versus “prescriptive” approach to discounting—the former approach arguing that discount rates should reflect observed behavior in markets, and the latter that ethical and policy considerations should be used to set the discount rate.

Recent research by RFF University Fellow Larry Goulder and RFF Senior Fellow Rob Williams offers fresh perspective on this debate. They have argued that the consumption rate of discount should be used to evaluate public projects for the following reason: when the consumption rate deviates from the return on investment, this indicates opportunities for increasing social welfare by adjusting the savings rate. For example, if the rate of return on investment is greater than the consumption rate of discount, more should be saved. ●

This article draws from the Intergenerational Discounting Workshop held at RFF September 22–23, 2011. The participants were Kenneth J. Arrow, Christian Gollier, Ben Groom, Geoffrey M. Heal, Richard G. Newell, William D. Nordhaus, Robert S. Pindyck, William A. Pizer, Paul R. Portney, Thomas Sterner, Richard S.J. Tol, and Martin L. Weitzman. The workshop was chaired by RFF Senior Fellow Maureen L. Cropper and sponsored by the US Environmental Protection Agency. Workshop presentations are available at www.rff.org/discounting.

FURTHER READING

- Arrow, Kenneth, et al. 2012. How Should Benefits and Costs Be Discounted in an Intergenerational Context? The Views of an Expert Panel. Discussion paper 12-53. Washington, DC: Resources for the Future.
- Damon, Maria, Kristina Mohlin, and Thomas Sterner. 2013. Putting a Price on the Future of Our Children and Grandchildren. In *The Globalization of Cost-Benefit Analysis in Environmental Policymaking*, edited by Michael A. Livermore and Richard L. Revesz. New York: Oxford University Press.
- Goulder, Lawrence H., and Roberton C. Williams III. 2012. The Choice of Discount Rate for Climate Change Policy Evaluation. Discussion paper 12-43. Washington, DC: Resources for the Future.

Whither Markets for Environmental Regulation?

In this policy symposium, RFF experts shed light on whether markets are the right tool to fix the nation's environmental ills.

Over the past 60 years, regulators have implemented market-based programs for air pollution, water pollution, land management, and other environmental policy problems at local, state, federal, and—in the case of greenhouse gas regulation—international levels. Some applications hew more closely than others to ideal market-based policy design, as defined by economic theory, and programs have met with varying degrees of success. In this symposium, drawn from discussions at RFF’s December 2012 First Wednesday Seminar, four RFF scholars draw lessons from the successes—of which there have been few—and the many failures. They also consider the desirability, feasibility, and design of market-based environmental policy in the future.

Dallas Burtraw on Air Quality Trading

In the standard undergraduate and graduate economics classrooms, the failings of regulation are made a caricature. The regulatory approach is erased and replaced with the market, and the problem is assumed solved.

The flaw in this caricature is the exclusion of any role for an expert agency in the implementation and management of economic ideas.

The US sulfur dioxide (SO₂) market is a good example. Surely, the US Environmental Protection Agency (EPA) did a beautiful job implementing the SO₂ Trading Program through its Clean Air Markets Division. The program achieved virtually 100 percent compliance, and the costs were much lower than expected. And by 1995 the marginal benefits of the program were estimated by RFF and EPA to be 30 to 50 times greater than the marginal costs.

So let’s pause and ask, “What’s wrong with this picture?” Specifically, how can a program with marginal benefits 30 to

50 times greater than marginal costs be considered an economic success?

The problem is that substantial cost-effective improvements to health and the environment were not taken advantage of under the market-based program. In fact, by 2015 more than half the reductions in SO₂ that will have been achieved since 1990 will have occurred through the regulatory authority of the Clean Air Act, not the emissions trading market.

Fortunately, EPA retained its role as an expert agency and used its regulatory authority under the Clean Air Act to realize tens of billions of dollars in health improvements and net benefits per year.

