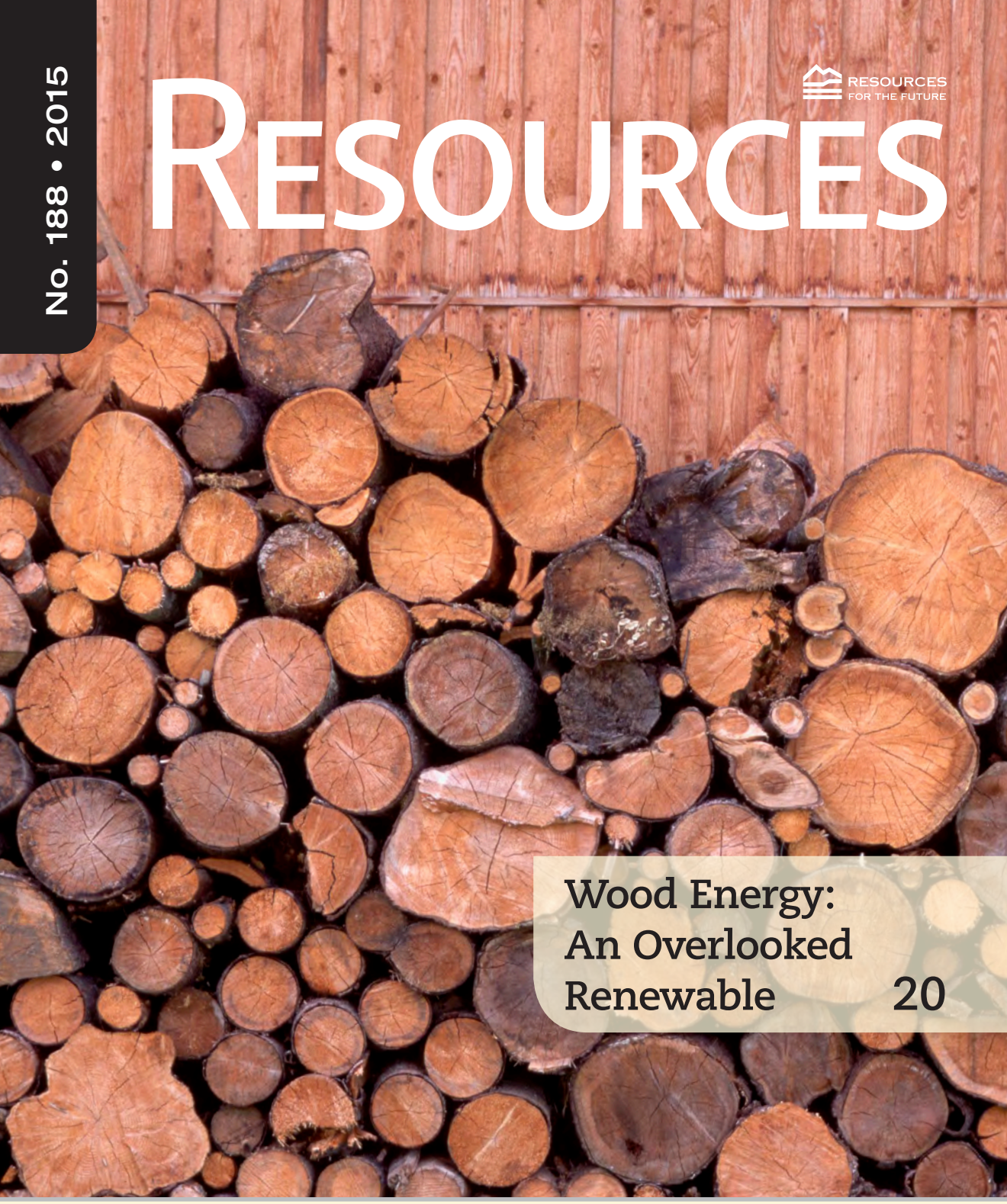
No. 188 • 2015

RESOURCES

RESOURCES FOR THE FUTURE



Wood Energy: An Overlooked Renewable 20

Conservation in Latin America and the Caribbean 28

What Homeowners Say about Energy Audits 34

Green Growth for China? 40

Resources

Resources for the Future
1616 P St. NW
Washington, DC 20036–1400
202.328.5000 • www.rff.org

Resources is available at no cost. To subscribe, email resources@rff.org or call 202.328.5006.

Officers
Phil Sharp, *President*
Edward F. Hand, *Vice President for Finance and Administration*
Lea Harvey, *Vice President for Development and Corporate Secretary*
Molly K. Macauley, *Vice President for Research and Senior Fellow*

Board of Directors
Richard Schmalensee, *Chair*

Board Members
James Asselstine, Vicky A. Bailey, Paul F. Balser, Anthony Bernhardt, Trudy Ann Cameron, Red Cavaney, John M. Deutch, Elaine Dorward King, Daniel C. Esty, Linda J. Fisher, C. Boyden Gray, David Hawkins, Rick R. Holley, Peter R. Kagan, Sally Katzen, Rubén Kraiem, Robert B. Litterman, Richard G. Newell, Henry Schacht, Robert N. Stavins, Joseph L. Stiglitz, Mark R. Tercek, Sue Tierney

Chair Emeriti
W. Bowman Cutter, Darius W. Gaskins, Jr., Robert E. Grady, Lawrence H. Linden, and Frank E. Loy

Editorial
Pete Nelson, *Director of Communications*
Sarah Aldy, *Editor*
Lauren Caserta, *Outreach Coordinator*
Shannon Wulf Tregar, *Deputy Director for Government and Public Affairs*
Adrienne Young, *Managing Editor*
Design and production by Amanda Nelson Design

Published since 1959, *Resources* (ISSN 0048-7376) contains news of research and policy analysis regarding environmental, energy, and natural resource issues. The views offered are those of the contributors and should not be attributed to Resources for the Future, its directors, or its officers.

©2015 Resources for the Future. All rights reserved. No part of this publication may be reproduced by any means, either electronic or mechanical, without permission from the publisher. Contact Pete Nelson at nelson@rff.org.

Printed with soy-based inks on 50% recycled (and recyclable) paper containing 25% postconsumer fiber, processed chlorine free, in an FSC-certified plant.

MIX
Paper from responsible sources
FSC® C006849

PRINTED WITH SOY INK

Cover photo: From 2005 to 2012, all nine states in the New England and Mid-Atlantic census divisions saw at least a 50 percent jump in the number of households that rely on wood as their main heating source, mainly in the form of split wood. © Adam Woolfitt/Corbis

Contents

No. 188 • 2015

departments

03 **Contributors**

05 **Welcome**

06 **Infographic**
Federal Disaster Aid: Reflections from Superstorm Sandy

08 **Goings On**
Highlights from EPA Administrator Gina McCarthy's Remarks at RFF

10 **Commentary**
Praying for Wind: Pollution Solution?
Phil Sharp

13 **Q & A**
Targeting Forest Conservation Investments
An Interview with Allen Blackman

45 **Inside RFF**

features

16 **Remembering Robert W. Fri (1935–2014)**
Colleagues from the US Environmental Protection Agency, the Smithsonian, the American Academy of Arts and Sciences, and RFF pay tribute to Robert W. Fri, an expert on energy and the environment who devoted himself to public service.
Pete Nelson

18 **Renewable Energy from Landfills**
US state and local governments provide incentives for important—but potentially expensive—projects that capture the methane emitted from landfills and convert it to energy. The question is, do they work?
Shanjun Li, Han Kyul Yoo, and Jhih-Shyang Shih

Contents

No. 188 • 2015

features cont.

20 Wood Energy in Developed Economies: An Overlooked Renewable

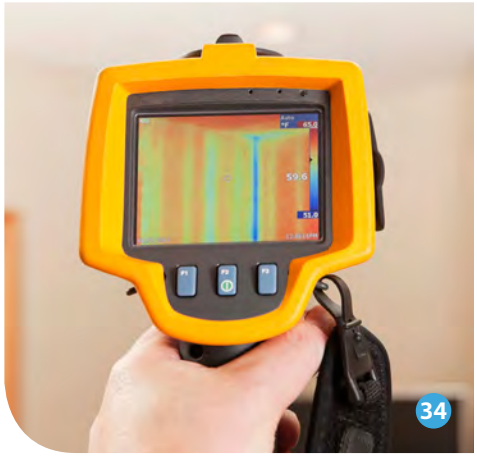
Wood energy is often ignored in national conversations about renewable energy, yet it dominates renewable energy portfolios in many developed nations—and is poised for even more growth.

Francisco Aguilar

28 Mapping the Value of Ecosystem Services in Latin America and the Caribbean

When making decisions about conservation priorities, examining the services provided by the diverse ecosystems in Latin America and the Caribbean helps to ensure that people living in the region reap the benefits.

Juha Siikamäki, Peter Vail, Rebecca Epanchin-Niell, and Francisco Santiago-Ávila



34 What Homeowners Say about Home Energy Audits

Less than five percent of American homeowners have had a home energy audit, and many have not followed through with recommended changes. A household survey helps explain why homeowners are not taking advantage of these opportunities to save money.

Karen L. Palmer and Margaret A. Walls

40 Green Growth for China?

For China's leaders, achieving a sustainable path that balances economic growth and environmental protection is now a political necessity. Reforms to the country's unique institutional reward system and governance structures are critical to this effort.

Mun S. Ho and Zhongmin Wang

In This Issue

Aguilar

Franciso Aguilar is a 2014–2015 Gilbert White Fellow at RFF and an associate professor in the Department of Forestry at the University of Missouri. His research interests include the study of spatial phenomena occurring in the forest industry. Given the current potential for the development of biomass energy sources, he also is studying the economic impact of renewable energy initiatives on forest resources.

Epanchin-Niell

RFF Fellow **Rebecca Epanchin-Niell's** research focuses on ecosystem management, particularly understanding how human behavior affects ecological resources and identifying strategies to improve management. Her work often draws on econometric and bioeconometric modeling approaches and incorporates spatial aspects of resource movement and use.

Ho

RFF Visiting Fellow **Mun S. Ho** centers his research on economic growth, productivity, taxation, and environmental economics. He is a senior economist at Dale Jorgenson Associates and contributes to the firm's analysis of energy and environmental policies for the US Department of Energy and Environmental Protection Agency.

Li

Shanjun Li is an assistant professor at the Cornell University Charles H. Dyson School of Applied Economics and Management. His research focuses on understanding consumer and firm behavior in the transportation and electricity sectors, the impacts of environmental and energy policies, and efficient policy design.

Nelson

Pete Nelson is the director of communications at RFF. He joined RFF in 1997 as a research associate, focusing on environmental and transportation policy issues. In 2010–2011, he directed the communications operation of the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. In 1991–1992, Nelson was a founder and editor-in-chief of *Greenwire*, a major online environmental news service.

Palmer

Karen L. Palmer is a research director and senior fellow at RFF. She specializes in the economics of environmental and public utility regulation, particularly on issues at the intersection of air quality regulation and the electricity sector. Her work seeks to improve the design of incentive-based environmental regulations that influence the electric utility sector.

Santiago-Ávila

Francisco Santiago-Ávila is a research assistant at RFF.

Phil Sharp became president of RFF on September 1, 2005. His career includes 10 terms as a member of the US House of Representatives from Indiana and a lengthy appointment on the faculty of the John F. Kennedy School of Government and the Institute of Politics at Harvard University.

Shih

RFF Fellow **Jhih-Shyang Shih's** research interests lie in quantitative analysis of environmental and resource policy and decision-making. He has extensive experience with modeling to study air quality, risk, surface water, and solid waste management. Recent research has focused on ozone and particulate matter control, recycling, small water systems, and space solar power.

Siikamäki

J**uha Siikamäki** is an associate research director and senior fellow at RFF. His research focuses on evaluating the benefits, costs, and cost-effectiveness of different environmental policy options. His work concentrates on natural ecosystems, such as forests, agricultural landscapes, and coastal ecosystems, and the empirical evaluation of different options for their management and conservation.

Vail

Peter Vail is a research assistant at RFF.

Margaret A. 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.

Walls

RFF Fellow **Zhongmin Wang's** research focuses primarily on energy-related economic issues. He has studied pricing, competition, regulatory, and environmental issues related to oil, gaso line, natural gas, and alternative transport fuels. He has started to research China's energy and environmental issues and is also interested in the economics of online markets.

Wang

Han Kyul Yoo is a research intern at RFF.

In Pursuit of a Greener Path

With the issuance of the US Environmental Protection Agency's (EPA) proposed Clean Power Plan, climate policy has taken center stage in the United States. At RFF, we were pleased to host EPA Administrator Gina McCarthy for a discussion, where she presented the economic case for the new proposal. While regulation of greenhouse gases under the Clean Air Act may not be as economically efficient as a national carbon tax, cap-and-trade system, or similar market-based approach, the agency has made a strong attempt to allow and encourage states to use flexibility and incentive approaches as they craft their compliance plans.

Climate change is a global challenge, and any progress will require international cooperation. As I write this, representatives are meeting in Lima, Peru, for the 20th meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change, the last one before the much-anticipated summit scheduled for Paris in 2015. The recently announced agreement between China and the United States to lower their greenhouse gas emissions over the next 20 years has raised hopes for a successful outcome in Paris. It is imperative to this effort that these two nations take a leadership role. The fact that they are moving together is auspicious and undercuts the arguments of factions in both countries who cite lack of action by the other as a reason to delay pursuing emissions reductions.

In China's case, the motivation for moving quickly to reduce its reliance on coal is obvious and hit me immediately upon my arrival to Beijing on a recent trip. The terrible air pollution that plagues Beijing is not isolated and threatens the quality of life and economic future of China. I discuss my experience there in this issue ("Praying for Wind: Pollution Solution?" on pages 10–12), and my colleagues Mun Ho and Zhongmin Wang offer their analysis of the institutional reforms needed for China to successfully pursue a more sustainable path in "Green Growth for China?" (pages 40–44).

The climate challenge is not the only environmental and resource issue facing the world, and this issue of *Resources* highlights other important work going on at RFF, including two exciting projects that map priority areas for land conservation using an economic framework.

On a more personal note, we recently lost some dear members of the RFF family, including former president Bob Fri, who led the institution for 10 years. All of us at RFF remain in his debt, and he continues to be an inspiration for us as we move forward. We have collected some remembrances of him on pages 16–17 of this issue.

