

# RESOURCES



Protecting Natural Resources,  
Managing Energy Needs

WELCOME

## Looking Beyond the Headlines



PHILIP R. SHARP, PRESIDENT

Like everyone else, we at RFF have been closely following media coverage of the tragedy in the Gulf of Mexico, out of deep concern for the harm that has come to many people as well as to the Gulf's treasured natural resources. But many RFF scholars have an added perspective, based on years of experience in assessing environmental damages and determining how the resulting costs should be assessed.

They think long and hard about the tough questions that many choose to overlook. As Senior Fellow Jim Boyd explains, shrimp and oysters have market prices—but what about the pelicans? They aren't bought and sold, yet no one would argue that they therefore have no value, or that the destruction of the birds and their breeding grounds has no economic meaning. The difficulty of making these calculations hardly means that the value doesn't exist.

The oil spill in the Gulf reminds us of the rising need for alternative ways to power American cars and trucks. Two of the three top contenders are biofuels and natural gas, both now in use but currently constrained from further expansion by engineering, infrastructure, and regulatory problems (the third option being electric cars). Journalist-in-Residence John Anderson and Nonresident Fellow Steve Brown lay out the challenges—ranging from trade barriers keeping out Brazilian ethanol made from sugar cane to environmental concerns regarding shale gas production—that temper the rosy projections made about their potential.

As the world's appetite for energy grows, so too does the competition for resources. In this country, anxiety about Chinese investment in energy sources on several continents is becoming audible. But the purpose of rigorous analysis is not necessarily to allay concerns but to focus them on the right targets. As Senior Fellow Joel Darmstadter writes, it is important to dwell not on the actions of one country, but rather on the rapidly increasing demand for fuel in all industrializing countries. If prices rise as the world comes out of the recent recession, the likelihood that oil prices will be volatile does as well. Estimating the costs of instability is not simple, but as in the case of the pelican, that doesn't mean that we should, or can, ignore it.

We recently received a prestigious award for our many contributions beyond the headlines. The Fondazione Eni Enrico Mattei, a leading research center in Italy, gave RFF the FEEM 20th Anniversary Prize in Environmental Economics. We are very proud.

A final word—our resources to address problems like these have been greatly enhanced with the addition of five new scholars to our staff: Fellows Joshua Linn and Lucija Muehlenbachs, Visiting Scholars Randall Lutter and P. Lynn Scarlett, and Nonresident Fellow Kenneth Small. Welcome to all!

# RESOURCES

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RFF Senior Fellow **James W. Boyd** is director of RFF's Center for the Management of Ecological Wealth. He works in the fields of environmental regulation and environmental law and economics, in particular, the analysis of environmental institutions and policy. Specific areas of expertise include water regulation, environmental and product liability law, and incentive-based regulation.

**Stephen P.A. Brown** joined RFF in 2009 as its first nonresident fellow and also serves as the co-director of RFF's Center for Energy Economics and Policy. He focuses his research on domestic and international energy markets, energy security policies, public finance, and government performance.

RFF Vice President for Research and Senior Fellow **Mark Cohen** began his academic research career studying oil spills. He has published several articles that examine regulatory and judicial practice toward both individuals and corporations convicted of environmental crimes and has frequently written and spoken before government and industry groups as well as academics on related issues of environmental enforcement and penalties.

In his nearly four decades at RFF, Senior Fellow **Joel Darmstadter** has conducted research centered on energy resources and policy. His recent work addresses issues of energy security, renewable resources, and climate change.

**Robert Fri** has been active for more than 35 years as both an administrator and analyst of energy and environmental policy. As the first deputy administrator of both EPA and the Energy Research and Development Administration, he was instrumental in organizing the federal government's programs in environmental regulation and energy technology. He served as president of RFF and the National Museum of Natural History during major transitions in the role of these institutions.

**Juha Siikamäki** is an RFF fellow. His work is centered on valuing the environment and evaluating the benefits, costs, and cost-effectiveness of different environmental policy options. He is especially interested in understanding the preferences of consumers, households, and landowners for different policy programs.

**Martin Wachs** is director of transportation, space, and technology at the RAND Corporation, a non-profit institution that helps to improve policy and decisionmaking through research and analysis.

**Margaret Walls** is the Thomas J. Klutznick Senior Fellow. Her new research focus is on city parks and urban open space. This area is an outgrowth of research she did as part of the Outdoor Resources Review Group, looking at a range of outdoor recreation and conservation issues (for more on this work, see her feature story in this issue). She also studies related urban and land issues, including urban transportation and transferable development rights programs. Thomas Klutznick, who endowed this chair, spent most of his career as a real estate developer who worked to find a balance between growth and environmental protection. He served on the RFF Board of Directors from 1985 to 1994, and was instrumental in establishing RFF's own real estate portfolio which helped build our endowment.

## RFF and the Gulf Oil Spill

The offshore oil spill in the Gulf of Mexico has brought oil-related energy, liability, natural resource damages, and regulatory issues to the forefront of public policy discourse. RFF has a strong legacy of research and public events on these topics that can provide context for the ongoing crisis and for the analysis of policy implications that will no doubt be debated for many years. You can turn to [www.rff.org/2010-Gulf-Coast-Oil-Spill](http://www.rff.org/2010-Gulf-Coast-Oil-Spill) for more on our work in these areas.

### Who is liable for cleanup and damages? How much should they pay?

RFF researchers have previously written about the role of liability rules in preventing environmental harm, including such diverse areas as toxic pollution, hazardous wastes, underground storage tanks, nuclear power, commercial space exploration, and oil spills. On oil spills, **Mark Cohen**, the vice president for research, has examined optimal liability rules and enforcement policy to prevent oil spills. He subsequently published research analyzing how the courts have treated firms held liable for causing environmental harms such as oil spills. **James Boyd**, a senior fellow, has written about liability rules and the role of financial responsibility requirements. More recently, **Nathan Richardson**, a visiting scholar, has reviewed the relevant environmental laws to determine the liability rules

President Barack Obama, LaFourche Parish president Charlotte Randolph, right, and U.S. Coast Guard Admiral Thad Allen, national incident commander for the BP Deepwater Horizon oil spill, look at booms laid out to collect oil.

most likely facing BP and other firms involved in the current oil spill crisis.