To fix the program would seem simple enough. Title IV of the 1990 Clean Air Act amendments needed to delegate to the expert agency the role of considering new scientific information in adjusting the cap accordingly. But this role is not typically envisioned in economic advice, which mostly treats environmental policy as a one-time problem, not an ongoing process in a dynamic policy context. On the other hand, regulation under the Clean Air Act does so explicitly.

Going forward, I think the challenge for economists in the next decade of air regulation is a move away from the mental model of markets replacing regulation. Instead, the big opportunity is to consider how incentives can be infused into the regulatory process.

Art Fraas on Opportunities for Market-Based Regulation

An important feature of the US Office of Management and Budget (OMB) review is to encourage agencies to incorporate economic incentive approaches in their rules. When I was at OMB, serving as chief of the Natural Resources, Energy, and Agriculture Branch in the Office of Information and



Steam and smoke billow from the three smokestacks of a Navajo coal-burning power plant outside of Page, Arizona.

Regulatory Affairs, marketable permits and trading were toward the top of our list of best approaches.

Over the years, we suggested a number of economic incentive approaches to the agencies, only some of which were adopted. One that was not adopted was a cap-and-trade program for the industrial use of asbestos as a response to the draft EPA Asbestos Ban Rule under the Toxic Substances Control Act. EPA's rule was not an absolute ban of asbestos. It provided for some uses of asbestos that are absolutely critical to certain industrial processes and for national defense.

Implementing a cap-and-trade program for these uses would have had a number of

advantages. The proposed program would have focused on industrial and government uses—and would not have applied to consumer products in order to limit general population exposure. There were a number of market participants, with heterogeneity across industrial and governmental users. Knowledge was dispersed among the various users. In fact, a number of uses for asbestos were secret, especially in the defense area.

These attributes made a cap-and-trade approach attractive. Cap-and-trade would direct asbestos to the highest-valued uses. The price of allowances would provide an incentive for innovation to reduce asbestos use. And the cap-and-trade program would provide EPA with information about how stringent the program was and allow it to calibrate any further phase-down of asbestos use.

Despite these advantages, EPA came back to us after several months of due consideration and responded that a cap-and-trade program would be too complicated. Monitoring and enforcing the proper use of an asbestos allowance, the agency said, would be too burdensome. Instead, it issued the Asbestos Ban and Phaseout Rule in 1989 without including trading. EPA's final rule was overturned in court two years later in part because EPA failed to consider less burdensome approaches as alternatives to an absolute ban.

There are some lessons to draw from this experience. The first is that the economic incentive approach has to be acceptable from a policy standpoint. I think EPA viewed the Asbestos Ban Rule as a slam dunk, so from the agency's perspective, it didn't need a better rule. Another factor is that users would have to pay for their allowances. After we proposed our approach, we heard from our colleagues on the budget side at the Department of Justice's National

Security Division. With a little bit of incredulity in their voices, they said, “You know, the Department of Defense would have to buy allowances for their users of asbestos.” And we said, “So?”

The SO₂ cap-and-trade program and its successors provide an additional cautionary tale. The original program, implemented under Title IV of the 1990 Clean Air Act Amendments, is a living legend—it achieved substantial cost-effective reductions in national SO₂ emissions from the electric power sector. Now that’s something to be excited about. But a recent paper suggests that trading may have increased damages because, ton-for-ton, trading did not take into account the location of damages.

A key problem of the successor programs, the Clean Air Interstate Rule (CAIR) and the Cross-State Air Pollution Rule (CSAPR), has been a concern with these location-specific damages. In order to ensure that downwind states are adequately protected, CSAPR adopted very stringent limits on the extent of interstate trading and the use of banked credits. So if you celebrated the economic incentive advantages of the Title IV SO₂

Program, there’s no basis for celebrating CSAPR with its stunted banking and trading programs. If CSAPR survives court challenge, banking and trading will be negligible—a ghost of the earlier trading programs.

There is a fundamental tension between the environmental goals of the regulators and the requirements for a well-functioning and efficient market-based approach. Where there is a conflict, my experience suggests that the preferences and prerogatives of the regulators will dominate. Market-based approaches will perform best where established through statute and structured to respond to the environmental goals of regulators.