Phil Sharp, President
sharp@rff.org

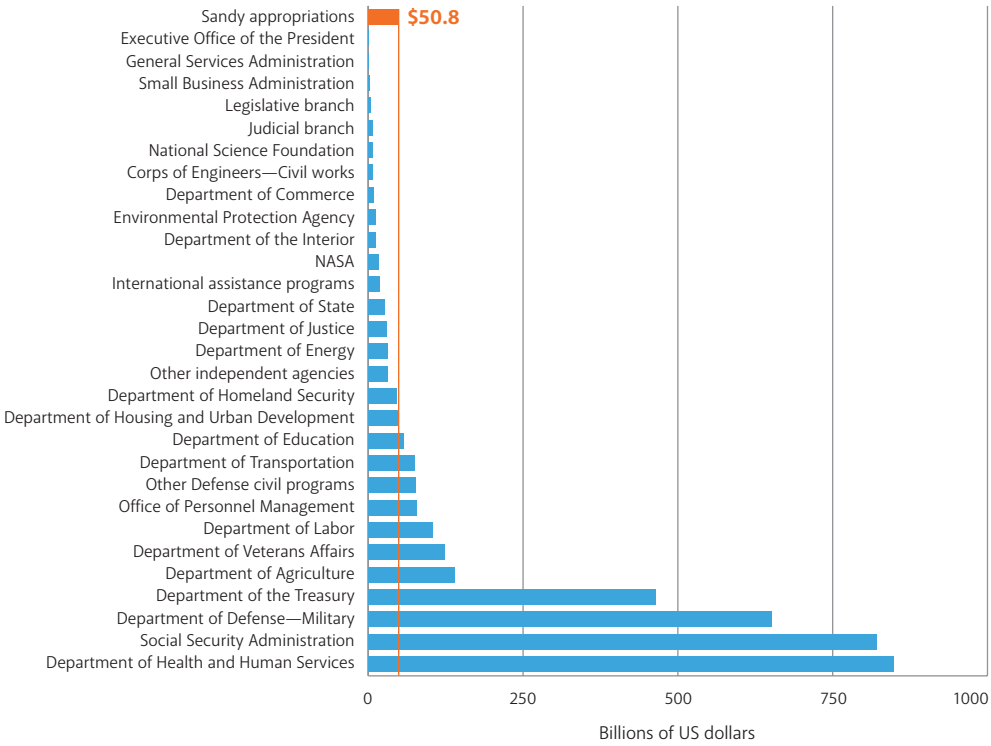
Infographic

Federal Disaster Aid: Reflections from Superstorm Sandy

Superstorm Sandy's total losses have been estimated at $65 billion. The president issued a disaster declaration and Congress approved more than $50 billion in supplemental funding for post-storm recovery. More than two years later, the northeastern coastal regions of the United States are still rebuilding, and much of that aid has yet to be allocated.

RFF's Carolyn Kousky and Leonard Shabman have been investigating federal disaster aid. They compared the Sandy supplemental to the 2012 outlays for federal agencies and found that it was greater than the amount spent by the US Environmental Protection Agency, National Aeronautics and Space Administration, State Department, Department of Justice, Department of Energy, and many others (Figure 1). As the costs of these disasters to the taxpayers have been rising, the number of presidential disaster declarations

Figure 1. Sandy Supplemental Compared with 2012 Agency Expenditures



Source: US Office of Management and Budget. 2013. Fiscal Year 2014 Historical Tables: Budget of the US Office of Management and Budget. *Washington, DC: US Government Printing Office. http://www.whitehouse.gov/sites/default/files/omb/budget/fy2014/assets/hist.pdf.*

has been growing significantly over time (Figure 2).

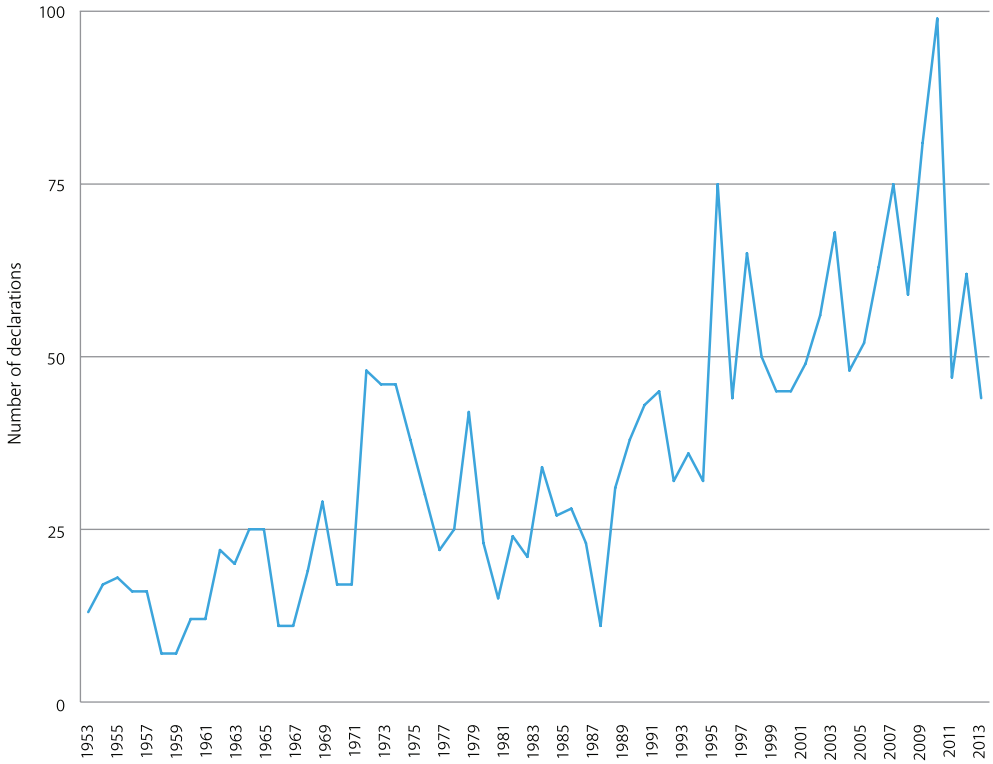
Most of the Sandy supplemental funds were designated as "emergency" spending for immediate recovery and thus are exempt from the normal appropriations process and budget caps. But affected individuals and households will only receive a fraction of the funds. Funds primarily were used to cover the costs to local governments, provide assistance to businesses, and rebuild infrastructure. In addition, the supplemental is funding many projects to reduce the damage from future storms. Though future-oriented projects may be worthwhile investments, many had not been considered justified before the storm. According to Kousky and Shabman, "If Congress is going to spend billions of dollars on future risk reduction, a more deliberate approach would evaluate risks around the country, assess the risk reduction investments, and then allocate funding to maximize the benefits." ●

FURTHER READING

Kousky, Carolyn, and Len Shabman. 2012. The Realities of Federal Disaster Aid: The Case of Floods. Issue brief 12-02. Washington, DC: Resources for the Future.

Kousky, Carolyn, and Leonard Shabman. 2013. A New Era of Disaster Aid? Reflections on the Sandy Supplemental. Issue brief 13-05. Washington, DC: Resources for the Future.

Figure 2. Major Disaster Declarations, 1935-2013



Source: Available from FEMA online at http://www.fema.gov/disasters/grid/year.

Highlights from EPA Administrator Gina McCarthy's Remarks at RFF

On September 25, RFF welcomed Gina McCarthy, administrator of the US Environmental Protection Agency (EPA), for a special Policy Leadership Forum. In her remarks, McCarthy discussed the economic benefits of halting climate change. In a discussion with RFF President Phil Sharp, she touched on topics ranging from the role EPA plays internationally to its proposed Clean Power Plan. A selection of McCarthy's comments from the event follows.

On the Worldwide Shift in Public Dialogue about Climate Change

"The dynamics around climate seem to be changing, not just here in the United States, but internationally. [Climate Week in New York City] was an incredibly positive experience. I think the march was a clear signal that people are getting restless, not about the actions we might take, but they're getting restless in that they need to see leadership here and a response on an issue that they consider to be closed. We need action."

On EPA's Role as an International Leader on Climate Change

"We spend considerable amounts of time working with other countries to try to build up their structure to address environmental protection at many levels. And then we try to share technical assistance and information on new technologies and how to do things in ways that allow them, when they begin to embrace the environmental challenge, to learn from our lessons in advance—and at a much quicker pace than we were able to do while we were developing these technologies and this understanding."

On the Climate Summit 2014

"It was an incredibly positive moment, I think, and one where [participants] were talking about the tipping point in an entirely different context. Originally, we had been talking about, 'How quickly do we need to act before the climate is out of control?' And this was more, 'I think we're done talking. The tipping point is that we have solutions today. We need to put the solutions into action at this point.'"

On the Ability of EPA's Clean Power Plan to Support US Climate Commitments

"Judging from the tone of the discussion at the United Nations, [the Clean Power Plan] is seen as a very big deal, not only for us in terms of having an aggressive goal, but also the opportunity for our goal to influence how other countries are going to come to the table. I think it's an important step forward, and it's recognized as such."

On the Use of "Building Blocks" in EPA's Clean Power Plan

"We're allowing every state to do what they want in terms of developing their own plans that they can send to EPA and say, 'I can get here this way the best.' We're not prescribing. We're just opening up opportunities and, frankly, it's a result of

both knowing that every state is different and also knowing that climate change has the uniqueness of really being able to be tackled in many, many different ways."

On the Importance of Continuing Dialogue about EPA's Clean Power Plan

"We're not slowing down on these conversations because we're learning a lot. And they continue to be incredibly positive, especially when we have meetings where the energy and environmental folks are at the table. It's when they go back to their respective corners that we have a less robust conversation."

On Public Interest in Climate Change and EPA's Clean Power Plan

"I think people are worried and, frankly, I think people really want leadership on these issues. They want to know that we're not all in our separate corners duking it out. And so I think that many of the states see enormous value in approaching [the Clean Power Plan] with this broad range of opportunities."

On the Market Influence of the Clean Air Act

"One of the things that's good about [the Clean Air Act], from a business perspective, is that it does provide a certain path forward. The business industry and markets are always looking for long-term signals. We just gave a very big long-term signal that I believe, and from what I'm hearing, is really opening the door to investments in the United States."

Visit www.rff.org/ginamccarthy for a video and complete transcript of the event.

© Resources for the Future

Praying for Wind: Pollution Solution?

Before the wheels touched down last March at Beijing's spectacular airport, we could smell the pollution. Burning eyes, raspy throats, and persistent coughing got our attention faster than smart phone apps which registered particulate levels (PM 2.5) off the charts—15 times worse than the World Health Organization's acceptable standard. We were lucky. The levels had been far worse the previous week, and fortunately, that night gusting winds brought major relief—lowering harmful levels to just three times the health threshold.

Beijingers told us their ancestors prayed for rain; they pray for wind.

The next day Premier Li Keqiang "declared war on pollution," unveiling plans to restructure the economy and promote clean energy development to advance growth while cutting conventional pollutants and greenhouse gas emissions. More recently, the government announced that it will not allow coal burning in the capital city by the end of 2020.

If laissez-faire environmentalism aided China's incredible growth—which has lifted hundreds of millions out of extreme poverty—the lack of strong constraints now undermines that growth. China confronts serious competitive drag: major health costs on the horizon, social unrest, the loss of international markets for contaminated products, and even the increasing reluctance of business leaders to let their families live in heavily polluted cities.

Facing massive environmental deficits—extensive poisoning of the land, air, and water—China will require years of aggressive policies and massive investment to correct the course. In the meantime, to get a few days of relief, Beijing is ready to trigger emergency measures: temporarily shutting down industrial plants and restricting driving of the ever-expanding auto fleet. Other cities are experimenting with geoengineering: seeding clouds to wash out some of the particulates—in short, creating acid rain, trading one pollution problem for another.

Landing back at Dulles Airport a week later, the air was breathable. But the airwaves in Washington carried loud voices denouncing the US Environmental Protection Agency (EPA) as a threat to American prosperity and to our global economic competitiveness.

Beijingers told us their ancestors prayed for rain; they pray for wind..

While many factors enhance or inhibit a nation's economic growth, it should now be clear that 40 years of attention to the environment by federal and state governments has been accompanied by major economic growth and has created a major American asset. For most people, prosperity is more than GDP growth.

It should also be clear that citizen activism has been essential to the political adoption and enforcement of strong envi-

Air pollution obscures the view of Guangzhou and the Pearl River.

© 145/Guy Vanderelst/Ocean/Corbis

ronmental policies. Indeed, in China, where citizen organizing is highly restricted, the government has had to deal with extensive environmental riots and, in a new environmental law, has decided to allow certain registered groups to sue polluters in court. It can no longer fully control such activism in the era of social media.

In the United States, citizens have access to government through elections, regulatory processes, and the courts. Citizen groups have been highly organized and periodically recharged when government and industry have failed to protect citizen health.

Many loud critics of US environmental constraints are fundamentally wrong in their claims that economic growth is impaired. They call for stripping EPA of its long-standing authorities and blocking the avenues enabling citizens to be heard. Such proposals should be, and almost certainly will be, rejected. China should be a lesson for us.

In rejecting such extreme views, however, we must recognize that policy choices can have economic consequences and activists do not always have the right answers or a strong case for government action. The future of our economy is not clear, and policymakers must take care not to squander public or private resources.

We must be smart about how we proceed. First and foremost, we should be guided by solid science as it continues to advance, whether dealing with small particulates, carbon dioxide, or radiation. In general, this is a requirement EPA must follow under the Clean Air Act, which historically has had strong bipartisan support. The abuse of science is not limited to those who deny the impact of pollutants; deliberately or inadvertently it arises among some activists.

Second, policymakers should set priorities based on the assessment of risks so that we focus our resources on serious threats. Third,

they should rely where possible on compliance strategies that are most cost-effective and likely to spur innovation. Finally, they should be willing to discard outdated or ineffective policies.

lead the global drive to mitigate climate disruption.

The recent agreement between President Xi and President Obama represents an important pathway for partially addressing this global challenge. Certainly the recent agreement undercuts the political factions in each country that have been justifying inaction by pointing to the failures in the other country—and it should help advance action by other nations as well.

China and the United States are in far different places, but the desire for prosperity by both requires continual attention to the intersection of the economy and the environment.

China and the United States are in far different places, but the desire for prosperity by both requires continual attention to the intersection of the economy and the environment. Neither nation has a guaranteed way to sustain economic growth with a healthy environment—but, to date, the United States has forged the more viable path.

The winds of prosperity do not blow steadily and will turn against both countries if the two biggest emitters of greenhouse gases neglect their obligation to collectively

We have much to learn from each other. We have much to do together if we are to provide posterity with options beyond praying for wind. ● —Phil Sharp

This article orginally appeared on the *Huffington Post's* The Blog, August 26, 2014.

Tai Chi practitioners assemble against the backdrop of a polluted Shanghai skyline.

© Robert Wallace/Corbis

Targeting Forest Conservation Investments

An Interview with Allen Blackman

Researchers at RFF are developing a free, Web-based interactive decision tool to help policymakers in Mexico, Central America, and the Dominican Republic decide where to invest scarce forest conservation resources. The tool uses rich spatial data on deforestation risk, forest ecosystem services, and the cost of conservation to map trade-offs in conservation investments.

During the past two years, a prototype has been used by The Nature Conservancy to help target conservation investments for the US Agency for International Development's $29 million program, Mexico Reducing Emissions from Deforestation and Degradation (MREDD). RFF Thomas Klutznick Senior Fellow and project director Allen Blackman recently talked with Resources about how the tool empowers conservation decisionmakers.

RESOURCES: What was the impetus for developing the Forest Conservation Targeting Tool?