### What should the government's policy be toward offshore drilling?

Following the Gulf oil spill, the president ordered a moratorium on deepwater oil drilling off the U.S. coast. What impact would a permanent ban on offshore drilling have on the price of oil or our nation's energy security? What if the government were to impose new regulatory standards that raised the cost of drilling for oil by 10 to 20 percent? **Stephen Brown**, a non-resident fellow, has studied these issues and reports on the impact of an offshore drilling moratorium or an increase in regulatory costs.

### Natural Resource Damages in Oil Spills

Many RFF Fellows have worked on developing methodologies and assessing natural resource

damages. During the Exxon Valdez spill, **Raymond Kopp**, a senior fellow, was part of a team that evaluated the public's willingness-to-pay to avoid wildlife destruction in the Alaskan spill. Jim Boyd has written extensively on natural resource damages in a marine context, including a recent paper explaining the concept of lost ecological wealth and its relevance to natural resource damages. He shows how the Gulf Coast oil spill could change the way in which ecosystem damages are estimated going forward.

### How do we take into account catastrophic risk in assessing the costs and benefits of offshore drilling?

As policymakers begin to reassess how catastrophic risk is accounted for in regulatory policy, RFF's expertise in this subject may be particularly useful. **Roger Cooke**, the Chauncey Starr Senior Fellow, is an expert on uncertainty and risk analysis and has written on such diverse topics as health risks from oil fires in Kuwait following the first Gulf War, chemical weapons disposal, nuclear risk, etc. **Carolyn Kousky**, an RFF fellow, is an expert on natural resource management and decisionmaking under uncertainty and has studied how both individuals and policymakers respond to changes in extreme events. Both of these researchers together have recently analyzed the extent to which extreme catastrophic events can be predicted and insured against. ■



AP PHOTO/TIM YELCO

## RFF President Phil Sharp and Scholar Robert Fri on the Energy Policy Challenges that Lie Ahead

In late April, RFF President Phil Sharp and Visiting Scholar and former RFF President Robert Fri testified before the Energy and Water Development Subcommittee of the U.S. Senate Committee on Appropriations, part of a panel that included Energy Secretary Steven Chu. Chairman Byron Dorgan (D-ND) called the hearing as part of an effort, "to take a broader look at our energy future and address the incrementalism that is part of the policy process."

In their separate remarks, Sharp and Fri addressed lessons to be learned from 40 years of energy policy.

"We are now grappling with how we should change and indeed, transform, our energy system to deal with global warming over decades ahead," Sharp said. "Significantly cutting emissions of greenhouse gases is a daunting challenge—global in scope, reaching deep into our economy, and requiring a long-term focus."

In the United States and elsewhere, major public and private efforts are underway to change the way we produce and use energy, Sharp said. Many incentives have been put in place to advance energy efficiency, renewables, and lower-carbon fuels, and to develop potentially critical technologies such as carbon capture and storage and advanced nuclear reactors.

"The hard challenge is to design a policy framework or architecture that will hold up over many years and change our economy in the most cost-effective way," Sharp said.

"We appear to have a choice between two broad strategies: put a rising price on carbon or regulate emitters of carbon under the current provisions of the Clean Air Act. Pricing



RFF President Phil Sharp (left), and Visiting Scholar and former RFF President Robert Fri.

carbon, of course, can be accomplished either by adopting a tax that rises over time or adopting a cap on emissions with allowance trading—or some combination of the two. Either strategy—pricing carbon or regulating emitters—can put us on a path to cut emissions; both will spur some level of technological innovation."

Most economists and many policy analysts, however, believe the pricing option is superior in terms of finding the least-costly emissions reductions and providing incentives for continuous technological innovation.

"Of course, in judging either strategy it is critical to know the details where the devil and angels reside," Sharp said. "In pursuing such a long-term challenge requiring persistent policy, there are a few, perhaps obvious, lessons from our previous experience:

- We should pursue a portfolio of fuels and technologies—indeed, a portfolio of policies. Do not put all your eggs in one basket, as the saying goes.

- We should periodically conduct major assessments of the effectiveness of our policies—perhaps every four to five years. Such evaluation should not only be done inside the government, but also independently of the government. Congressional committees, naturally, will need to continue their critical oversight role.

- And, whenever possible in policymaking, we should capitalize on the dynamism competitive markets can provide in meeting our policy goals."

### Driving Change in the Private Sector

"Unless the nation responds aggressively to the challenges of energy security and climate change, the energy system of the future will look very much like the one of today," Fri said. It will be cleaner as environmental regulations continue to tighten and increasingly efficient as old capital stock turns over. Electricity will continue to be produced mostly by burning fossil fuels and most light-duty vehicles will continue to rely on gasoline.

"But more of the same is not destiny," Fri said, outlining four strategies that would help government policy spur technological change in the private sector:

### Align private incentives with public goals.

Both price signals and regulation can provide the necessary incentive to drive innovation: the former is usually more directly linked to the desired outcome (pricing carbon directly affects carbon dioxide production, for example) and the latter can also have a potent effect as has been the case with refrigerator

efficiency and light-duty vehicles. But the danger of unintended side effects must be considered: the efficiency standard for light-duty vehicles substantially reduced fuel-consumption but it also helped induce a vast market for unregulated trucks posing as sports utility vehicles.

**Fund purpose-driven basic research.** Basic research will be essential for creating an energy system that is affordable and effective but it must be plausibly connected to desired outcomes. One way would be to focus on fundamental changes in our energy options, such as artificial photosynthesis, which could revolutionize the capture and storage of solar energy. Another would be to encourage experts from diverse disciplines, such as nanotechnology and genomic engineering, to converge on a problem.