Margaret Walls on Transferable Development Rights

Land markets are a local story because private markets are regulated through zoning codes, building codes, and a variety of regulations that are established at the local level.

The use of market mechanisms at the local level is in the form of programs for transferable development rights (TDR). In

Suburban development encroaches on farmland in Virginia Beach, Virginia.



a TDR program, the ownership of development rights is separated from ownership of the land itself. Landowners are permitted to sell those rights in a marketplace separate from actually selling their land. In general, these sellers are the people who are going to put an easement on their property and protect it. The demanders are developers who are then going to use those rights and develop somewhere else.

There are about 180 such programs in communities across the country, and they're designed in various ways. They're targeted to achieve a variety of different outcomes, including protecting farmland, limiting sprawl, and preserving environmentally sensitive sites.

As with air and water, the literature on landmark TDR programs tells the same story. Regulations are very command-and-control oriented and have lacked flexibility. So trading theoretically should engender cost savings and efficiency enhancements.

What are the outcomes we've seen in TDR programs? So far, among these 180 programs, I could count on one hand the number in which trades have taken place. The primary reason, in my view after studying these for many years, is related to the demand side of the marketplace.

Often the programs have been over-prescribed and over-regulated by the local planners who set them up. They can't let go of the zoning idea, so they restrict who is allowed to use the rights and develop more densely. As a result, a market never develops. Another problem is the markets are established within an individual county or municipality level, so you have a fairly thin market.

Even the successful programs are subject to controversy. These are the ones that have managed to protect, in many cases, tens of thousands of acres of land at zero cost to the government. One example is a very flexible TDR program in Calvert County,

Maryland. It has protected about 23,000 acres of land and is the most market-like TDR program I've found.

Yet there are many critics of that program. Why? In my view, it's that no one knows the counterfactual. I look at the program, and I see that 23,000 acres were protected. I see that trades were made. That must mean voluntary purchasers and sellers made themselves better off by engaging in a trade; otherwise, they wouldn't do it.

But the planners don't like the Calvert program because it hasn't led to farming, which they have as a goal, and there is still quite a bit of development in the county. So some people see sprawl where I see voluntary trades that have been made to everyone's benefit. Our measures of success need further elaboration.

Len Shabman on Water Quality Trading

Most water quality trading programs today bear little resemblance to the market-like effluent tax or cap-and-trade policy designs long advocated by economists. Most are basically designed to force regulated sources of pollution and their customers to pay for pollution-reduction practices at unregulated non-point sources—that is, on farms and ranches. As such, these so-called trading programs are not performance-based or outcome-oriented. They do not give dischargers the flexibilities that would allow them to innovate.

The principal reason lies with the passage of the Federal Water Pollution Control Act Amendments of 1972, which—unintentionally, perhaps—are hostile to any form of trading or effluent tax. The amendments reflect the notion that the only acceptable discharge is zero discharge. At the time the amendments were written, that vision applied only to what were defined as point sources: factories, sewage treatment plants, and the like. To push these regulated sourc-



Brown algae blooms, fed by nutrient-rich agricultural runoff, fill the Florida Bay.

es toward zero, the act set up a particular permitting system that is the antithesis of flexibility. The regulator would decide when the technologies that should be used in waste control were attainable. Then as new technologies came along, the regulator would ratchet down and continually drive the regulated sources toward zero.

Non-point sources were not considered significant in the 1972 law and are outside the reach of the regulatory program. So what regulators wound up doing—and are continuing to do—was seeking to reduce agricultural sources with US Department of Agriculture and state cost-share subsidiary programs. These programs essentially pay farmers and ranchers a certain amount of the implementation costs associated with practices that are predicted by models to make a difference in water quality. The design of most, but not all, water quality trading programs is basically to force urban water customers and customers of affected industries to subsidize the installation of these farm and ranch best-management practices.