ALLEN BLACKMAN: Deforestation and degradation continue to be severe problems in developing countries. They cause all kinds of local and global environmental problems, from soil erosion and flooding to biodiversity loss and climate change. But resources available to address those problems are scarce. That means it is critically important that the resources we devote to forest conservation have the biggest bang for the buck possible.

Juha Siikamäki [RFF associate research director and senior fellow] and I conceived of the Forest Conservation Targeting Tool to do that. The goal is to help decisionmakers choose locations where conservation has the greatest payoff. Building the tool has been a team effort, and I think Juha and I have put together a really good one. RFF Research Assistant Len Goff is responsible for programming the model, and it looks good and works well because of him. Jessica Chu is our geographical information systems expert. We've just hired a post-doc named Joe Maher who will play a big role over the next couple of years. And Matt Hansen and Peter Potopov at the University of Maryland are creating our forest loss data using satellite images.

The targeting tool is actually one of two forest conservation decision tools we're developing as part of a larger project funded by the National Aeronautics and Space Administration's SERVIR program and the Moore Foundation. While the targeting tool can be used to plan future conservation investment, the other tool is for evaluating the effectiveness of specific policies, such as protected areas and payments for ecosystems, that already are in use.

Looking ahead, we hope to combine these two approaches. We want to enable policymakers to get answers to questions such as, "Where are payments for ecosystem services likely to be particularly effec-

tive?" and "Where are protected areas likely to work best?"

RESOURCES: An important feature of the Forest Conservation Targeting Tool is that it allows users to choose which conservation goals are most important to them and gauge the consequences of those judgments. What factors come into play when estimating the return on investment for a given conservation investment, and how does the tool account for these?

ers of well-funded projects may care less about conservation costs than benefits. So the tool allows users to weight these factors as they please, with an easy-to-use slider graphic. In general, we have tried to make the tool as flexible as possible so that users can adapt it to their specific needs.

RESOURCES: So this rich dataset is the first contribution, and the second is that you have developed a user-friendly, Web-based interface that allows a non-technical person to use these data. When a user sits down at this application, what does that person see?

It is critically important that the resources we devote to forest conservation have the biggest bang for the buck possible.

BLACKMAN: The model works by dividing up forested land into parcels. The user can define these parcels in a number of ways. Where we have data on property boundaries, they can be used. In other places, fine-scale administrative boundaries or simple one-kilometer cells can be used.

For each of these parcels, the model estimates the conservation return on investment, which depends on three factors. The first is the risk of deforestation in the parcel. If you have very low risk, investment in conservation is not going to buy you anything additional.

The second factor is how much it costs to conserve forests in the parcel.

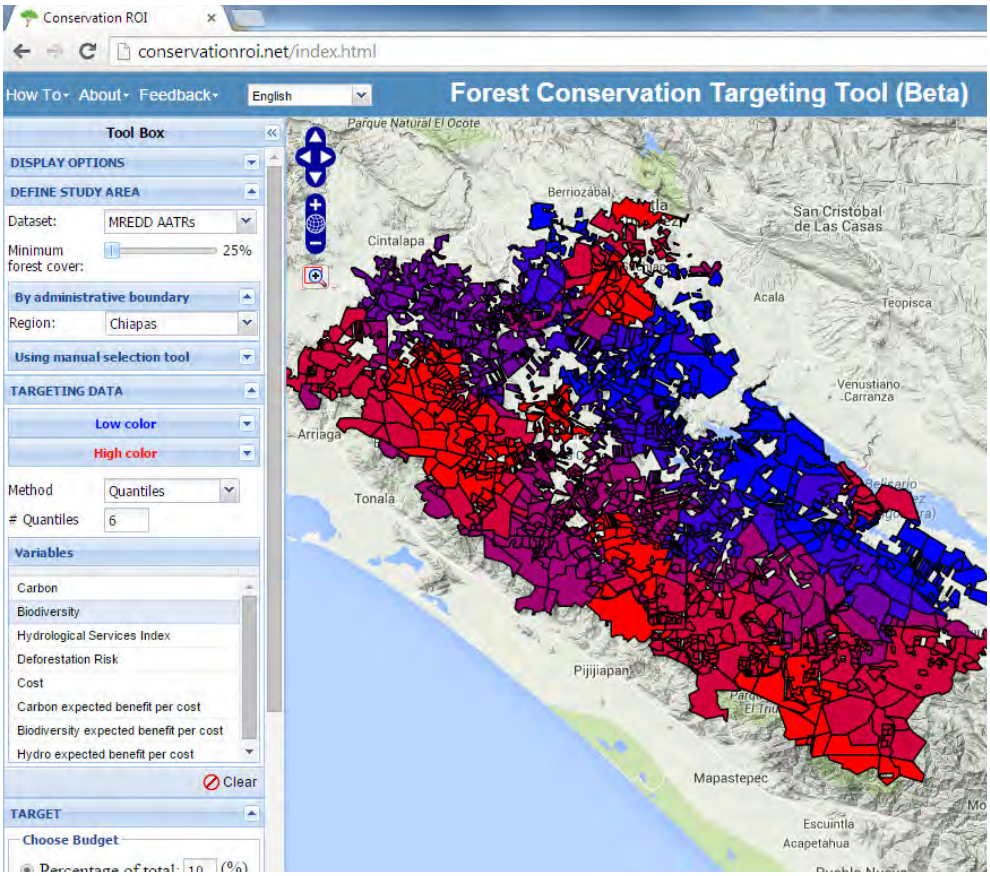
The third factor is the level of ecosystem services the forests in the parcel produce. We look at three forest ecosystem services—carbon storage; hydrological services, such as flood prevention and replenishing of aquifers; and the provision of biodiversity habitat.

All users of the tool will not place the same weights on these factors. For example, managers of REDD programs may care more about carbon than biodiversity. And manag-

BLACKMAN: The main way that data is conveyed is through a map. At the simplest level, the model does two things. First, it maps deforestation risk, conservation costs, and ecological services. And second, it tells you where the greatest conservation bang for the buck is.

A variety of pull-down menus and selection tools allow the user to define the study area and parcels and to control how bang for the buck is calculated, what the conservation budget is, what information is displayed, and what information is outputted. The maps are designed to be intuitive; the data are displayed in a color-coded format, where red areas typically are high values and blue areas are low ones. The model allows the user to take advantage of rich onboard data and to download results in map or tabular form.

RESOURCES: Where are you in the process of developing the Forest Conservation Targeting Tool?



The Forest Conservation Targeting Tool maps areas that will have the highest (red) to lowest (blue) return on conservation investment, as defined by the user's particular budget and goals.

BLACKMAN: We are two years into a four-year project. The goal, at the end of the project, is to launch both the targeting tool and the evaluation tool, make them publicly available on the Web, and train an initial set of users.

We are on track to meet that goal. The tool is basically ready to be used for Mexico. We are close to being at that stage for Central America and the Dominican Republic. We've been taking trips to the region to lay the groundwork for training and dissemination in the last year of the project.

The software architecture is more or less where we need it to be except for one thing: creating the ability for users to upload and use their own data. We think that the onboard data we have now is pretty good given the challenge of covering all of Mesoamerica. But users may be interested in conservation efforts targeting just a small part of that region, and they may be interested in a very specific question for which they have better data.

For example, let's say they're interested in conserving habitat for jaguars in northern Guatemala. While our data on species richness are reasonably good given our large geographic scope, they are not the most accurate data if you are interested in one particular place or species. If users have better data on jaguars, or some other species, we want to enable them to upload and use those data. ●

Remembering Robert W. Fri

(1935–2014)

by Pete Nelson

The first time I met Bob Fri, he was in uniform, as was I. He had volunteered for the unenviable task of guiding a pack of 10-year-old Cub Scouts, a job he was spectacularly well suited for. He was clear, supportive, and always had a twinkle in his eye. When I joined RFF some decades later and found myself lucky enough to call him a colleague, it was obvious that those qualities were fundamental to him and I think explain his marvelous career.

I arrived at RFF after Bob had stepped down as president, so I have less of a window on that career than other colleagues do. My memories are more personal—of a man who from the first time I met him to the last time I saw him was always generous to me in his support and advice. His observations were often very funny and invariably wise.

We have assembled here tributes to Bob based on some of the major institutions where he invested his considerable talents. The arc of his career spans service at RFF, the Environmental Protection Agency, the Energy Research and Development Administration, and the Smithsonian's National Museum of Natural History, as well as major engagement with the National Academy of Sciences and the Academy of Arts and Sciences. His memory will live on in the research field and through support to RFF as a member of the Legacy Society.

"Whatever the venue, Bob brought to bear his considerable talent for leadership, his remarkable intellect, his insights into institutional behavior, his strong focus on the public good, and his humor. Certainly Bob is a sterling model for those who wish to advance public well-being.

At RFF, he continued his efforts to support our mission long after his time as president—indeed, even in the last weeks of his life. We are deeply grateful for his service. He will be missed by his many professional friends here."

—Phil Sharp, president, RFF

"When the EPA was created in December 1970, we clearly needed someone with deep managerial experience. Fortunately for the country, EPA, and me, Bob Fri was available. He was nominated deputy administrator by the president and confirmed by the Senate. He performed in superior fashion in the agency's formative years.

Bob was quiet, self-effacing, and extremely talented. His contributions to our country's well-being are incalculable. People like Bob, whose enormous talent he consistently dedicated to the public interest, don't come along very often. He will be sorely missed."

—Bill Ruckelhaus, the first administrator of the US Environmental Protection Agency

"I am honored to share some highlights of my friend Bob Fri's time at the Smithsonian Institution. Bob served as director of the National Museum of Natural History from 1996 to 2001, opening significant exhibitions, strengthening research, expanding collections storage, and building the Advisory Board. Under his leadership, the museum opened to the public Geology, Gems, and Minerals; African Voices; Vikings–The North Atlantic Saga; and a renovated rotunda. Bob commissioned a review of the museum's scientific activities and laid the groundwork for a 125,000-square-foot expansion of the Museum Support Center, for collections and laboratories. He remained a steadfast supporter of the museum, serving as a trusted mentor to subsequent directors, staff, and board members."

—Roger Sant, regent emeritus of the Smithsonian Institution and vice chairman of the Board of the Smithsonian National Museum of Natural History

"Elected as a Fellow of the American Academy of Arts and Sciences in 2010, Bob Fri was deeply appreciated there for his extensive knowledge of energy policy and his astute leadership. As co-chair of the Alternative Energy Future project, Bob was an effective champion of the value of the social and behavioral sciences in understanding the social and regulatory barriers to the adoption of new energy technologies. We and all his collaborators will miss profoundly the wisdom, wit, vision, and generosity he brought to this and many other projects throughout his extraordinary career."

—Jonathan F. Fanton, president, American Academy of Arts and Sciences; and Maxine L. Savitz, co-chair, Alternative Energy Future project

"Bob Fri made presiding over a think tank look easy. It isn't. He made hiring the right people seem routine. It never is. He knew instinctively which of his subordinates' mistakes to overlook and which to rectify. That's a rare quality.

Bob was very smart and skilled but always self-effacing. He seemed serious but laughed easily and had a great sense of humor. When everyone around him was flapping wildly, Bob was absolutely unflappable. Most importantly, Bob Fri encouraged service—to one's family, church, community, employer, and country. We could use many, many more just like him."

—Paul R. Portney, former president, RFF

At the time of printing, we were saddened to learn of the deaths of two other members of the RFF family, Kenneth D. Frederick and Robert A. Young. We will offer tributes to these RFF legends in the next issue of *Resources*.

Renewable Energy from LANDFILLS

Shanjun Li, Han Kyul Yoo, and Jhih-Shyang Shih

Americans produce about 4.4 pounds of waste per capita every day, according to the latest information from the US Environmental Protection Agency (EPA). About 65 percent of that waste—a total of about 164 million tons each year—is disposed in landfills. But is burial in a landfill the end of the story? Not at all. The organic matter in landfills is eventually broken down by bacteria. This process produces an abundance of gases, including methane. In fact, landfills represent the third-largest source of methane emissions in the United States. Methane is a potent greenhouse gas and thus a concern—but it increasingly is being captured and used to power homes and other establishments.

The first landfill gas energy projects started operation in Wilmington and Sun Valley, California, in 1979. Today, more than 630 US landfill gas energy projects generate 16.5 billion kilowatt hours of electricity per year—equivalent to the electricity consumption of 1.5 million homes—and deliver 317 million cubic feet per day of landfill gas to direct-use applications. EPA has identified an additional 450 landfill sites for the potential development of energy projects.

However, these projects come at a price. Between 1991 and 2010, the average cost for a landfill gas energy project to generate a kilowatt hour of electricity was 4 to 5 cents. The wholesale electricity price was 2.5 to 3 cents during that same period.

Given the important energy and environmental benefits of these projects—and the potentially prohibitive price tag—state and local governments use various policy tools to encourage municipal landfills to adopt them. But do these incentives work?

To answer this question, we conducted the first in-depth analysis of the factors that affect project adoption, primarily using two datasets: a database of potential landfill sites for landfill gas energy project development from EPA's Landfill Methane Outreach Program and a database of state tax incen-

© Mihai Brasoveanu

tives and renewable portfolio standards from the Database on State Incentives on Renewable Energy and Efficiency, maintained by North Carolina State University. We looked at policy variables, the physical characteristics of landfills, and energy prices. Our focus was on four types of government policies that offer incentives to landfill gas energy projects: renewable portfolio standards, production tax credits, investment tax credits, and state grants.

Of the four policies, our analysis shows that only two—renewable portfolio standards and investment tax credits—have positive and statistically significant effects on the development of landfill gas energy projects.

Renewable portfolio standards—adopted in 30 states—require utility companies to supply a designated portion of their electricity from eligible renewable energy sources. Most states also allow utilities to use renewable energy credits to satisfy their requirements. When a landfill gas energy facility is included as an eligible technology, it can obtain revenue from the electricity it sells and the sale of renewable energy credits.

Investment tax credits are granted for installation of a renewable energy facility, usually as a percentage of the cost to construct the system. In the seven states that have adopted such a policy, the rate ranges from 10 percent (in Kansas) to 100 percent (in Kentucky), with an average of 35 percent.

These two policies account for the development of 13 of the 277 landfill gas energy projects built during our data period (1991 to 2010). In turn, those 13 projects have led to an estimated 10.4 million metric tons of carbon dioxide–equivalent reductions in greenhouse gas emissions. If these emissions reductions are valued at the official US social cost of carbon, they represent a net benefit of $41.8 million.

How Do Landfills Generate Energy?