**Focus applied research to overcoming well-defined market barriers.** Unlike basic research, the Department of Energy's applied research programs cover fairly well-defined technologies, which in some cases have a reasonable chance of market success if they meet attainable technical and commercial goals. Market barriers could be a risk that an innovator is unwilling to accept, such as demonstration of carbon capture and storage, or a problem of market structure, as is often the case in adopting energy efficiency measures.

**Invest with great care in technologies that do not yet have markets.** In the past, government energy programs have invested heavily in technologies that were not competitive at the time but seen as needed in the future to meet public policy goals. Unfortunately, such programs usually don't work out very well. The market turns out not to materialize, or if it does, addresses the problem in ways that were not foreseen. The crash of oil prices in the 1980s—not the synthetic fuels program—solved the looming oil crisis of the 1970s. "This is not to say, of course, that government should never invest in insurance policies, only that it should do so with its eyes open," Fri said. ■

## New Academic Talent Augments RFF Research Agenda

As RFF expands and focuses its research horizons on emerging policy areas, it has concentrated on recruiting notable academicians to fill key senior-level roles. That effort has attracted five leading scholars who are steeped in policy experience drawn from their work in academia as well as government.

The newest additions to the research staff will augment RFF work in a variety of disciplines, including ecosystem management, energy efficiency, solar power, fuel economy, food and drug safety, land and water conservation, urban congestion, and mass transit.

Researchers joining RFF so far in 2010 include Fellows Joshua Linn and Lucija Muehlenbachs, Visiting Scholars Randall Lutter and P. Lynn Scarlett, and Nonresident Fellow Kenneth Small.

"We are delighted that these outstanding individuals are part of the RFF family," said President Phil Sharp. "Their backgrounds and perspectives will further solidify our reputation for sound and serious research."

Vice President for Research Mark Cohen added that "the range of academic and policy experience that these new researchers bring to RFF will be enormous assets to our policy research."

### Joshua Linn

Linn's research focuses on corporate responses to environmental regulation and market incentives. Several of his studies have investigated the effect of the Corporate Average Fuel Economy standards on new vehicle characteristics and the effects of different regulatory instruments on technology adoption in the electric power sector. In research on the manufacturing sector and new vehicle markets, Linn has empirically studied the effect of prices on energy efficiency and new vehicle fuel economy. He has published in leading general interest and field journals in environmental, energy, and health economics.

Linn joined RFF as a fellow in March 2010. Previously, he was an assistant professor in the Economics Department at the University of Illinois at Chicago and a visiting research scientist at MIT, where he served as the executive director of the MIT Study of the Future of Solar Energy.

### Randall Lutter

Lutter, a former chief economist and deputy commissioner for policy at the U.S. Food and



JOSHUA LINN



RANDALL LUTTER

Drug Administration (FDA), joined RFF as a visiting scholar on May 1. His research will focus on the economics of selected regulatory issues related to risk, including food

safety and the environment.

During his tenure at FDA, Lutter oversaw policies on a variety of public health concerns, ranging from pandemic flu countermeasures to the risks of imported and counterfeit drugs, and from nanotechnology to genetically engineered animals. He also changed the management of FDA's advisory committees to improve transparency and predictability.

Before joining FDA in 2003, Lutter was a resident scholar with the American Enterprise Institute and a fellow with the AEI-Brookings

Joint Center for Regulatory Studies. From 1991 to 1997, he served at the Office of Management and Budget in the Office of Information and Regulatory Affairs, and from 1997 to 1998 he was senior economist for regulation and the environment at the President's Council of Economic Advisers.

Lutter coedited the 2004 RFF Press book, *Painting the White House Green: Rationalizing Environmental Policy Inside the Executive Office of the President*, which examined the

public disclosure of environmental violations, and oil and gas activity on First Nation reserve lands.

#### **P. Lynn Scarlett**

Scarlett, deputy secretary and chief operating officer at the U.S. Department of the Interior from 2005 to 2009, has joined RFF as a visiting scholar, focusing on climate change and its effects on land, water, and wildlife; conservation

Plan. She serves on the boards of the American Hiking Society, the Continental Divide Trail Alliance, and RESOLVE, and is a trustee emeritus of the Udall Foundation.

Scarlett received her B.A. and M.A. in political science from the University of California, Santa Barbara, where she also completed doctoral coursework and exams in political science.

#### **Kenneth A. Small**

Small, research professor and professor emeritus of economics at the University of California at Irvine, is RFF's newest nonresident fellow. He specializes in urban, transportation, and environmental economics, with recent research covering urban highway congestion, measurement of value of time and reliability, effects of fuel efficiency standards, public transit pricing, and fuel taxes.

Previously, Small was associate editor of *Transportation Research Part B—Methodological*, and he remains on the editorial boards of that and four other professional journals. He was also North American coeditor of the international journal *Urban Studies*. Small has served on several study committees of the National Research Council, examining cost-benefit analysis and the federal program on congestion management and air quality. His book, *Urban Transportation Economics*, was recently updated in a new edition (*Economics of Urban Transportation*), which has become a widely cited standard reference in the field.

Small was honored in 1999 with the distinguished member award by the Transport & Public Utilities Group of the American Economic Association, and in 2004 with the distinguished transportation research award by the Transportation Research Forum. He has advised many public and private groups including the Canadian Royal Commission on National Passenger Transportation, the European Union, the South Coast Air Quality Management District, the World Bank, and the California Air Resources Board. ■



LUCIJA ANNA MUEHLENBACHS



P. LYNN SCARLETT



KENNETH A. SMALL

interface between economics and environmental policymaking at the top levels of the federal government.

He received his B.A. in economics from the University of California at Berkeley and his M.A. and Ph.D. in economics from Cornell University.

#### **Lucija Anna Muehlenbachs**

Muehlenbachs, who joined RFF as a fellow on July 1, will pursue research on energy-related topics as part of the Center for Energy Economics and Policy. A 2002 graduate of the University of Alberta, Muehlenbachs received her Ph.D. in agricultural and resource economics in 2009 at the University of Maryland.