Let me quickly evaluate this trading-as-funding approach: I'm a skeptic. Even leaving aside the very real monitoring and

evaluation challenges, the revenue potential of trading for funding for these best practices is extremely limited. Consider one illustration from the Gulf of Mexico.

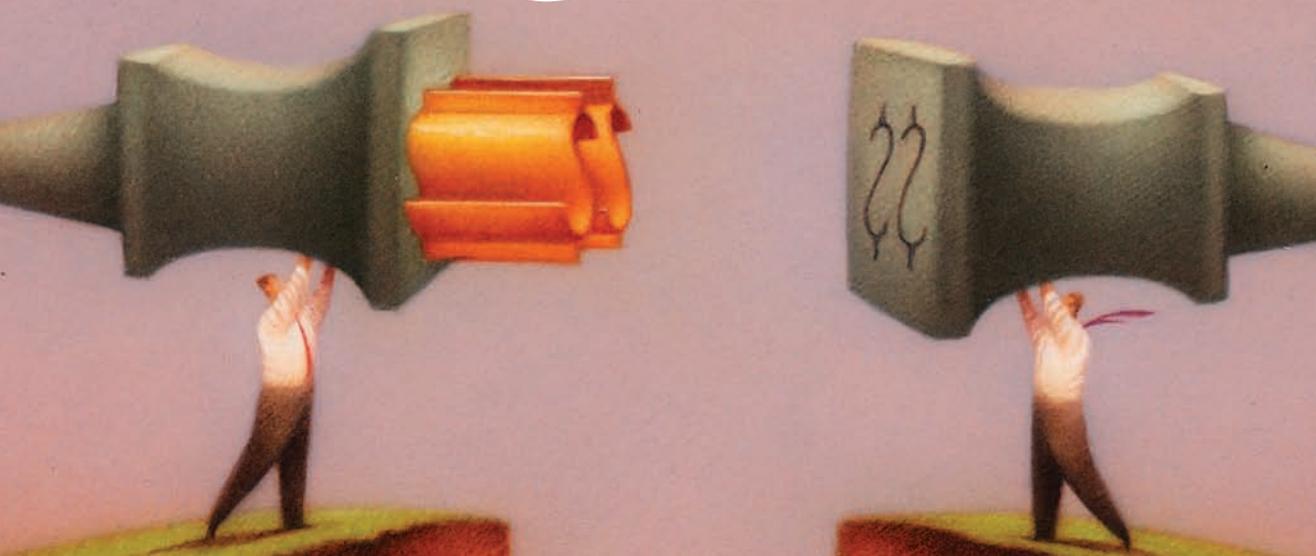
Ten percent of the total pollution load going into the Mississippi Basin and causing the hypoxia problem in the Gulf comes from point sources. If those 10 percent didn't even have to ratchet down anymore and instead were pushed to pay agriculture for some offsets, we wouldn't make a dent in the water quality problems that are being caused by agriculture in the Gulf of Mexico. So this idea that trading is going to somehow generate revenue falls flat, let alone other issues that could be raised. ●

Visit www.rff.org/markets to watch presentations from the First Wednesday Seminar "Whither Markets for Environmental Regulation of Air, Water, and Land?"

FURTHER READING

- Burtraw, Dallas. 2013. The Institutional Blind Spot in Environmental Economics. *Resources* 182: 30–35.
- Shabman, Leonard, and Kurt Stephenson. 2011. Rhetoric and Reality of Water Quality Trading and the Potential for Market-Like Reform. *Journal of the American Water Resources Association* 47(1): 15–28.
- Walls, Margaret. 2011. Markets for Development Rights: Lessons Learned from Three Decades of a TDR Program. Discussion paper 12-49. Washington, DC: Resources for the Future.

SIZING UP THE *Energy-Efficiency* GAP



Kristin Hayes summarizes some of the latest research examining a long-lived policy puzzle: Why aren't more people making energy-efficiency improvements that supposedly pay for themselves?