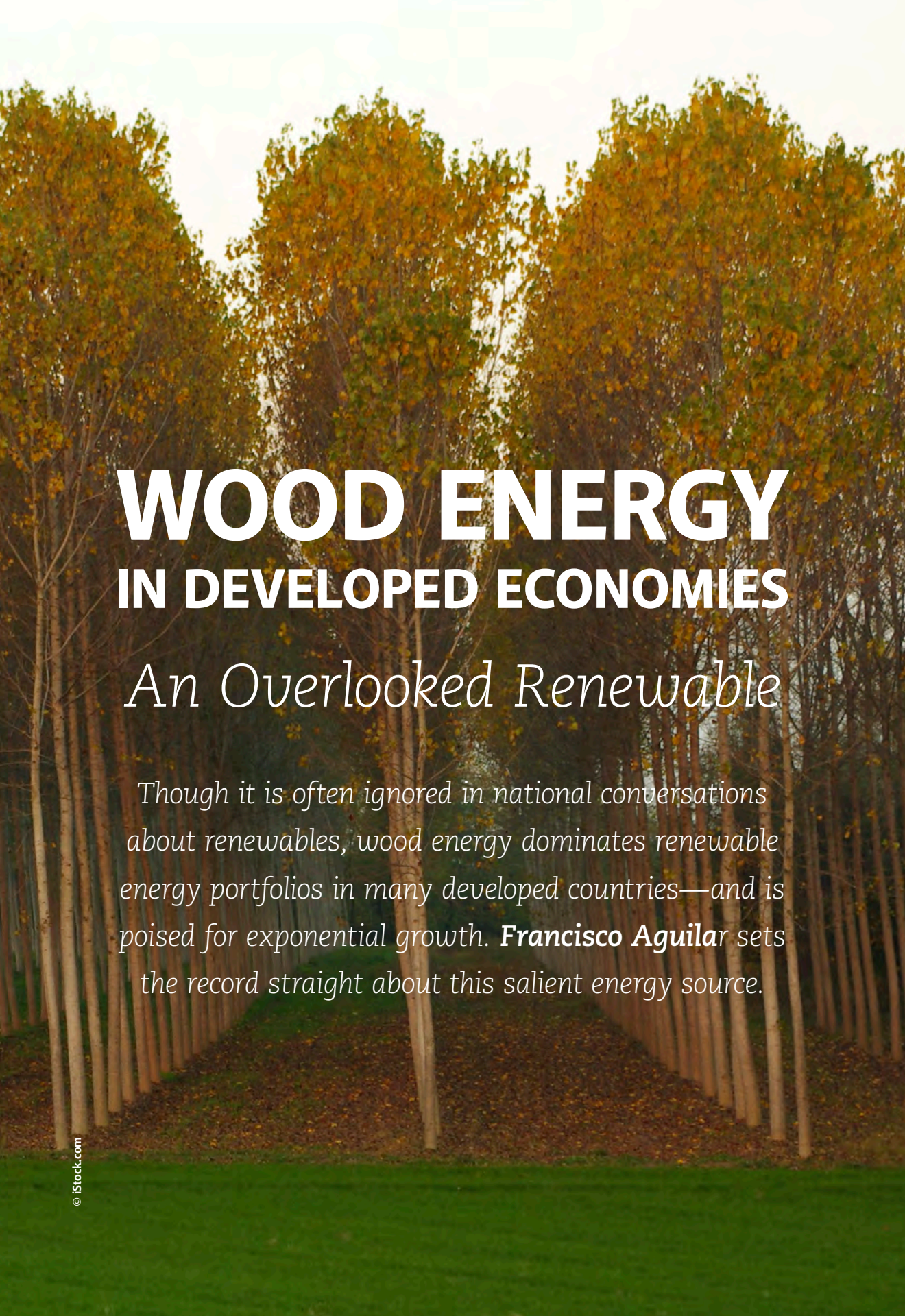
Landfill gas is generated from a chain of microbial decomposition, volatilization, and chemical reaction processes. The most important of these is the anaerobic decomposition of organic waste, which takes place over the course of 10 to 50 or more years. This process emits gases composed of 40 to 45 percent carbon dioxide and 50 to 55 percent methane, which is a primary constituent of natural gas and an important energy source.

To generate energy, landfill gas energy projects first collect gas from the waste in extraction wells distributed throughout the landfill. A gas collection pipe connects the wells and directs the gas to a central point for processing and treatment tailored to the ultimate use of the gas—for example, electricity generation, cogeneration, or direct use as a replacement for natural gas.

What factors have spurred development of the remaining projects? Not surprisingly, high natural gas prices help. Other factors include landfill age, weather, amount of waste, proximity to the electricity grid, and public versus private ownership. In particular, privately owned landfills are more likely than publicly owned ones to adopt landfill gas energy projects. This may reflect stronger incentives among private proprietors to pursue additional sources of income compared to public officials operating local landfills for waste management only. ●

FURTHER READING

Li, Shanjun, Han Kyul Yoo, Jhih-Shyang Shih, Karen Palmer, and Molly Macauley. 2014. Assessing the Role of Renewable Energy Policies in Landfill Gas Energy Projects. Discussion paper 14-17. Washington, DC: RFF.



WOOD ENERGY
IN DEVELOPED ECONOMIES
An Overlooked Renewable

Though it is often ignored in national conversations about renewables, wood energy dominates renewable energy portfolios in many developed countries—and is poised for exponential growth. ***Francisco Aguila****r sets the record straight about this salient energy source.*

© iStock.com

Considered to be the first form of energy harnessed by humans, wood was long the primary source of heat and illumination for people in every corner of the globe. Today, it is estimated that more than 2 billion people in developing countries rely primarily on wood and other forest products for their daily cooking and heating needs, causing the public to associate the use of such resources with tropical deforestation and poverty. Meanwhile, energy headlines in developed economies have been dominated by stories about coal and oil since the mid-1800s, making it easy to forget that the exploitation of those fossil sources by humans has been a relatively recent development.

Both ideas—that energy derived from forests is used primarily in developing nations and that its importance in the energy portfolios of developed economies is negligible—fail to capture the reality of current energy markets. Wood energy represents the leading source of renewable energy in many developed countries across North America and Europe. And in the United States, wood energy accounts for 25 percent of renewable energy consumption, second only to hydropower and more prominent than wind and solar energy. This high level of generation has been achieved thanks to healthy forest resources supported by a combination of recent market and policy developments.

Wood Energy in the Twenty-First Century

The term "wood energy" refers to energy derived from solid, liquid, and gaseous wood fuels, including raw firewood, processed charcoals, pellets, briquettes, residual fibers, and black pulping liquors. Some of these fuels can be sourced directly from forests or indirectly as by-products from the wood processing and pulp industries, whereas others can be created from processed wood products that are recovered and repurposed at the end of their consumer life cycles. About 58 percent of wood fuels across the United Nations Economic Commission for Europe (UNECE) region—a group of 56 countries that includes the United States, Canada, European nations, the Russian Federation, and the Commonwealth of Independent States—come from indirect sources. The rest are attributed to direct sources (32.9 percent), recovered wood (3.8 percent), and unspecified supplies (5.4 percent).

Wood fuels are ultimately converted to energy through combustion using one of three main processes. Direct firing or co-firing with other fuels—such as coal—is likely the method most familiar to consumers and requires the least amount of pre-processing in order to render fuels usable. Woody feedstock can also be biochemically transformed (using chemicals or enzymes) into sugars for the production of biofuels, or thermochemically transformed (using heat, pressure, and catalysts) into biofuels and other co-products.

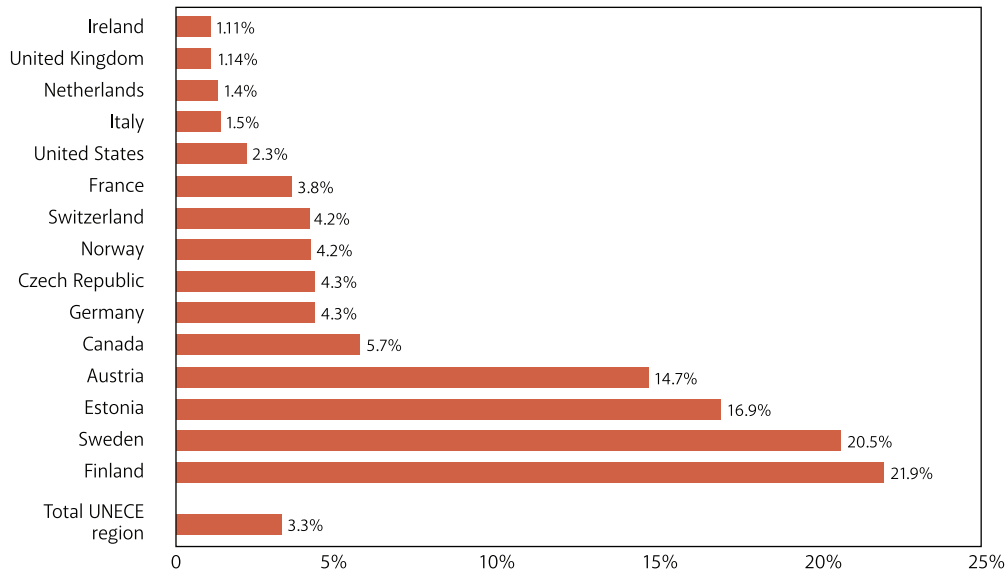
The wide range of feedstocks and conversion processes available today allows for a diversity of sectors that manufacture and use wood energy. Forest-based industrial producers, such as pulp and paper manufacturers, burn wood-based fuel to generate electricity or heat used internally to support production. So do plants designed to generate electricity or combined heat and power to sell to third parties. And residential consumers use wood-burning fireplaces or pellet stoves for home heating. Technological progress has allowed an increase in energy output while reducing the amount of associated pollution, including particulate matter, that limited wider adoption in the past.

Modern Wood Energy Markets

One of the most comprehensive sources of information about wood energy markets in developed countries comes from the Joint Wood Energy Enquiry, a survey of wood energy consumption in the UNECE region. The most recent results, from a 2011 Joint Wood Energy Enquiry answered by 27 UNECE member countries, revealed that wood energy accounted for 3.3 percent of the region's total primary energy supply (Figure 1). Although absolute wood energy consumption tends to fluctuate in the United States and Canada, the European Union has experienced an increase in consumption of more than 104 percent in the last two decades. Notably, the share of wood used for energy jumped during the recent recession, suggesting that energy production may have provided an alternative market for wood fibers while demand for more traditional products, such as paper and cardboard, declined.

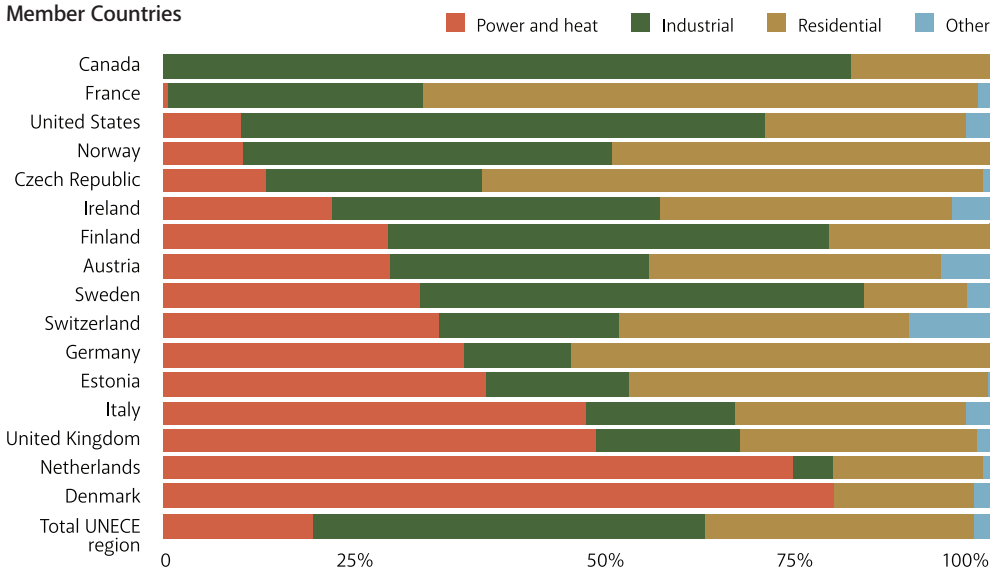
Overall, the industrial sector consumes the largest amount of wood energy at 47 percent—representing about 282.8 million cubic meters of wood—followed by residential consumers (33 percent), the power and heat sector (18 percent), and other undesignated uses (2 percent). These statistics are significant in highlighting the relationship between output and wood fuels, but they don't reveal the large variations among the ways that individual countries consume wood energy. Figure 2 on page 24 provides a fuller picture. Note that Canada's industrial sector is the largest consumer of wood energy at 83 percent, whereas the power and heat sector is domi nant in Denmark (81 percent) and the Netherlands (76 percent). Additionally, half of all wood energy in Germany was shown to be consumed by the residential sector, while Austria has a near-equal balance among power and heat, industry, and residential wood energy usage.

Figure 1. Share of Wood Energy in Total Energy Supply in Select United Nations Economic Commission for Europe (UNECE) Member Countries



Source: Joint Wood Energy Enquiry 2011, a survey of wood energy consumption answered by 27 UNECE countries. http://www.unece.org/forests/jwee.html.

Figure 2. Wood Energy Uses in Select United Nations Economic Commission for Europe (UNECE) Member Countries



Source: Joint Wood Energy Enquiry 2011, a survey of wood energy consumption answered by 27 UNECE countries. http://www.unece.org/forests/jwee.html.

Historically, the amount of wood energy produced and consumed in an economy has been heavily dependent on the local availability of forest resources. In recent years, markets have become regional and reached almost global scale, thanks to renewable energy mandates and technological advances. The pelletization of wood, for example, allows producers to condense the energy content found in wood fuels. By making the transportation of wood fuels more cost-effective, these advances have helped to encourage the creation of a dynamic international market for wood energy that may further diminish proximity limitations. In the United States, for example, where forested area has remained stable over the last century and annual forest growth rates exceed removals and mortality, some of the excess biomass and by-products from the industry are pelletized and traded regionally and abroad. In 2013, US wood pellet exports to Europe reached nearly 3 million metric tons.

Despite technical advances, the growing wood energy market is still very much influenced by transportation costs and the location of nearby wood resources, explaining the vast differences in wood market involvement among UNECE members. Nordic and Baltic nations are by far the most invested consumers of wood energy; in Finland and Sweden, wood fuels generate more than 20 percent of total primary energy supplies—the largest of any developed countries. Conversely, countries such as the United Kingdom and Ireland, which lack the vast forests of their Scandinavian counterparts, reported the lowest levels of wood energy consumption in the survey. Still, some countries have already circumvented this link through imports; the Netherlands and Denmark both support higher-than-average per capita wood energy consumption by sourcing wood from a number of other countries. Their import of wood highlights the growing capacity of the international wood energy market.

This residential biofuel boiler burns wood pellets to supply the home with heat and hot water.