Muehlenbachs has used computational methods to study issues in the oil and gas industry. She has experience in structural estimation of dynamic programming models, and has estimated conventional oil and gas extraction costs as well as the probability of change in recoverable reserves, production, and prices. Her current research interests lie in financial assurance of environmental liability,

policies; and ecosystem adaptation strategies. Her research will explore the nexus of science and policy, the challenges of large landscape conservation, and the opportunities of using natural landscapes to benefit communities.

From 1982 through 2001, Scarlett held a variety of positions at the Los Angeles-based Reason Foundation, a nonpartisan public policy organization. She served briefly as president of the organization in 2001 before being appointed to the Interior Department.

After leaving government, she was named the Zurich Financial Services Distinguished Visiting Lecturer on Climate Change at the Bren School of Environmental Science and Management at the University of California, Santa Barbara. She also has been an independent consultant with the Environmental Defense Fund on issues pertaining to climate, ecosystem services, and stewardship of open lands.

She is a member of the Commission on Climate and Tropical Forests, and from 2003 to 2004, she chaired the Wildland Fire Leadership Council, an interagency, intergovernmental forum for implementing the National Fire



## RFF Receives Prestigious Award from FEEM

**R**esources for the Future was awarded the FEEM 20th Anniversary Prize in Environmental Economics at the Fourth World Congress of Environmental and Resource Economists held in June in Montreal, Canada.

FEEM (Fondazione Eni Enrico Mattei) is a nonpartisan research institution headquartered in Italy that is devoted to the study of sustainable development and objective analysis on a wide range of environmental, energy, and global economic issues. The prize celebrates the 20th anniversary of FEEM's founding in 1989. Corecipient of the prize is Martin L. Weitzman, professor of economics at Harvard University. The prizes bestow a monetary award of €10,000 to each awardee.

In awarding the prize, judges of the international competition, considering more than 90 nominations, said:

"It is difficult to think of any group of economists who have had more impact in environmental economics, particularly in terms of its extension to actual policymaking, than Resources for the Future. RFF has probably incubated more research and made more advances than any other organization by getting researchers started on careers, by supporting a distinguished staff of senior researchers, and by providing infrastructure for the profession in general.

Acknowledged as the organization that got environmental and resource economics off the ground in the '50s and '60s, RFF remains highly influential and productive in the field of research, and continues as a leader in effective interface with the policy process and in capac-

ity building. Particularly in the United States, RFF invented the field as a serious contributor to policy choices and key driver of market-based environmental policy.

RFF has pioneered the application of economics as a tool to develop more effective policy about the use and conservation of natural resources. Its scholars continue to analyze critical issues concerning pollution control, energy and transportation policy, land and water use, hazardous waste, climate change, biodiversity, ecosystem management, public health, and the environmental challenges of developing countries."

In accepting the award, RFF President Phil Sharp expressed the institution's deep gratitude and emphasized the important role that resource and environmental economics plays in helping address global challenges. RFF will use its share of the prize to support further research and continue its tradition of objective analysis.

Following the award presentation, Richard Schmalensee, a member of the RFF Board of Directors and former dean of the Sloan School at MIT, gave the session's keynote speech on the structure and merits of various renewable energy policy options. ■

## RFF Also Awarded for GIS Work

The Environmental Systems Research Institute (ESRI) presented RFF with a Special Achievement in GIS award earlier this month for our work on the Global Adaptation Atlas. The award is bestowed upon 100 organizations worldwide and signals innovative use of mapping technology and principles to improve decision and policymaking. Nominations are made by ESRI staff and partners, and personally reviewed and selected by ESRI's president, Jack Dangermond. ■

## Status Report on Biofuels: Progress, but It's Getting Harder

J.W. Anderson

**I**n light of the massive oil spill in the Gulf of Mexico, there's a rising urgency to the search for alternative fuels. Among the most prominent prospects are biofuels manufactured from renewable feedstocks. But while the first phase of substituting biofuels for gasoline has been successful, further progress will require solutions to daunting challenges.

Ethanol, the most common of the biofuels, has now replaced almost 7 percent of the country's gasoline consumption. But nearly all of this ethanol is made from corn, which raises a couple of important concerns. The first is that the enormous new demand for corn is having an impact on world food and feed markets—tolerable so far, perhaps, but not a trend that wise public policy would push much further. Second, the process of making and consuming corn ethanol produces volumes of climate-changing greenhouse gases that, per unit of energy, are not much lower than those generated by gasoline.

Congress has worked for years to advance biofuels, with the enthusiastic support of the farm lobbies. Responding to the objections about the increasing use of corn ethanol, Congress, in the Energy Independence and Security Act (EISA) of 2007, imposed an intricate set of mandates intended to force the ethanol industry to shift to sources that would not threaten food price increases and would produce less greenhouse gas emissions.

Under these mandates, refiners are required to blend 12.95 billion gallons of biofuel into the gasoline supply in 2010. (Current consumption of gasoline plus ethanol is running around 136 billion gallons a year.) Ethanol

production is currently approaching 13 billion gallons a year. So far, so good.

But the EISA also mandates a proportion of ethanol, rising rapidly over the years, to be made from sources other than corn. That's where the trouble arises. The mandate for 2010 originally required 950 million gallons of "advanced" renewable fuel—that is, not made from corn and resulting in much lower greenhouse emissions—of which 100 million gallons was to be, specifically, cellulosic. Production of advanced renewables is rising, but earlier this year the U.S. Environmental Protection Agency reduced the mandate for cellulosic fuel from 100 million gallons to 6.5 million gallons because there was no way to meet the original requirement. For 2011, the statute calls for 250 million gallons of cellulosic fuel but in July, the agency proposed to lower the figure to somewhere between 5 million and 17.1 million gallons, depending on what the market appears capable of producing later in the year.

In a survey of the prospects for biofuels published last May, the U.S. Department of Agriculture's Economic Research Service estimated that production capacity for cellulosic biofuel will rise to about 200 million gallons by 2012, although actual production will be lower because some of the plants will be experimental or demonstration facilities not designed for continuous production. The statutory mandate for 2012 is 500 million gallons.