In its high-profile analysis of more than 250 technologies and fuel-switching options to reduce greenhouse gas emissions, the consulting firm McKinsey & Company in 2007 highlighted a number of investments predicted to save purchasers or users money over time. Many of the most promising measures are related to energy efficiency: think lighting retrofits, improved HVAC systems and building envelopes, and energy-efficient appliances.

Underlying this seemingly optimistic finding is a question economists have puzzled over for decades: With so many options for supposedly low- or negative-cost energy-efficiency upgrades, why aren't more consumers taking advantage of them? This phenomenon is commonly referred to as the energy-efficiency gap.

Understanding the energy-efficiency gap is especially important for policymakers, who employ a wide variety of strategies—such as tax incentives, product labeling programs, and standards—to increase the energy efficiency of everyday services. The size and sources of the gap help determine the effectiveness of these approaches.

Why Consumers Don't Invest in Energy Efficiency

Economists have long attributed underinvestment in energy efficiency to market failures and are beginning also to consider other possible sources, for example, systematic behavioral biases or the presence of “hidden” costs associated with efficiency investments that make them less of a bargain than they appear to be. A recent paper by Yale University Assistant Professor Kenneth Gillingham and RFF Senior Fellow Karen Palmer reviews various explanations for the energy-efficiency gap, noting where there is empirical evidence and where there is not. Some of the most compelling possibilities are as follows:

» *Agency Problems.* Agency problems arise when energy users and purchasers of energy or energy-using equipment are not one and the same and thus have non-aligned incentives to invest in energy efficiency. A good example of this is in the landlord–tenant relationship: landlords are the ones placed to make investments in energy-efficient appliances, heating and cooling, and insulation, but they don't reap the benefits of reduced electricity prices. Instead, those benefits go to tenants.

» *Externalities.* Many economists believe that the price of energy does not reflect the true costs associated with environmental damages, such as carbon dioxide (CO₂) emissions or the cost of protecting access to foreign sources of energy. These extra “uninternalized” costs are known as externalities—and when they aren't reflected in the price of energy, consumers pay less than they should and therefore have less incentive to invest in energy-efficiency measures that would reduce consumption.

» *Asymmetric Information.* Gillingham and Palmer also find evidence that when one individual has more information than another, this asymmetry can contribute to the energy-efficiency gap.

» *Behavioral Anomalies.* Consumers appear to undervalue future fuel savings from investments in energy efficiency, perhaps due to factors such as inattention and systematically incorrect beliefs about the future. In other words, people have a hard time spending more on costlier energy-efficiency appliances or systems in the present, even when their investments will pay off over time. Although there is not yet empirical evidence for behavioral explanations, Gillingham and Palmer find them plausible.

These are several of the most important explanations for the energy-efficiency gap—but overall, Gillingham and Palmer

note, the great diversity of energy users and uses inhibits a complete explanation. Further complicating the picture, the role of factors such as uncertain future energy prices and hidden costs—like lower product quality that might be associated with an energy-efficient technology—could cause the size of the gap to be overstated.

Policy Interventions in the Residential Sector

Gillingham and Palmer emphasize that the extent to which market failures explain the energy-efficiency gap matters—but eludes quantification. Research by RFF Thomas J. Klutznick Senior Fellow Margaret Walls provides an instructive example. A 2012 paper by Walls examines several policy interventions to encourage energy-efficiency improvements in the residential sector, which is responsible for a little more than 20 percent of US energy consumption. In particular, she looks at options for spurring adoption of more

effectiveness in achieving those emissions reductions.

The research shows that a loan is the most cost-effective policy of the three—that is, it has the lowest welfare cost per ton of CO₂ emissions reduced. However, it provides only very small reductions in emissions and energy use because the consumer's financial incentive is relatively small—the loan has to be repaid. Energy and emissions reductions are seven times greater with a subsidy, but this policy option is costlier. An efficiency standard costs even more than a subsidy but generates approximately the same reductions.