© Ashley Cooper/Corbis

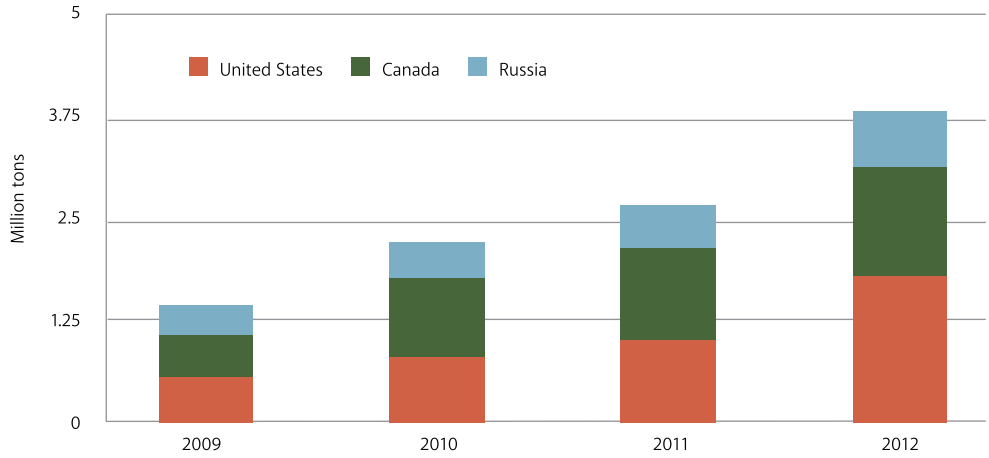
Renewable Energy and Mandates

Wood energy's role in modern energy usage is often understated. Its renewable energy designation has made wood fuel a popular choice for countries seeking to meet specific renewable energy targets. The near-doubling of EU wood energy consumption since 1990, for example, is often attributed to the "20-20-20 by 2020" directive set by the European Parliament and the Council of the European Commission. Officially known as Directive 20009/28/EC, this policy requires that 20 percent of the total primary energy supply of participating countries comes from renewable sources, alongside a 20 percent increase energy efficiency and a 20 percent reduction in greenhouse gas emissions by the year 2020.

This increasing demand for renewables also has affected countries on the other side of the Atlantic; Canada's own wood energy use is declining, but its export of wood pellets—as well as that of the United States and Russia—has dramatically increased as a result of European import needs (Figure 3). And the European Union is expected to double its demand for wood for energy from 435 million cubic meters in 2010 to reach 860 million cubic meters in 2030, which will likely require even greater reliance on imports.

Wood energy commonly qualifies under renewable portfolio standards adopted by many states across the United States. Recently instituted state-level mandates coupled with federal incentives under the Public Utility Regulatory Policies Act of 1978, and others, have resulted in greater use of wood in coal-fired power plants and dedicated boilers. According to data from the US Environmental Protection Agency, 89 coal-fired power plants use some quantity of biomass for the generation of power. For some power plants, incorporating wood as an energy feedstock can be fairly easy, requiring relatively modest investments in new infrastructure. Some estimates

Figure 3. EU Imports of Wood Pellets from Canada, Russia, and United States



Source: EuroStat.

suggest that about 10 percent of coal used by power plants in the northeastern United States could be replaced with available and cost-competitive woody materials.

Although wood is widely recognized as a renewable source of energy, its designation as a carbon-neutral alternative depends on many factors. Trees can be replanted to replenish stocks of harvested timber, and a significant number of regional and national forest management programs have been established worldwide to responsibly maintain the number of trees available for future harvests. Trees also absorb varying levels of carbon dioxide for use in photosynthesis. And although this does reduce the impact of wood fuel combustion on the environment, it takes time to fix carbon back into growing trees. Unquestionably, the better opportunities to reduce carbon emissions using wood energy arise from an integrated approach that maximizes forest productivity and energy conversion, minimizes greenhouse gas emissions along the supply chain, optimizes manufacturing by using by-products for energy, and promotes the replacement of non-renewable materials with wood products.

The Future of Wood Energy

The use of wood energy among many UNECE countries, and possibly even non-UNECE countries in Asia, is expected to continue climbing through 2020. But wood fuel's long-term usage in future energy portfolios will likely be decided by a number of uncertain factors that differ depending on the sector. The use of wood energy by the industrial sector is largely a function of wood product output. Overall economic growth and consumption of other wood products will have a large influence on future wood energy used by industry.

In the residential sector, any changes in competing energy prices might pose a risk to—or present an opportunity for—the expansion of wood energy consumption. The advent of inexpensive natural gas supplies in large areas of North America will likely cause a decline in its overall residential wood energy demand. But in some particular areas, such as the northeastern United States, wood energy is likely to remain price competitive and become a more prominent source of household heating. Whether natural gas becomes cheaply

Pelletization allows producers to condense the energy content found in wood.

© Monty Rakusen/Corbis

available in Europe will affect residential wood energy use.

Natural gas will likely play an important role in how much wood energy is used in the power and heat sector, too, although renewable energy mandates will likely sustain or increase wood energy use unless there is a significant paradigm change in public policy.

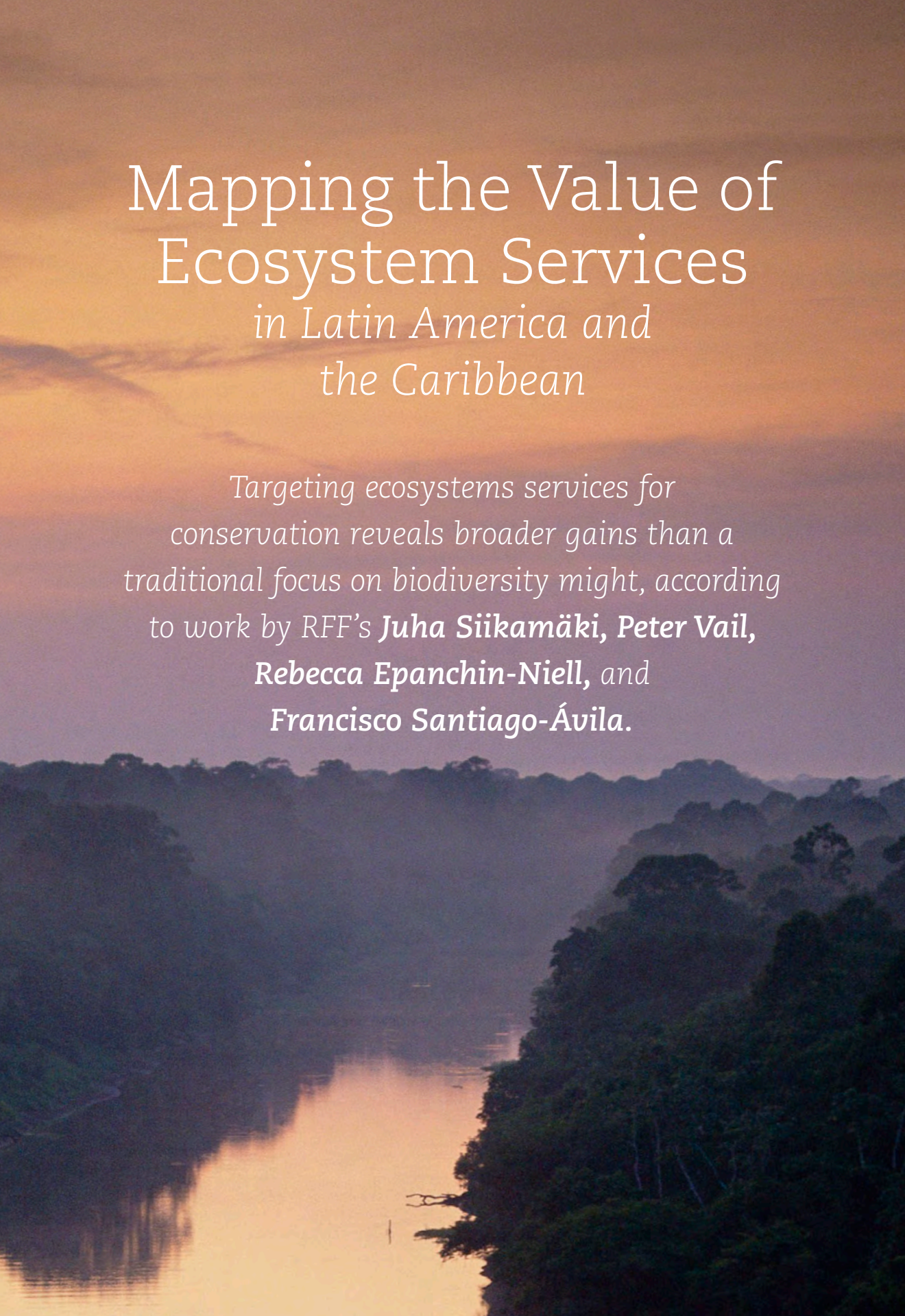
Wood energy use is highly dependent on policy interventions and timber markets, and significant questions remain about the economic availability and feasibility of obtaining more wood fuels than are currently being generated. Additionally, any expansion in the use of wood resource for energy will need to be evaluated and justified on the basis of its impact on the environment, including potential forest depletion and net greenhouse gas generation. If the demand for wood energy continues to grow, materials that would otherwise go into the manufacturing of other wood products might be pulled into the wood energy market, requiring landowners to assess how much more wood they should allow to be removed from their forests. All these questions are further dependent on whether timber and wood energy markets are able to produce competitive prices and, ultimately, profitable economic and environmental returns.

Wood energy is unique in that it requires the alignment of a diverse group of issues, including land management, energy production, socially acceptable environmental objectives, and varying methods of fuel production and combustion. This alignment involves participants at every stage of energy production, with forest owners, power generators, and industry members working to supply the energy requirements of policymakers and consumers. Studying the elements that make up this network—from management and economics to ownership and trade—can help foster a better understanding of how public policy influences the developmentof wood energy. ●

FURTHER READING

Aguilar, Francisco X., ed. 2014. *Wood Energy in Developed Economies: Resource Management, Economics, and Policy* New York: Routledge.

Goerndt, Michael E., Francisco X. Aguilar, and Kenneth Skog. 2013. Resource Potential for Renewable Energy Generation from Co-firing of Woody Biomass with Coal in the Northern US. *Biomass and Bioenergy* 59: 348–361.



Mapping the Value of Ecosystem Services

in Latin America and the Caribbean

Targeting ecosystems services for conservation reveals broader gains than a traditional focus on biodiversity might, according to work by RFF's ***Juha Siikamäki, Peter Vail, Rebecca Epanchin-Niell,*** *and* ***Francisco Santiago-Ávila.***

In Latin America and the Caribbean, biodiversity and ecosystems are among the region's most valuable assets and of strategic importance for attaining long-term sustainable development. But traditional conservation approaches that focus only on biodiversity may miss opportunities to provide benefits in the form of ecosystem services to the people living in the region.

Latin America and the Caribbean cover vast areas on both sides of the equator, including a wide range of tropical, subtropical, and temperate ecosystems, and even the icy waters off Antarctica. The region contains close to 800 million hectares of forested areas, 570 million hectares of wild savannas, 700 million hectares of productive lands, and 27 percent of the planet's available drinking water.

The region is known for its exceptional biodiversity. South America alone accounts for half of the global terrestrial biodiversity. Some of the world's most biologically diverse countries are situated in the region, including Brazil, Colombia, Ecuador, Mexico, Peru, and Venezuela. More than half the Caribbean flora cannot be found anywhere else on the globe.

At the same time, the region is rapidly changing in ways that put pressure on biodiversity. Between 1950 and 2010, the population in Latin America and the Caribbean grew by more than 250 percent, and the last 20 years have seen a near doubling of the GDP. As the countries in this region become wealthier, the urban and middle class populations grow. So, too, does the demand for energy, water, food, forest products, land, and minerals. Now at a crossroads, the region faces an enormous opportunity and challenge to ensure that ecosystems are managed sustainably to provide the services needed to meet this demand.

© Galen Rowell/Corbis

Traditionally, conservation efforts tend to focus on areas unique in biodiversity, such as those with the greatest number of species. But a more comprehensive approach is becoming popular that considers broader ecosystem benefits in addition to biodiversity. Conservation funding can be seen as an investment with measurable returns—often in biophysical quantities, such as the number of species, but sometimes also in dollars. At its core is the concept of ecosystem services (see the box on page 30).

Despite the fact that many ecosystem services are not readily transacted and valued by the market, they are still economically valuable. Over the last several decades, economists have developed different approaches to determine the value of non-market benefits so that they can be considered alongside market values in the management and protection of ecosystems. Estimates of the value of ecosystem services in various parts of Latin America and the Caribbean are sparse, but what information we do have offers cues about the drivers of the value of ecosystem services.

We compiled these estimates from the economics literature and were able to develop models to predict localized ecosystem values as a product of the ecological and socioeconomic factors of each area. We found considerable geographic variation in the value of ecosystem services. And when these values are combined with the rate of habitat destruction—which drives the loss of ecosystem services—a clearer picture emerges of areas where potential conservation investments would have the highest returns in protecting the value of ecosystem services.

These areas are not necessarily where biodiversity is richest or ecosystem values are highest. Instead, they may be located in places where ecosystem services values

The Economic Benefits of Healthy Ecosystems

Ecosystems in Latin America and the Caribbean support a wide range of human activities—such as agriculture, fishing, forestry, and tourism—that produce market goods and services. These activities play important roles in supporting income and employment in the region; in particular, the four sectors just mentioned employ 17 percent of the region's workforce and account for 15 percent of its GDP.

The same ecosystems also contribute many services that are not bought and sold in markets. For instance, ecosystems provide habitats for various species, help control floods and water runoff, and purify and store water for drinking and other uses. They maintain soil productivity and support the pollination of crops and other vegetation. And they maintain and improve air quality, provide climate control, contribute to the carbon cycle, and support a wide range of amenities to people.

Consider the following examples of the importance of ecosystems to economic activities:

» In Latin America and the Caribbean, 73 percent of freshwater use, critically supported by the availability of wetlands, is for irrigated agriculture, which contributes 10 percent to the region's GDP.

» Supported by rich natural resources that range from the Amazonian jungles to the sandy beaches of the Caribbean, regional tourism revenue in 2011 was US$364.3 billion.

» Fish consumption is extremely important throughout the region and is often supported by artisanal fishing; in Brazil, it represents over half of production.

are mid-range but threaten to plummet because of high rates of habitat loss. These include parts of the Amazon, southeastern Atlantic Coast, Gulf of Mexico, and parts of the Caribbean and Mesoamerica.