Congress has previously used mandates in environmental legislation to force technology forward, and the tactic has had some notable successes. But in the case of cellulosic biofuels, once seen as the solution to the threat to the food supply, the technology of large-scale production is coming along a good deal less rapidly than its proponents had hoped.

### **A Chicken-and-Egg Dilemma**

The shift to greater reliance on biofuels is also inhibited by a separate challenge that the industry calls the "blend wall." Ethanol is more corrosive than gasoline, and most American cars are not designed to use fuel that contains more than a small fraction of ethanol. Currently, most American gasoline contains 10 percent ethanol,

as the signs on the pumps tell us. Whether our cars can handle higher percentages is a matter of some controversy and may become an issue in the months ahead. But at present, unless you have one of the small minority of flex-fuel vehicles, you will risk voiding the warranty on your car if you use fuel that is more than one-tenth ethanol.

It's another example of the chicken-and-egg dilemmas that bedevil the shift away from

**It's a chicken-and-egg-dilemma. Until there are more flex-fuel cars on the road, refiners have no reason to produce high-ethanol fuels. And until the fuels are widely available, car buyers have little incentive to buy flex-fuel cars.**

fossil fuels. Until there are more flex-fuel cars on the road, refiners have no reason to produce high-ethanol fuels. And until the fuels are widely available, car buyers have little incentive to buy flex-fuel cars. Because it involves consumers' habits and the inertia of America's vast highway transportation system, the blend wall may be harder to overcome than the engineering difficulties of biofuels production.

To encourage the transition to biofuels, Congress has constructed over the years a substantial structure of subsidies and protection. The most important of the subsidies is a tax credit of 45 cents a gallon of ethanol blended with gasoline.

You may wonder why Congress is subsidizing a product the consumption of which it has mandated by law. That subsidy currently costs more than \$5 billion a year and, if the ethanol program stays on schedule, the cost will triple over the next 12 years—a conspicuous target in a time of severe budget-cutting.

Domestic producers are also protected by a tariff of 54 cents per gallon of ethanol, plus an *ad valorem* tax of 2.5 percent. That's to keep out, primarily, Brazilian ethanol made from sugarcane. It is much cheaper to produce than American corn-based ethanol, yields more power per acre of crop, and generates much less greenhouse gas emissions in the cycle of production and consumption.

And beyond the subsidy and tariff issues lie broader questions about the value of the whole ethanol program. Let's make the optimistic assumption that, by vigorous public action such as tightening vehicle fuel standards, the United States can hold automobile fuel consumption to its present level despite growth of the population and the economy. In 2022, the mandated 36 billion gallons a year of ethanol would represent about a quarter of automobile fuel consumption by volume. Because a gallon of ethanol contains only two-thirds as much energy as a gallon of gasoline, it would replace about 18 percent of petroleum-based gasoline consumption compared with nearly 7 percent today.

That raises the question whether that modest reduction in oil consumption is worth the effort of adapting the highway fuel system to ethanol over the next 12 years. The larger question is whether Congress is wise to try to predict technological breakthroughs, and to steer markets toward them.

What about the tariff and the subsidy? The debate over those will come to a resolution later this year, for under present law they will expire on December 31. The case for them is weak. Energy security is improved by diversifying supply, not by economic isolationism. And the cost of the shift to ethanol is most fairly carried by the people who drive cars, not by the taxpayers. ■

# A Resource War Resurgence?

## Divining Facts and Fears in China's Energy Strategy

Joel Darmstadter

Quite apart from periodic concerns about resource scarcity that can drive up worldwide prices but are available for those able to pay, anxiety about the—literally physical—lack of critical natural resource supplies has intermittently been part of one or another nation's strategic concerns. The most recent example that has made the headlines, for reasons that aren't entirely clear, concerns China's ongoing shopping spree for energy resources.

To set the context for what's now going on in China, let's pause for a quick history lesson. Past examples of resource shortages invariably include Germany's situation during World War II, when the country's only source of petroleum—critical to its military needs—was Romania. But, with that country the target of Allied bombing, adequacy of German oil supplies depended critically on liquefaction of its abundant coal resources. Similarly, in the post-World War II years, apartheid South Africa employed advanced coal-liquefaction technology to guard against the threat of embargoed foreign oil deliveries.

In the United States, Cold War rivalry and tensions that followed the critical materials challenges of World War II prompted new fears of resource supply shortages at the highest levels and, in turn, establishment of the Paley Commission (so called after its chairman, William Paley). The commission's comprehensive five-volume effort (*Resources for Freedom: Report to the President by the President's Materials Policy Commission, 1952*) took a somber look at the "worsening relationship between our requirements and our means of

satisfying them," concluding, at the end of its work, with the chastening statement that "The evidence brought together in this report points to the breadth, depth, and complexity of the materials problem that confronts the United States and other free nations." (In turn, the commission's findings helped lead to RFF's establishment nearly 60 years ago.)

Since the Cold War did not metamorphose into the shooting kind, but also because of the robustness and efficiency of international resource trade and markets, the last six decades have, almost uninterrupted and largely successfully, warded off any serious disruption in the flow of world resources. Even the at-

tempted Arab oil embargo of 1973–1974, primarily directed at the United States, was foiled by a combination of OPEC discord and the inherent fungibility that characterizes oil and its world market network. (As the international liquefied natural gas trade begins to take on that fungibility characteristic, unsettling acts, such as Russia's episodic disruptions of natural gas exports, may similarly prove futile.)