Built into these results is Walls's assumption that moderate market failures exist in the market for energy-efficient technologies. To show how this affects her calculations, she determines the cost-effectiveness of the subsidy and loan policies under more extreme assumptions on either end of the spectrum. When hidden costs rather than market failures are assumed to be

Understanding the energy-efficiency gap is especially important for policymakers, who employ a wide variety of strategies to increase the energy efficiency of everyday services.

energy-efficient heating and air conditioning equipment and water heaters, which together account for an average of 70 percent of a home's energy use.

Walls examines three specific policies: subsidies for the purchase of energy-efficient technologies, low-cost consumer loans for the same purchases, and more stringent standards for the performance of those technologies. She then compares the three policies based on their effectiveness in reducing energy-related CO₂ emissions, as well as on their cost-

the cause of the energy-efficiency gap, the policies become much more expensive per ton of carbon reduced. In this case, the policies are creating market distortions rather than correcting them. However, if one believes that very significant market failures exist, the future energy savings far outweigh the costs of both policies.

CAFE Standards and the Energy-Efficiency Gap

It's not just consumers who fail to make seemingly cost-effective investments in

energy efficiency. In the transportation sector, trucking companies have been slow to adopt supposedly low- or no-cost fuel-efficient technologies, prompting government intervention in the form of corporate average fuel economy (CAFE) standards.

Policy interventions are most cost-effective when they target specific market failures.

Before releasing the first CAFE standards for heavy-duty vehicles, the US Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) carried out the required regulatory impact analysis (RIA) to examine the costs and benefits of the proposed new regulations. The RIA determined that the benefits of improvements in fuel economy would far outweigh the costs of upgrading engines and making other necessary changes to equipment. The analysis reports net benefits of the policy to be almost \$10 billion per model year. These benefit figures factor in increased energy security, significant cost savings from reduced fuel use, and reduced climate damages associated with reduced fuel use (among other benefits).

But RFF Senior Fellows Winston Harrington and Alan Krupnick have pointed out that the cost-benefit estimates are subject to skepticism, in part because of the energy-efficiency gap. In their analysis, EPA and NHTSA assume that market failures and behavioral anomalies explain this gap, but empirical evidence for their existence in the trucking industry is lacking. If, alternatively, hidden costs associ-

ated with more fuel-efficient trucks are primarily to blame, the benefits of regulation are much smaller.

Policy Implications

These examples illustrate how the energy-efficiency gap can complicate efforts to

craft sound policy. The energy-efficiency gap has many explanations, and it is not always clear which forces are at play. There is some ground for optimism for policymakers, though. Gillingham and Palmer find empirical evidence that externalities and information market failures do create a gap between individuals' chosen level of energy efficiency and the socially optimal one, and evidence is growing that systematic behavioral anomalies influence investment decisions. It's also clear from the literature that policy interventions are most cost-effective when they target these specific market failures. Increasing our understanding of the causes of the efficiency gap can greatly facilitate the development of well-crafted energy policy. ●

FURTHER READING

- Gillingham, Kenneth, and Karen Palmer. 2013. Bridging the Energy Efficiency Gap: Insights for Policy from Economic Theory and Empirical Analysis. Discussion paper 13-02. Washington, DC: Resources for the Future.
- Harrington, Winston, and Alan Krupnick. 2012. Improving Fuel Economy in Heavy-Duty Vehicles. Discussion paper 12-02. Washington, DC: Resources for the Future.
- Walls, Margaret. 2012. Policies to Encourage Home Energy Efficiency Improvements: Comparing Loans, Standards, and Subsidies. Discussion paper 12-47. Washington, DC: Resources for the Future.

A Look at What's Happening

Inside RFF

RFF welcomes two new fellows to its research staff this fall: **Marc Hafstead** and **Ariel Ortiz-Bobea**. Hafstead joins RFF from his post-doctoral position at Stanford University's Institute for Economic Policy Research, where he has been working on topics in both macroeconomics and environmental economics. Recent research includes an examination of how a federal cap-and-trade program would affect industry profits and GDP and a comparison of the costs of reducing carbon emissions through either a clean energy standard or a cap-and-trade program. Hafstead has a PhD in economics from Stanford University.