Estimating Ecosystem Values

To determine the magnitude of ecosystem values in the region, we turned to the studies that have collected evidence of economic benefits from ecosystems in Latin America and the Caribbean. We looked for estimates that are tied directly to an ecological endpoint and expressed in a clear and consistent ecological unit, like dollars per hectare. The resulting 88 value estimates covered a wide range of ecosystem services and analytical approaches, and the estimates themselves vary significantly. The estimates vary by ecosystem service addressed but are less distinguished by ecosystem type (see Figure 1 on page 31). To understand the drivers of the value of ecosystem services, we developed models that predict the value of local ecosystems (in dollars per hectare) as a product of these ecological and socioeconomic factors:

» ecosystem characteristics (coral reef, wetland, tropical forest, other forest, other);

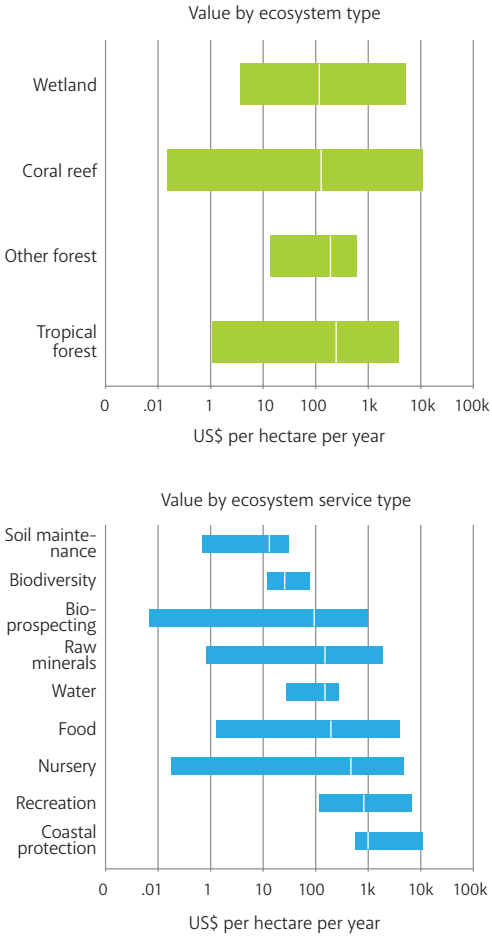
» ecosystem service (protective services, recreation, biodiversity, genetic resources, food, nursery);

» provisioning services (raw materials, soil maintenance, water); and

» study area characteristics (GDP per capita, population density, protected area status).

Our analysis reveals systematic associations between the value of ecosystem services and the ecological and socioeconomic characteristics of the ecosystem. For example, we found that the value of ecosys-

Figure 1. Estimated Values of Ecosystems by Studies Included in the Analysis



Note: Median values are indicated by the white lines within the boxes.

tem services increases with the income level and population density of the study area. We also find that the estimated value of coastal protective services (for example, storm and flood protection) tends to be highest on a per hectare basis, on average.

Mapping the Value of Ecosystem Services

Using these associations, we projected the local value of ecosystem services throughout Latin America and the Caribbean. We developed these values by "ecoregions," which denote biogeographic delineations of the region based on distinct collections of natural communities and species.

Our predictions (Figure 2a on page 32) show considerable geographic variation in the estimated value of ecosystem services, which ranges from near zero to several thousand per hectare. We find the highest values for much of southern South America, parts of the Caribbean, and parts of Mexico. On the other hand, parts of Mesoamerica, much of the rest of the Caribbean, and interior South America have relatively low values.

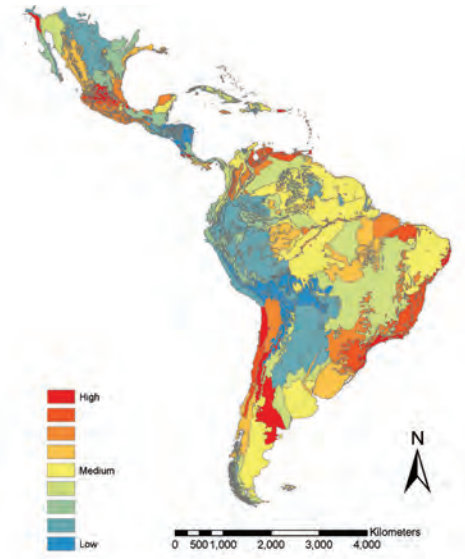
Where Are the Greatest Potential Gains from Conservation?

When thinking about where the most potential exists to generate benefits from increased conservation efforts, the story doesn't end here. Another important element to consider is which ecosystems are under the biggest threat. In other words, where are ecosystem values expected to decline the most, given ecosystem degradation? When overlaid with a map of predicted habitat loss, the picture changes dramatically.

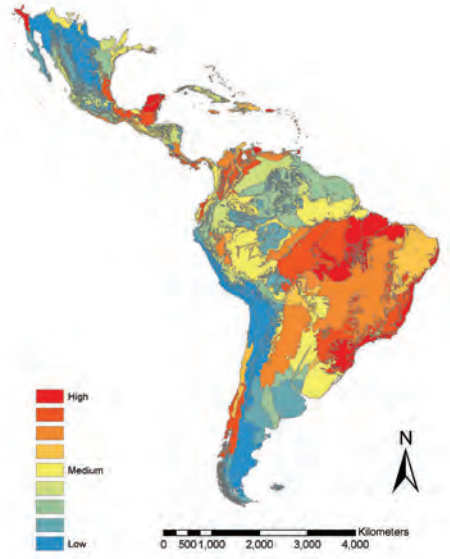
Habitat loss is one of the key concerns in the protection of ecosystem services. The value of these services often depends on the quality and extent of ecosystems, which are reduced by the conversion of land for uses such as agriculture, forestry, or urban development.

A comparison of the value of ecosystem services (Figure 2a) and their past losses triggered by habitat loss during the first decade of the century (Figure 2b) shows a discrepancy between the two. What emerges is that losses in value are largest in ecoregions concentrated in parts of the Amazon, southeastern Atlantic coast of South America, and parts of the Caribbean and Mesoamerica. Ecosystem service

Figure 2. Predicted Value (per hectare) of Ecosystem Services and Loss in Ecosystem Services due to Habitat Loss, 2000–2010



a. Value of ecosystem services



b. Value of ecosystem service loss due to habitat loss

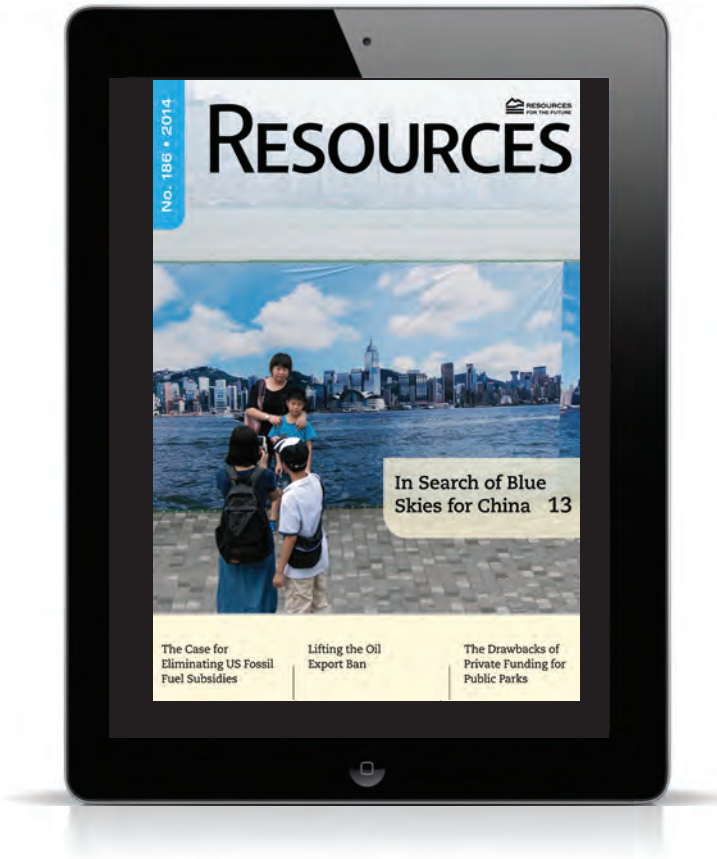
values there are midrange, but the rate of habitat loss is high. In these places, we see losses in value on the scale of roughly a few hundred dollars per hectare per decade. On the other hand, in parts of southwestern South America, where the estimated baseline value of ecosystem services is exceedingly high (Figure 2a), losses have been relative small.

These findings highlight the potential for developing conservation interventions and policy in light of the geographic variation in the value of ecosystem services at stake. Consider a hypothetical conservation program to prevent the loss of ecosystem services in Latin America and the Caribbean. As the maps indicate, the greatest returns under such a program may not come from regions where the current value of ecosystem services is the highest. Instead, the greatest losses of ecosystem services may be prevented where the current value of ecosystem services is somewhat lower but where the loss of habitat is relatively high.

The maps also indicate that the value of ecosystem services in Latin America and the Caribbean are much broader than the value of biodiversity alone. Whereas biodiversity in the region is particularly high in areas such as the western Amazon, Colombia, Ecuador, and northern and central Andes (the eastern slope of the Andes is considered the world's most biodiverse area), the areas of especially high value of ecosystem services are more broadly distributed and include even areas of relatively low biodiversity, such as several of the southernmost ecoregions. This discrepancy underscores that a focus on species does not necessarily account for the full range of services ecosystems have to offer. But conservation agencies may be interested in both biodiversity and ecosystem services, so the task of priority setting may ultimately be to find target regions that best support both objectives. ●

Resources

Digital Edition for the iPad™



RFF goes mobile with *Resources* magazine—also available on the iPhone™ & Android.

- Gain unlimited access to cutting-edge economic analysis
- Discover RFF experts online
- Explore special digital features on environmental and natural resource issues

Get a *Resources* digital subscription for just $.99 per year and access the latest research, analysis, and insight on the environment and the economy—all at your fingertips.

Available on the App Store

ANDROID APP ON Google play

Download the app today | www.rff.org/resourcesapp
Powered by Resources for the Future

What Homeowners Say about HOME ENERGY AUDITS

Only a small percentage of American homeowners have had an energy audit, and many have not followed through with recommended changes. ***Karen L. Palmer*** *and* ***Margaret A. Walls*** *conducted a household survey to better understand why.*

Building scientists and energy efficiency experts have a message for homeowners: plenty of cost-effective improvements exist to lower your energy bills, from simple weather stripping and air sealing to appliance upgrades. But many homeowners don't know where to begin. They might know they have an old furnace, but they have no idea how effective the attic insulation is, where the air leaks in the house are, and which improvements are likely to pay off.

This is where home energy audits come in. A professional can determine where a house is losing energy and how to correct the problem. Yet only about 4 percent of the homeowners surveyed in the US Department of Energy's 2009 Residential Energy Consumption Survey reported having an audit recently. Even among people who have had audits, the follow-up with improvements is usually incomplete. If energy efficiency investments pay for themselves in energy savings, why aren't more homeowners taking advantage of these opportunities?

We recently surveyed 1,784 homeowners across 24 states to help answer this question. A total of 566 respondents said they had an audit in the past four years. (This percentage differs from the national average because our survey technique involved a stratified sampling approach to ensure we got a large enough number of people with audits to be able to statistically analyze the data.)

© iStock.com

Of those who hadn't had an audit, 29 percent said they had "never heard of them," and 16 percent said that they "had heard of them but didn't know anything about them." This finding alone suggests that consumers are lacking the information they need to make wise energy efficiency decisions

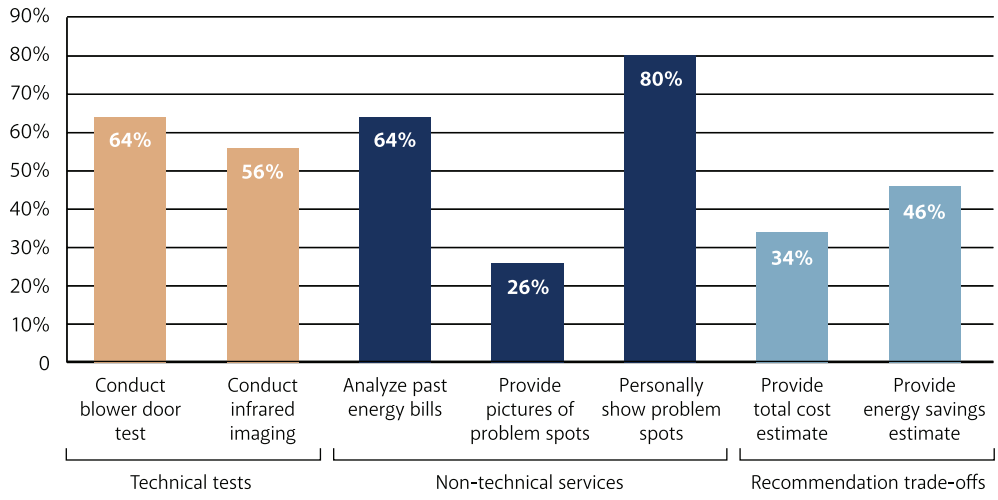
The Costs and Quality of Home Energy Audits

During a typical home energy assessment, auditors look for air leaks all around the home; evaluate air ducts for leaks; assess insulation in the attic, crawlspace, walls, and around pipes; and evaluate heating, air conditioning, and water heating equipment. They may use special techniques, such as a blower door test to manipulate air pressure in the house and draw air through unsealed cracks and openings, and infrared imaging to show where heat is escaping. These and other services are listed in Figure 1.

To assess the quality of the audits they received, we asked the respondents who had audits which of these services the auditors' assessments included. As seen in Figure 1, almost 80 percent of respondents reported that their auditor "personally showed them trouble spots," but only 26 percent were provided photos of the trouble spots.

Only 64 percent of homeowners reported that their audit involved a blower door test, which is standard practice for a quality home energy audit and required by the Building Performance Institute (BPI), a national standards development and credentialing organization for residential energy-efficiency retrofit work. In fact, in our previous survey of home energy auditors (see Further Reading), 91 percent reported that they use blower door tests fairly often or always. Similarly, 80 percent of auditors in that survey said that they analyze past energy bills fairly often or always, and 63 percent said they use infrared imaging fairly often or always. In this survey of homeowners, the corresponding numbers are 64 percent and 56 percent. What explains the discrepancy? All the auditors in the earlier survey were BPI certified and many were members of Efficiency First, a trade association that develops best practices and advocates for the home energy efficiency workforce. Our current survey seems to suggest that many home-

Figure 1. Percentage of Survey Respondents Whose Audits Included Particular Services



A home energy auditor conducts a blower door test to locate any unsealed cracks and openings.

owners may be using auditors who are not BPI certified. Certainly it shows that not all auditors are using the same techniques and performing the same services. People in our two pre-survey focus groups also reported quite different audit experiences.

We also asked homeowners in our survey how much they paid for their audits and got some unexpected responses. Almost 70 percent received their audits for free. However, in our survey of auditors, the average price was $349. Thus, most homeowners in our sample received heavily subsidized audits. These subsidies could come from utilities or from local government programs to promote energy efficiency. It's also possible that some survey respondents could be part of the federal Weatherization Assistance Program, which provides free audits and free or heavily discounted energy improvements and retrofits to income-eligible households. However, the income levels of the respondents in our survey who reported paying zero are mostly too high to qualify for this program.

Are these free audits different from the paid ones? We looked into this, and the answer is yes. Among respondents who paid for their audits, 83 percent had a blower door test compared to only 55 percent of those who got the audit for free. And 71 percent of paid audits included infrared imaging, while only 51 percent of free audits incorporated this test. Similar results show up for analyzing bills, showing pictures, and other such techniques.

Taking Advice: Do Homeowners Follow Up on Home Energy Audits?