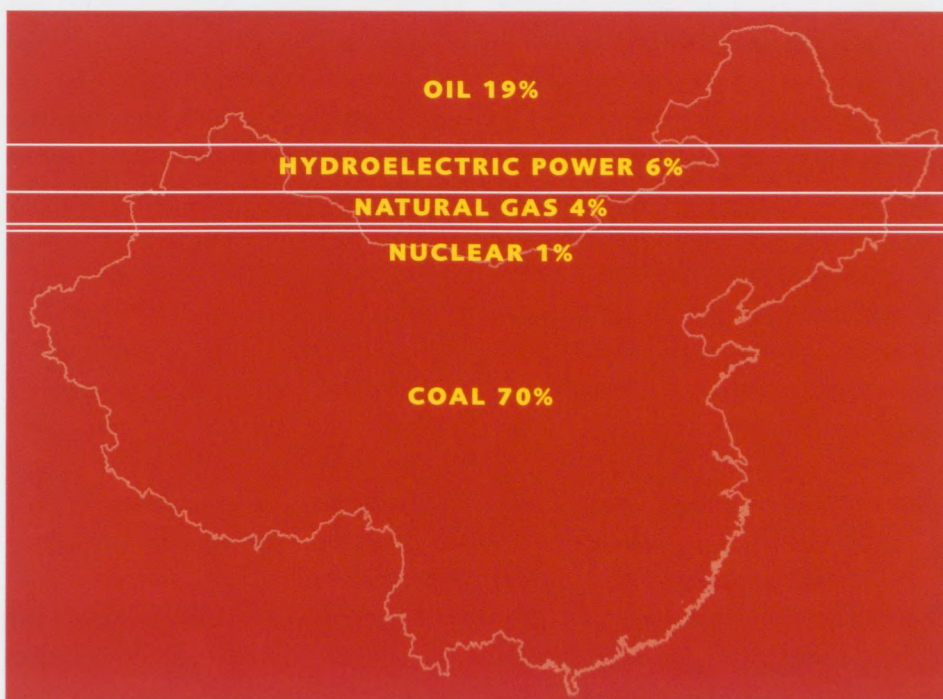
### Renewed Resource Fears

But that reassuring long-term record has evidently not foreclosed a noticeable re-emergence of concern over access to natural resource supplies. Is this development grounded in misapprehension, new realities, or perhaps some of each?

Given its size and robust economic growth, China is clearly the most conspicuous among nations showing concern about meeting their natural resource—and especially energy—requirements. (Annual GDP and energy growth of around 10 percent and 7 percent, respectively, have been China's norm for much of the past decade.) You don't have to go very far perusing the financial and business pages without encountering word of yet one more

### Total Energy Consumption in China, by Type (2009)

Source: BP. 2010. *Statistical Review of World Energy* June 2010. [www.bp.com/statisticalreview](http://www.bp.com/statisticalreview).



Chinese bid for, or acquisition of, an equity stake in some country's natural resource sector—whether in Africa, Latin America, Iraq's Kurdish area, Canada, or elsewhere. In fact, it is Canada where China's drive for acquiring access seems to be most pronounced. In just the latest such transaction (April 2010), China's Sinopec purchased a 9 percent (\$5 billion) stake in Syncrude Canada, the country's largest oil-sands producer.

Frequently, even in the less sensational press, these deals are couched in language reminiscent of wartime (hot and cold) resource anxieties. One example of such peacetime resource anxiety was reflected, not long ago, in a *New York Times* account of the China National Offshore Oil Company's purchase of an interest—the *Times* labeled it a “beachhead”—in an Argentine offshore oil company. As other such articles typically observe, the *Times* painted the deal in the context of a strategic “international drive to secure raw materials;” and, in an earlier piece, described China as having “long been scouring the globe for energy and commodities to feed its thrumming economy.”

It might make sense not just to cool the language, but to parse this investment phenomenon into some analytically separable components. (What can be readily dismissed is the prospect of China achieving market power in international energy resources, whose concentration, after all, is much greater elsewhere in the world.) On at least one level, things seem relatively straightforward. If a Chinese company successfully edges out another nation's firm in an overseas investment bid, the return on such investments will accrue to China's GDP rather than another country's. The investment may additionally expand outlets for Chinese exports and, in joint ventures, provide opportunities for capitalizing on the technological capabilities of partnering firms. Finally, a search for higher yields than those offered by investments in U.S. Treasury securities may be yet one other complementary motive.

But do these investment decisions play out under competitively transparent ground rules? Maybe an internationally level playing field can be assumed to govern Chinese negotiations

with Canadian firms. However, if Sudan lures Chinese petroleum investments with favorable exploration, royalty, and production-sharing terms, how connected might such preferential treatment be to, say, China's abstention from Security Council deliberations on Sudan's human rights record? In this and similar situations, might the host country willingly shrug off economic-efficiency losses in return for political advantages? Geopolitical expertise, no less than economic analysis, is needed to probe such possible tacit reciprocal understandings.

### **Capital Investments versus World-Market Purchases**

But even apart from such a political dimension, the matter of guaranteed Chinese resource access through foreign investments is more complicated. Unquestionably, China—like other countries experiencing energy-intensive economic growth—wants to be able to count on an abundant supply at stable prices. The key question is, how is that condition more likely to be satisfied through foreign investment than through transactions on the world market?

Let's say there's a sharp rise in the world oil price. Even if China has somehow negotiated preferential access through its stake in Sudanese, Venezuelan, Nigerian, or—for that matter—Canadian reserves and production, can it count on obtaining such supplies more cheaply than buying on the world market? Even if, in the unlikely event that country X (or a firm in country X) was obliged to accommodate Chinese demand at \$70 per barrel while the world price stood at \$90 per barrel, would not China itself face a dilemma? In so many words, yes, we can meet the needs of our domestic energy-hungry industry with a \$20 per barrel subsidy, but we'd be forfeiting a corresponding amount of revenue by not selling that barrel on the world market.

Reinforcing that argument, a 2006 U.S. Department of Energy report on the national security aspects of America's international energy requirements succinctly observed that “[e]ven if China's equity oil investments ‘remove’ assets from the global market, in the sense that they are not subsequently available for resale, these

actions merely displace what the Chinese would have otherwise bought on the open market.” But the report then reminds us as well that “[r]egardless of whether China secures its oil through equity investments or purchases on the global market, its increasing demand for these resources will continue to play a role in world oil markets (as will rising demand from other areas, such as the U.S. and India).”

In short, it seems insufficient to answer the question “What is China seeking?” the way an otherwise insightful analysis by the Federal Reserve Bank of San Francisco recently did: “One evident goal of Chinese acquisitions is access to resources, especially those China lacks.” Doesn't that simply beg the question of “With what intent?”