Ortiz-Bobea joins RFF from the University of Maryland's Department of Agricultural and Resource Economics, where he has been working on climate change impacts and adaptation, agricultural economics, and applied and spatial econometrics. He also has a master's degree in public administration focused on international and development administration from the Maxwell School of Citizenship and Public Affairs at Syracuse University. Ortiz-Bobea served previously as the special assistant to the minister of the environment and natural resources in the Dominican Republic.

RFF Senior Fellow **Timothy Brennan** received the Distinguished Service award from the Public Utility Research Center at the University of Florida, honoring his contributions to the understanding of regulatory economics and finance.

RFF Visiting Scholar and Co-Director of RFF's Center for the Management of Ecological Wealth **Lynn Scarlett** was appointed to the National Parks Conservation Association's board of trustees.

RFF Vice President for Research and Senior Fellow **Molly Macauley** was selected for membership in the Women's Forum of Washington, DC, which is dedicated to enhancing opportunities for engaging women in leadership roles around the world.

RFF Board Member **Trudy Ann Cameron**, Raymond F. Mikesell Professor of Environmental and Resource Economics at the University of Oregon, was named a 2011 Fellow by the Association of Environmental and Resource Economists at its 2012 summer conference.

RFF Welcomes a New Board Member

RFF is pleased to announce the appointment of **Rick Holley**, president and CEO of Plum Creek Timber Company, to its board of directors. He brings a wealth of experience and leadership in a variety of fields to help RFF improve its research and outreach in the coming years.

Holley was elected president, CEO, and a member of the board of directors of Plum Creek in 1994. Prior to assuming this role, he served as vice president and chief financial officer since 1985.

Holley began his career at General Electric Company in 1974, where he served in a variety of financial management positions. In 1983, he joined Burlington Northern, Inc., where he worked as assistant vice president of corporate audit. He held that position until joining Plum Creek.



He received a bachelor of science in accounting and business administration from San Jose State University. He also completed an advanced education program at Northwestern University.

In addition to serving on Plum Creek's board, Holley serves on several private and nonprofit boards, including those of the Sustainable Forestry Initiative, Inc.; National Alliance of Forest Owners; National Association of Real Estate Investment Trusts; Avista Corporation; the *Seattle Times*; and the Blethen Corporation. He also serves on the Economic Advisory Council of the Federal Reserve Bank of San Francisco.

RFF Launches the Consortium for Energy Economics and Policy in China

RFF's Center for Energy Economics and Policy (CEEP) has partnered with institutions in China to create a new organization dedicated to improving energy policy in China: the Consortium for Energy Economics and

Policy in China (CEEPIC). The consortium is led by Director Zhongmin Wang, an RFF fellow, along with CEEP Director and RFF Senior Fellow Alan Krupnick and Jintao Xu, director of the Energy Economics Institute in the School of Economic Development at Peking University.

CEEPIC conducts long-term, integrated economic studies; policy analyses and outreach; and student-researcher exchanges that contribute to the sustainable development of China's energy resources. The creation of such a network will allow for coordinated research and engagement with policymakers, as well as capacity building.

Funded by the World Bank, the first project under way is a major study on the social costs of unconventional fuels, in response to a series of presentations on the subject at the International Forum on Shale Gas Development and Utilization in Beijing in November 2012. Learn more at www.rff.org/ceepic.

Experts from RFF's Consortium for Energy Economics and Policy in China gathered in Beijing in November 2012.



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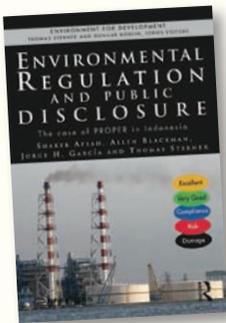


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The Case of PROPER in Indonesia

By Shakeb Afsah, Allen Blackman, Jorge H. García, and Thomas Sterner

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