Given these differences, subsidies might not be serving their intended purpose to induce energy-efficient changes: our survey reveals that audit quality, as measured by the techniques and services included in Figure 1, has a considerable effect on whether homeowners follow auditors' recommendations.

© Jose Luis Villegas/ZUMA Press/Corbis

Other factors, such as procrastination and cost, also play a large role.

The two most common recommendations from home energy audits are to seal air gaps and add insulation. Air gaps are often identified during an audit using a blower door test and can be around windows and doors, in attics, and in many nooks and crannies of the home. The most common area for insulation is the attic, but ideally crawlspaces, walls, and pipes are also insulated.

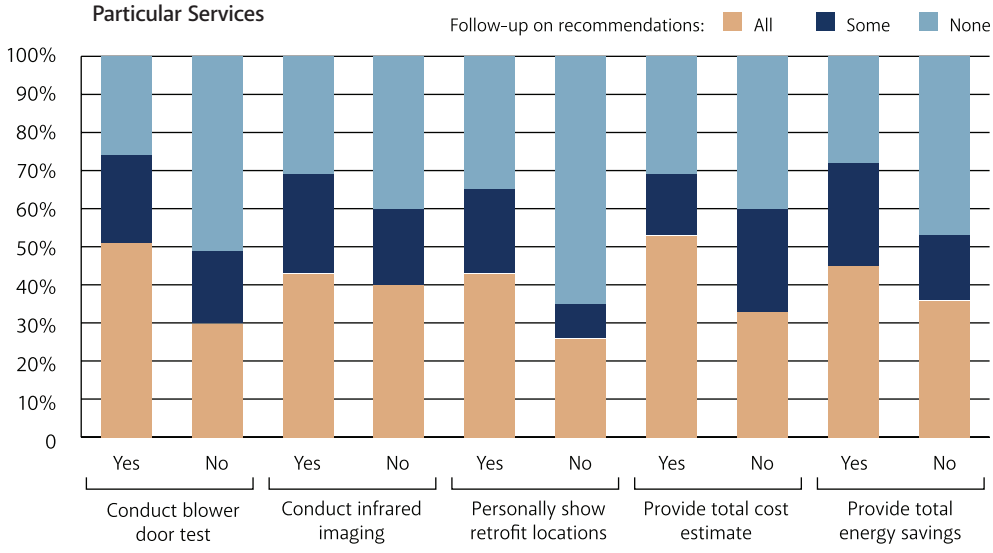
In our survey of home energy auditors, more than 90 percent said they recommend air sealing and insulation improvements fairly often or always, and in our homeowner survey, 67 percent said that their auditor recommended air sealing. However, only 41 percent of homeowners did all the air sealing that was recommended in their audit. Another 38 percent said they did some, and 21 percent said they did none.

Auditors recommended attic and crawlspace insulation somewhat less frequently; in our case, only 56 percent of homeowners reported receiving such a recommendation from their audits. Of these, about 41 percent said they did all the insulation improvements that were recommended, and 36 percent said they did none.

Audit follow-up appears to vary with the quality of the audit. Figure 2 shows that follow-up on insulation recommendations is higher when the audit includes special tests and services that are indicators of higher quality; the results are similar for air sealing. A few of these features are associated with a difference that is statistically significant: a blower door test, personally showing the homeowner where changes need to be made, and providing estimates of energy savings.

What are the main reasons people report for not taking their auditors' advice? Procrastination seems to be the most important reason: nearly 50 percent of homeowners said the main reason for their failure to seal air gaps was that they "had not gotten around to it," with a slightly smaller percentage saying the same for recommendations about insulation. Insufficient energy savings is the second most cited reason for failure to do air sealing, while insufficient savings and high cost of

Figure 2. Extent of Follow-up on Insulation Recommendations by Whether Audit Included Particular Services



An infrared thermal imaging system shows a distinct cold (blue) area within the home's insulation.

improvements are equally cited as reasons for not adding insulation.

Do homeowners find that audits are useful? We asked homeowners to rate the quality of the information in their home energy audit on a scale of 1 to 10, where higher numbers mean greater satisfaction. The mean and median rating across respondents was 7. This seems pretty high to us. However, the responses varied widely: while 12 percent gave a rating of 10, 4 percent gave a 1 or a 2, and about 11 percent rated their audit below 5.

Perhaps a better indication of the level of satisfaction is whether a homeowner has recommended getting an audit to others. Though homeowners claim to think highly of their audits, at least based on the numerical rating, only 45 percent reported that they had recommended home energy audits to others, and only about one-third recommended the actual auditor they used.

The Importance of Salience and Attentiveness in Energy Decisions

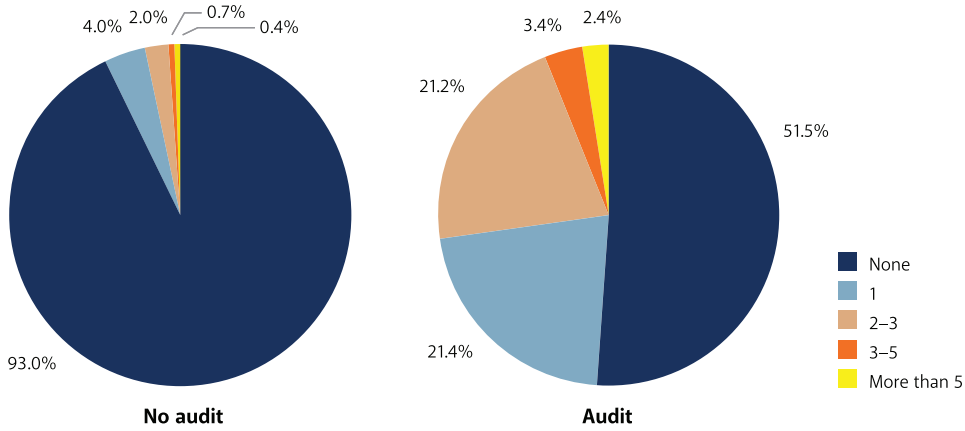
As economists, we like to think that, by and large, people make decisions based on a rational accounting of costs and benefits. In the case of home energy audits, homeowners are paying for information that should allow them to make better energy investment decisions. If the benefits of that information outweigh the costs of acquiring it, we would expect them to spend the money for an audit.

But recent research on behavior and energy efficiency suggests that many other factors come into play in people's decisions about energy use and related investments in appliances, equipment, and buildings. The salience of energy costs and attentiveness to energy usage are two important factors identified by many researchers. In our survey, we asked some questions related to energy attentiveness and salience, and the data hint that some of these factors may influence the decision process.

One class of variables associated with the decision to get an audit pertains to homeowners' awareness of the energy-related features of their houses. Homeowners in our survey who had audits were more likely to know the age of their heating systems (at the time of the audit) than homeowners who had not had audits. They were also more likely to have a general idea of their annual total energy expenditures and especially more likely to know how much attic insulation they had.

©iStock.com

Figure 3. Number of Friends or Neighbors Who Had Audits, by Respondents Who Had Audits and Those Who Did Not



People who had audits were also more likely to service their heating and AC equipment regularly and set their monthly electricity bill to be paid based on an annual average level of monthly use (to avoid month-to-month fluctuations). They were also more likely to have received a home energy report—a letter, usually from the local utility, comparing their home's energy use to that of other, similar houses.

Between homeowners in our survey who had audits and those who hadn't, we saw the sharpest contrast in the number of friends or neighbors that each group said they knew had had audits. Among the non-audit respondents, only 7 percent said that they knew someone whose home had been audited. In contrast, almost 50 percent of the respondents who had an audit said they knew one or more persons whose home had been audited prior to having theirs (Figure 3). Among those who had had audits, 21 percent knew one other person who had an audit, 21 percent knew two or three people, and nearly 6 percent knew more than three.

We cannot conclude from this preliminary look at the survey data that attentiveness to one's house and energy use or cues, such as receiving a home energy report, spurs people to get an audit. But the associations we are seeing, especially in light of previous research, reinforce the need to dig into this possibility more deeply.

If our planned in-depth analysis reveals that attentiveness and cues do indeed affect audit uptake, there could be important policy implications. Subsidies and other financial incentives for audits may have limited effects in the absence of complementary information programs that make energy use more salient to homeowners. Or it might be important to combine financial incentives with deadlines. Another option may be a series of cues to jog people's memories. Conducting careful field experiments around some of these options could provide useful information as to what works. Our survey should provide guidance for such experiments. ●

This article originally appeared as a three-part series on RFF's blog, *Common Resources*.

FURTHER READING

Palmer, Karen, Margaret Walls, Hal Gordon, and Todd Gerarden. 2013. Assessing the Energy Efficiency Information Gap: Results from a Survey of Home Energy Auditors. *Energy Efficiency* 6(2): 271–292.

Mun S. Ho *and* **Zhongmin Wang** *trace China's rapid economic growth and the associated environmental problems to its unique and fundamental institutions—and discuss the implications for a more sustainable path.*

The recent history of China has been one of spectacular economic growth. The country's GDP soared from 3.43 percent of global GDP in 2000 to 11.35 percent in 2012. Its per capita income of US$6,100 in 2012 puts China in the category of middle-income countries such as South Africa, Egypt, and Thailand.

At the same time, China has experienced very serious environmental degradation. Its energy consumption has increased rapidly, and it overtook the United States as the world's largest energy consumer in 2010. Coal has been China's dominant source of energy, accounting for 66.6 percent of the country's total primary energy consumption in 2012. Given this heavy reliance on coal, China became the world's largest carbon dioxide (CO_2) emitter in 2006, and in 2012 it accounted for 29 percent of global CO_2 emissions.

In addition, China's air, water, and soil have been polluted to alarming degrees. Extreme air pollution in China, for example, is making international headlines, and this is not just anecdotal: In March 2014, China's Ministry of Environmental Protection announced that only 3 of the 74 large Chinese cities it monitors met official standards for air quality in 2013.

The environmental situation is so dire that the country's prior consensus of focusing on economic growth over environmental protection has broken down, spawning interest in the potential for green growth strategies for China. "Green growth" is a politically attractive term because it speaks simultaneously to two key challenges currently faced around the world: economic growth needed to improve the living standards of the world's growing population, and measures needed to address the issues of environmental sustainability and climate change.

Sweeping energy and environmental policies—such as China's enormous effort to decarbonize its energy system through increased reliance on wind and nuclear generation—are one crucial step toward a green growth path. But they will not succeed without the support of changes to the country's institutional rewards system and governance structures, which until now have prioritized GDP growth over environmental protection.

The environmental situation in China is so dire that the country's prior consensus of focusing on economic growth over environmental protection has broken down.

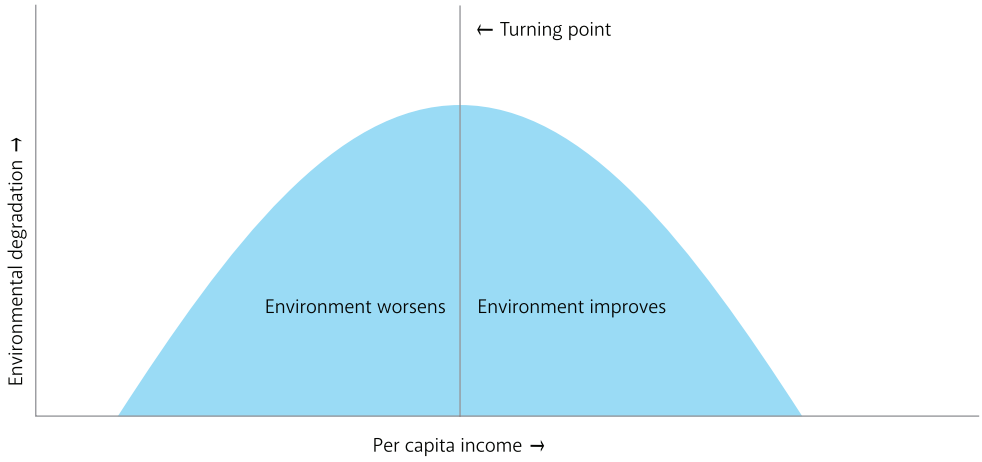
The Relationship between GDP Growth and the Environment

Green growth is generally used to mean economic growth that is environmentally sustainable. Thus it carries with it the claim that environmental protection is, at a minimum, compatible with economic growth. When economists think about the relationship between GDP growth and the environment, they often point to the environmental Kuznets curve.

As income rises over time, environmental pollution first becomes more serious but then eases after the GDP per capita in the country or region reaches certain levels. This stylized fact is known as the environmental Kuznets curve, where the vertical axis is environmental degradation instead of environmental quality (Figure 1 on page 42). The environmental Kuznets curve is the

© Tang Yau Hoong/Ikon Images/Corbis

Figure 1. An Environmental Kuznets Curve



subject of vigorous debate in the economics literature. Many observers have noted that this curve does not fit many indicators of environmental quality, such as soil fertility and the health of fisheries, as well as levels of greenhouse gas emissions. While the richer countries today are indeed reducing the levels of some pollutants—such as sulfur dioxide, ozone, and DDT—most are still raising their levels of CO2 emissions per capita. Still, it is useful to invoke this phenomenon to think about the driving force behind the decoupling of most pollutants and GDP growth in developed countries and the meaning of green growth.

Just as GDP growth effects the environment, environmental policies can affect GDP growth and social welfare through a variety of channels. One positive outcome is that they may increase natural capital, such as cleaner air. Cleaner air, in turn, increases labor supply and reduces damages to buildings and equipment. They also may change technology. Energy efficiency policies, for instance, may trigger innovations that lower both energy use and costs. And they can reduce production inefficiencies, such as in the case of a policy that organizes a fishing community to avoid overfishing.

On the other hand, environmental policies can be costly and thus can have a negative economic effect if not designed optimally—leading to layoffs, for example, or forced early retirement of existing physical capital.

While the idea that there are no trade-offs between growth and the environment may be controversial, it is well accepted that specific projects can be win–win and that certain types of policies, such as removing energy subsidies, can be win–win with a proper set of supplementary redistributive policies.

What Led to China's Rapid Economic Growth and Environmental Degradation?

To understand China's spectacular economic growth and its environmental failures, and to determine how the country can begin to grow more sustainably, it is necessary to understand China's institutional reward system. China's governance structure can be characterized by economic decentralization and political centralization. Regional governments are directly responsible for, and deeply involved in, developing the economies within their jurisdiction, and these subnational governments carry out

most government functions. However, in the political domain, the national government controls not only ideology and the media but also the personnel matters of subnational governments through its cadre evaluation system.

This system provides government officials, who are motivated by career concerns, with powerful incentives to perform by promoting those with better performance. It also promotes regional competition in economic development and regional experiments in economic reforms. Some argue that this is a major reason China experienced rapid economic growth.

In this system, performance targets are separated into three categories: targets with veto power, hard/binding targets, and soft/guidance targets. Social stability and the one-child policy had long been targets with veto power, understood to be the most important type of targets. Failure to meet these veto targets results automatically in punishment, and poor performance on these targets cannot be compensated by good performance on other targets. Economic growth has long been a hard target, while environmental goals have been soft targets in the past.