### **A Note on Environmental Connections**

As if these investment-and-trade strategy questions weren't tough enough, they may become increasingly intermingled with environmental issues. A Chinese firm contemplating acquisition of, say, a stake in Canadian oil sands, as mentioned earlier, must reckon on the possibility of emissions restrictions in Canada that could alter the economic and strategic calculus driving its investment decision.

Such a turn of events could hardly be surprising. After all, China finds itself under increased international pressure to improve its own environmental performance—not least, when that performance occurs under a kind of carbon-intensive “pollution haven,” with some considerable amount of investment and manufacturing activity ultimately directed to serving green foreign markets. (A cheeky *Science Daily* headline describes the broader trend—not limited to just China—as “Carbon Emissions ‘Outsourced’ to Developing Countries.”) A recent 20-year \$60 billion (U.S.) deal to supply Chinese power stations with Australian coal inspired an American academic to observe that, facing political curbs on using its coal domestically, Australian “production is going to flow where there is no restriction for using coal.”

Perhaps as a way of parrying rumblings about China's culpability in intensifying the

global warming problem, some of the country's leaders—pre-Copenhagen—pointed precisely to an estimated 30 percent of China's emissions attributable to production destined for Western consumers. This table-turning argument—that it's the West's responsibility to offset such emissions—was reported to have been sympathetically greeted by other developing countries.

### Summing Up

Looking ahead, rapid economic growth in China, India, and elsewhere could signal perhaps inescapable real price increases for energy and other resources, not to mention accompanying environmental stress. In both cases, smart anticipatory policies—in R&D, conservation, and technology—could blunt such outcomes. What seems more problematic is the logic and success of strategies to lock in or guarantee resource supply availability through investments in resource-rich countries. Given the efficacy of transactions on relatively open international energy and other resource markets over a period of some 60 years, the argument for a resurgent resource war seems therefore tenuous. Still, without more rigorous analysis of the issue, it may be unreasonable to expect the press and some in the public-policy community to, any time soon, ease up on the more single-minded and alarmist perspective on the matter. ■

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## RFF POLICY COMMENTARY

# When Fuel Taxes No Longer Get the Job Done

## The future of transportation finance

Martin Wachs



The principle of paying for roads and transit by charging those who use the system has served our nation well, but in its current form it will soon outlive its usefulness. Americans are driving more but paying less fuel tax, creating a crisis in transportation financing. For economic, environmental, and political reasons, this is the moment to transition to a new and better approach to charging for road use.

### History

Before 1920, state governments faced fiscal crises because of growing demands for infrastructure resulting from burgeoning use of autos and trucks. States could not afford to build and maintain their growing networks of roads needed to connect cities. Oregon, long an innovator in transportation finance, was the first to respond by inventing the concept of user financing. It shifted from using general government revenues, as other states were doing,

reasoning instead that drivers of trucks and cars should pay more directly for roads and bridges because users both imposed the costs of these facilities on the states and benefited from them most directly.

Tolls were seen as the most direct and appropriate form of user fee. But toll booths had to be built and staffed around the clock, even where roads carried only light traffic. The costs of toll collection in many locations could be a third or more of the revenue. In response, Oregon adopted a "second best" solution: taxes levied on gasoline and diesel fuel. Collected at a handful of wholesale distribution points and passed on to road users at the fuel pumps, fuel taxes per gallon had collection costs of only a small percentage of the revenues. Users of fuel paid more when they drove more, roughly proportional to the tolls they might have paid.

By 1940, all states and the federal government had motor fuel taxes. The federal motor fuel tax was the largest source of revenue sup-

porting development of the National System of Interstate and Defense Highways. To emphasize that user fees were not general taxes, most states and the federal government created dedicated "trust funds" into which fuel tax revenues were deposited and funds were disbursed for transportation projects.

### **A new crisis in transportation finance**

Today, antitax sentiment, combined with the high price of gasoline, makes governments reluctant to raise the per-gallon tax on motor fuels. The federal tax has been 18.4 cents per gallon since 1993. Inflation has, over time, robbed the trust fund of much of its value. Improvements in vehicle fuel economy have even more dramatically reduced the effectiveness of fuel taxes because we drive more miles than ever before per penny of fuel tax we pay. Federal regulations require that the average of all cars sold by a particular manufacturer achieve fuel economy of 35 miles per gallon by 2016. Many observers look beyond the next decade and foresee vehicles that use no petroleum at all.

We will still need to pay for road building and maintenance, but fuel taxes are no longer sufficient to get the job done. That is, of course, a good thing but for different reasons. The United States wants to reduce its carbon footprint and dependency on foreign energy sources, which clearly suggests promoting greater fuel efficiency. Under the current transport finance system, however, the government also has a dominating but conflicting interest in selling more gasoline and diesel fuel in order to raise the money it needs for highways and transit.

Unwilling to raise gasoline and diesel taxes—and faced with a federal trust fund in deficit—Congress has in recent months appropriated to the trust fund \$19.5 billion from general funds to bail out the national highway and transit programs. Charging users higher taxes on fuel would encourage the purchase of more fuel-efficient vehicles and might cause Americans to drive less, whereas increasing reliance on general funds contributes nothing to energy efficiency and adds to the ballooning national deficit.

### **A moment of opportunity**

Congress will soon debate the next multiyear transportation bill, and its recent actions have caused many to speculate that the end of user financing of transportation is in sight.

Policymakers should recognize that recent technological advances allow for the gradual introduction of user fees that more directly charge for road travel. Americans have increasingly been paying tolls electronically, using Fas-Trak and E-Zpass. In several countries trucks have for years been paying to use roads via a central billing system linked with global positioning satellites (GPS) that allows vehicles to record information on where and when they have traveled.

In Oregon, where user-fee financing was pioneered, an experiment was recently completed in which hundreds of motorists were charged for travel using devices in their vehicles that metered their travel between gasoline fill-ups. The devices tracked both the fuel tax payments that would be due and the number of miles driven since they last refueled, then calculated the difference between them. The experiment worked technically and was acceptable to the motorists who were involved.