As one would expect, government officials respond to this evaluation system by focusing more on economic growth than on environmental protection. Empirical evidence suggests that provincial leaders' economic performance—measured by GDP growth rate—relative to the national average had a significant impact on the probability of their promotions. There is also some evidence that spending on environmental amenities negatively affects city-level officials' odds of promotion.

Other institutions than just the cadre evaluation system push government officials to focus on the growth of GDP—especially the growth of energy-intensive and high-emissions industries—instead of environmental protection. One example is China's fiscal system. About half the tax revenue in China comes from value-added tax, which is directly related to the growth of industry and shared with local governments. In addition, subnational government revenue is not commensurate with the expenditure responsibilities of those regional jurisdictions. According to a 2012 World Bank study, subnational governments are responsible for 80 percent of government expenditure responsibilities but receive only slightly more than 40 percent of tax revenue. Local governments thus have a strong incentive to find additional revenue to finance their expenditures and a very weak incentive to invest in environmental protection.

Another such policy is the below-market prices of natural resources, including energy, land, and water, as well as those of interest rates. The low prices of natural resources and capital lead to economic growth that is resource and capital intensive.

Implications for China's Green Growth Strategies

For China to be on a green growth path, it is not sufficient to simply introduce environmental and resource policies at the national level; environmental protection has to be emphasized more in the cadre evaluation system. Indeed, as China's economy has continued to grow and many indicators of its environmental health worsen, environmental protection has become more important in cadre evaluation.

In the 11th Five-Year Plan (2006–2010), several environmental targets became binding for the first time, including a 10 percent reduction in sulfur dioxide emissions and chemical oxygen demand releases, and a 20 percent reduction in energy intensity. Subnational governments took substan

tial action to meet these hard targets. For example, by the end of 2010, subnational governments had shut down about 70 gigawatts of small, "backward" thermal power plant capacity. The 12th Five-Year Plan (2011–2015) contains more binding environmental targets, including a 17 percent reduction in carbon intensity.

In December 2013, the Organization Department of the Communist Party of China announced that it would modify the cadre evaluation system. GDP growth should not be the only main criterion in evaluating government officials, the announcement stated, and more weight should be given to environmental protection, resource efficiency, and other social and economic considerations.

A more nuanced cadre evaluation system would certainly help protect the environment, but as with other multitask principal-agent problems, it still has weaknesses. For example, the binding environmental targets in the 11th Five-Year Plan were met—at least on paper—but they led some local government officials to fake data and take highly inefficient measures.

Since the cadre evaluation system has inherent weaknesses, it will be important to strengthen environmental laws and law enforcement. Chinese legislators have made some progress in this endeavor. In April 2014, the Standing Committee of the National People's Congress approved major amendments to its Environmental Protection Law, the first since the law was enacted in December 1989. One critical revision replaces the previous one-off limited fine system for pollution violations with a new penalty system, in which the amount of the fine continues to accumulate for each day the violation continues. Another is that nongovernmental organizations can take legal actions against polluters on behalf of the public interest.

Although current efforts have been substantial, they have not matched the scale and complexity of the pollution problem generated by rapid economic growth in China. Many proposals have been put forward to address particular aspects of the air, water, and solid waste pollution problems, including "technology-push" policies and fuel taxes based on environmental damages.

For China's leaders, green growth is now a necessity. They have started down this path of reform, but the scale of the problems requires greater efforts and some fresh thinking and experimentation. International groups, such as the World Bank and the United Nations, recognize the need for a global network that can address major knowledge gaps in green growth theory and practice. Policy advisers in China and the global environmental community have much to do. ●

For China to be on a green growth path, environmental protection has to be emphasized more in the cadre evaluation system.

FURTHER READING

Ho, Mun S., and Zhongmin Wang. 2014. Green Growth (for China): A Literature Review. Discussion paper 14-22. Washington, DC: RFF.

World Bank. 2012. *Inclusive Green Growth: The Pathway to Sustainable Development*. Washington, DC: World Bank.

Xu, Chenggang. 2011. The Fundamental Institutions of China's Reforms and Development. *Journal of Economic Literature* 49(4): 1076–2151.

A Look at What's Happening

Inside RFF

RFF named the following academic fellowship recipients to conduct environmental and energy research during the 2014–2015 academic year.

Gilbert F. White Postdoctoral Fellowships

» **Francisco Aguilar,** associate professor in the Department of Forestry at the University of Missouri, is at RFF studying a range of forestry-related topics.

» **James Salzman,** Samuel F. Mordecai Professor of Law and professor of environmental policy at Duke University, is visiting RFF to further his research on the development of payments for ecosystem services.

Joseph L. Fisher Dissertation Fellowships

» **Stephie Fried,** a PhD candidate in economics at the University of California, San Diego, is studying the macroeconomic effects of climate policy, with a particular focus on the links among energy price volatility, energy technology, and carbon mitigation policy.

» **Evan Herrnstadt**, a PhD candidate in economics at the University of Michigan, is conducting research on bridging the fields of natural resource and environmental economics and industrial organization by examining firm behavior in the presence of environmental regulation.

» **Eric Lewis**, a PhD candidate in economics at the University of Michigan, is focusing on the economics of the onshore oil and gas industry.

Walter O. Spofford Memorial Internship

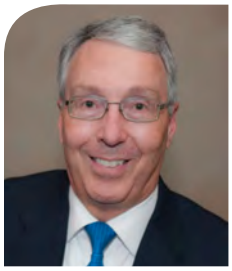
» **Kuangyuan Zhang**, a PhD candidate in energy management and policy at Pennsylvania State University, spent the summer of 2014 studying carbon trading in China and Chinese housing and transportation issues.

Richard Schmalensee Chairs RFF Board of Directors

In October, **Richard Schmalensee** assumed leadership of RFF's Board of Directors, after serving as a member since April 2009. Schmalensee is the Howard W. Johnson Professor of Economics and Management and dean, emeritus, at the Massachusetts Institute of Technology's (MIT's) Sloan School of Management. From 1998 through 2007, he was the John C. Head III Dean of the Sloan School. He was a member of the President's Council of Economic Advisers from 1989 through 1991. Schmalensee was formerly director of the MIT Center for Energy and Environmental Policy Research and a member of the MIT Energy Council. He also has served on the executive committee of the American Economic Association and as a director of the International Securities Exchange, MFS Investment Management, and the International Data Group.

RFF Welcomes New Board Members

RFF is pleased to announce the appointment of three new members to its Board of Directors. In addition, **Vicky A. Bailey, Daniel C. Esty**, and **Robert N. Stavins** have returned for an additional term.



James Asselstine
Tyler Hill, PA

Before his retirement, James Asselstine served as managing director and senior credit research analyst at Lehman Brothers and Barclays, where he focused on the electric utility and power industry. He also has previously served as the senior vice president of Donaldson, Lufkin, & Jenrette. He has held numerous government positions, including commissioner for the US Nuclear Regulatory Commission, associate counsel for the US Senate Committee on Environment and Public Works, and staff attorney in the US Nuclear Regulatory Commission's Office of the Executive Legal Director.

Paul F. Balser
Founding Partner, Ironwood Partners and Generation Partners

Paul Balser has been a founding partner of the private equity firms Ironwood Partners and Ironwood Manufacturing Fund since 2001 and of Ironwood Management Partners Fund II, LP, since 2007. In 1996, Balser cofounded Generation Partners, a $325 million private equity firm with offices in Greenwich, Connecticut, and San Francisco, California. Prior to Generation Partners, Mr. Balser was a founding partner of Centre Partners, LP, the managing general partner of Centre Capital Investors, LP, a $150 million investment fund for the partners and affiliates of Lazard Frères & Co., LLC. He is chairman of the board of the Hudson Guild and also currently serves on the boards of Tweedy Browne Funds, Inc.; United Neighborhood Houses; Metropolitan Waterfront Alliance; Hale Foundation; and a number of private companies. He is also a class agent for the Lawrenceville School and Yale University, and a member of Business Executives for National Security.

Sue Tierney
Senior Advisor, Analysis Group Inc.

Sue Tierney is an expert on energy policy and economics, specializing in the electric and gas industries. In her current role, she has consulted to companies, governments, nonprofits, and other organizations on energy markets, and economic and environmental regulation and strategy. She previously spent over a dozen years in state and federal government, most recently as assistant secretary for policy at the US Department of Energy. She also served as a state cabinet officer for environmental affairs, state public utility commissioner, and chair of the Water Resources Authority in Massachusetts. She currently chairs the External Advisory Board of the National Renewable Energy Laboratory; chairs the ClimateWorks Foundation Board; and is a director of World Resources Institute, the Alliance to Save Energy, and the Energy Foundation.

Goals for Society, Revisited

Chuck Howe Remembers Kenneth Boulding

One of the most rewarding experiences of some 40 years as a professor of economics at the University of Colorado, Boulder, was that, during half that period, I was a close colleague of Kenneth Boulding (1910–1993)—in both the Department of Economics and the Institute of Behavioral Science, which I directed. (RFF's former board chair Gilbert White was another member of that body.) Boulding was an outstanding economist, educator, and poet; a prescient environmentalist; and the originator of general systems theory for the social sciences. His peace activism—rooted in Quaker teachings—was part of his deeply felt commitment to social justice. He always spoke passionately, white hair flailing and his trademark stammer coming back when needed for emphasis. While he could be contentious, he was always a peacemaker in the Department of Economics.

The untitled poem below opened "New Goals for Society?"—Boulding's chapter in the 1972 RFF Press book *Energy, Economic Growth, and the Environment*. Far from incidental to his interests, poetry was an important element in his breadth of expression.

The thing in pollution we most need to know
Is, where does it come from and where does it go?
One major idea in the pot must be tossed,
That things may be missing, but never are lost.
Most chemical elements cannot be changed.
They can't be destroyed, they are just rearranged.
So clean water and air, and, indeed, your clean shirt,
Are obtained by the wise segregation of dirt.
So if our research is to bear healthy fruit,
The critical question is what to pollute.
One policy matter is clear; the polluter
Should not be allowed to become a commuter.
And as long as industrial systems have bowels
The boss should reside in the nest that he fouls.
Economists argue that all the world lacks is
A suitable system of effluent taxes.
They forget that if people pollute with impunity
This must be a symptom of lack of community.
But this means producing a mild kind of love
So let's hope the eagle gives birth to a dove.

—Kenneth E. Boulding

Energy, Economic Growth, and the Environment by Routledge. Reproduced with permission of Routledge in the format "Republish in a journal/magazine" via Copyright Clearance Center.

Highlights from Recent Journal Articles by RFF Researchers

Cost-Share Program Participation and Family Forest Owners' Past and Intended Future Management Practices

Nianfu Song, Francisco X. Aguilar, and Brett J. Butler

Forest Policy and Economics | September 2014 | Vol. 46 | 39–46

Cost-share programs are commonly used for agricultural lands, but their association with landowner behavior on forested lands has not been as thoroughly studied. Using a dataset of over 3,500 observations, this study finds that family forest owners in the northern United States who engaged in cost-share programs participated in more silvicultural and conservation management activities than those who did not.

Designing Efficient Surveys: Spatial Arrangement of Sample Points for Detection of Invasive Species

Luděk Berec, John M. Kean, Rebecca Epanchin-Niell, Andrew M. Liebhold, and Robert G. Haight

Biological Invasions | July 2014| doi: 10.1007/s10530-014-0742-x

The efficiency of surveillance systems to manage biological invasions can be affected by the pattern of sample locations, which range from random to fixed-grid arrangements. This paper explores how they affect the probability of detecting a target population and the overall cost of eradicating populations. For single-period surveys, regular sampling patterns performed better than did random samples at intermediate sample densities, but only when sample sensitivity is high. Otherwise, the sample point arrangement has little effect on survey sensitivity.

The Costs and Consequences of Clean Air Act Regulation of CO_2 from Power Plants

Dallas Burtraw, Josh Linn, Karen Palmer, and Anthony Paul

American Economic Review | May 2014 | Vol. 104, No. 5 | 557–562

Under the Clean Air Act, the US Environmental Protection Agency and states will determine the form and stringency of the carbon dioxide regulations for power plants. Various approaches would create an implicit price on emissions and assets that would be distributed differently among electricity producers, consumers, and the government. The authors compare a tradable performance standard with several cap-and-trade policies. Distributing asset values to fossil-fueled producers and consumers has small effects on average electricity prices but imposes greater social cost than a revenue-raising policy.

Two World Views on Carbon Revenues

Dallas Burtraw and Samantha Sekar

Journal of Environmental Studies and Sciences | March 2014 | Vol. 4, No. 1 | 110–120

The introduction of a price on carbon dioxide is expected to be more efficient than prescriptive regulation. It also represents substantial economic value. This paper asks who should receive this revenue and summarizes six trends among existing carbon-pricing programs. Deciding how to categorize the atmosphere—either as government property or as a common resource—has efficiency and distributional consequences that affect the political economy and the likelihood and durability of climate policy.

RESOURCES
FOR THE FUTURE

At RFF, we believe

THE BEST IS YET TO COME.

Support RFF and invest in the power of ideas to build a better world.

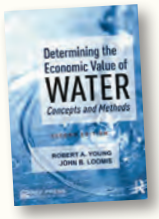
Use the envelope in this issue to make a donation, or learn more at www.rff.org/support.

RESOURCES
FOR THE FUTURE

1616 P St. NW
Washington, DC 20036-1400

NONPROFIT ORG
U.S. POSTAGE
PAID
PERMIT NO. 8
HANOVER, NH

NEW TITLES from RFF PRESS

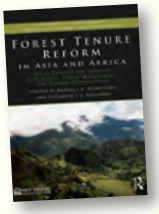


Determining the Economic Value of Water

Concepts and Methods, 2nd Edition

By Robert A. Young and John B. Loomis

July 2014
Paperback: 978-0-415-83850-4
http://www.routledge.com/9780415838504



Forest Tenure Reform in Asia and Africa

Local Control for Improved Livelihoods, Forest Management, and Carbon Sequestration

Edited by Randall Bluffstone and Elizabeth J.Z. Robinson

November 2014
Hardback: 978-1-13-881964-1
www.routledge.com/9781138819641

The Measurement of Environmental and Resource Values

Theories and Methods, 3rd Edition

By A. Myrick Freeman III, Joseph A. Herriges, and Catherine L. Kling

June 2014
Paperback: 978-0-415-50158-3
http://www.routledge.com/9780415501583

Biodiversity Conservation in Latin America and the Caribbean

Prioritizing Policies

By Allen Blackman, Rebecca Epanchin-Niell, Juha Siikamäki, and Daniel Velez-Lopez

May 2014
Hardback: 978-0-415-73096-9
www.routledge.com/9780415730969

The 2014 RFF Press Catalog is now available online. Please browse all our latest books here: www.routledge.com/u/RFFCatalog.

RFF Press is an imprint of Routledge/Taylor & Francis, a global publisher of quality academic books, journals, and online reference.