### **A national trial of the options**

Several technologies are nearly ready that would meter travel and charge fees for road use on a national scale. But larger-scale testing is required in order to compare the technical merits of each technology and test acceptability. In principle, systems almost ready for deployment can charge per-mile road use rates for travel that differs by jurisdiction, vehicle type, road type, time of day, and even current level of service or congestion. A proposed system of user fees could also charge for automobile insurance based on miles and location of driving and provide a technological pathway for the introduction of "congestion pricing," which is advocated by many to control the growth of urban traffic.

Charging users more directly than we do today could save some travelers money while rewarding greener options such as public transit, walking, and cycling. Knowing more precisely

where travel actually takes place, the federal government could more accurately fund jurisdictions for road maintenance. Because vehicle miles of travel are growing faster than consumption of petroleum fuel, a revenue-neutral switch to vehicle miles traveled (VMT) charges would cause revenue to grow without increasing the rates charged over time. In contrast, gas taxes would have to rise over time to keep pace with inflation and road costs.

Many are concerned that VMT fees would lead to an invasion of privacy, while others worry that they will be inequitable in comparison with current methods of charging some groups of travelers, like rural residents who must drive longer distances than urban residents. Though several trials so far have been encouraging, VMT systems haven't been tested on a sufficiently large scale to know how to counter attempts at breaching privacy or security, whether they can be as reliable when operating at a national scale as in local experiments, or what the system failure rates and operating costs will be when tens or hundreds of millions of vehicles are involved.

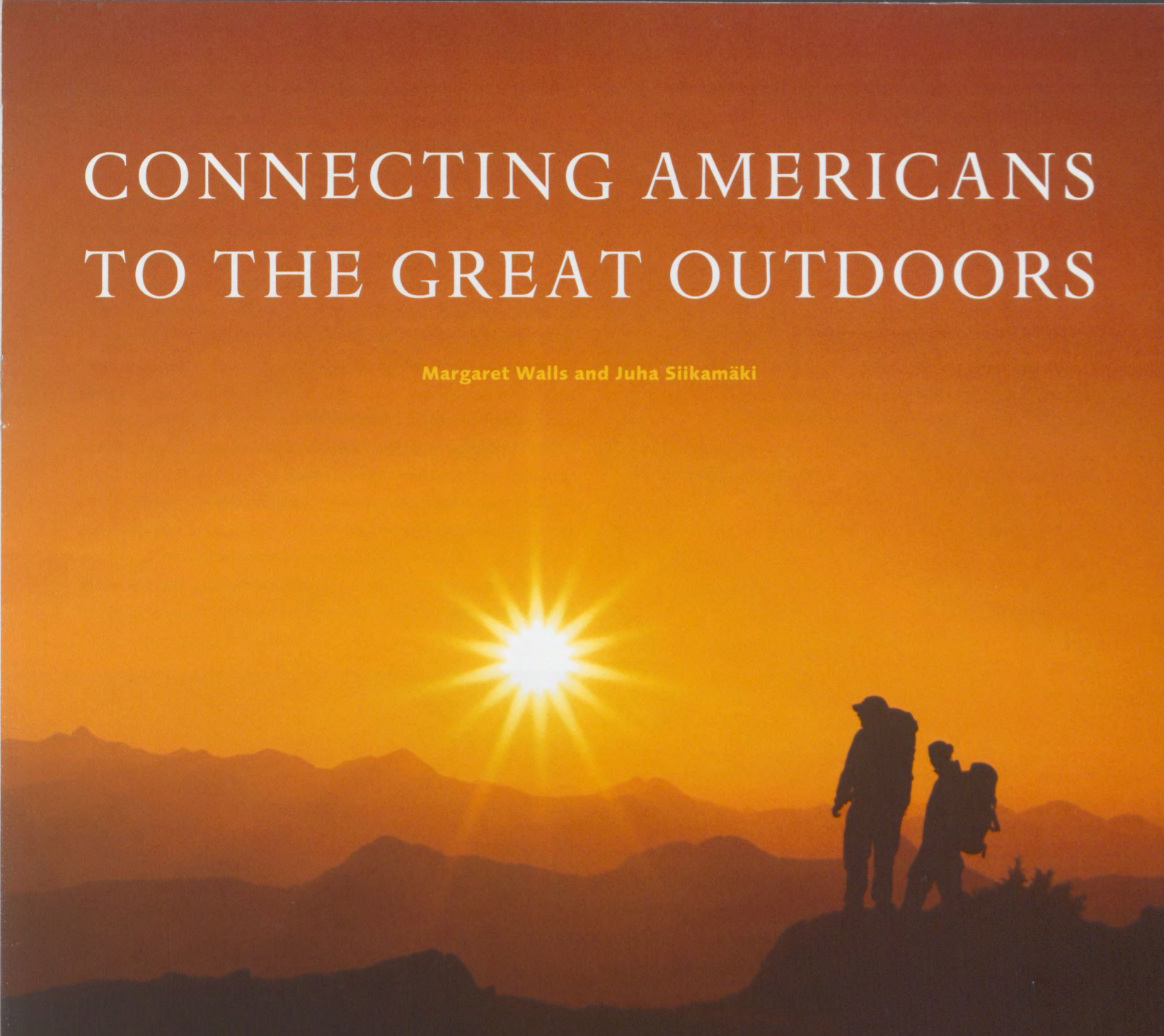
### **A time for action**

Other countries are implementing charges for trucks on the basis of VMT using GPS systems and central monthly billing. If this country is to transition to a new system of user fees, the next transportation reauthorization bill should include a program of trials at a substantial scale—perhaps one or more whole states or entire classes of vehicles. It is vital that the trial carefully evaluate at least a few of the most promising technologies.

The cost of a realistic test would be substantial, perhaps hundreds of millions of dollars. Participation might be voluntary, and costs could be shared among the federal government, states, and vehicle and monitoring equipment manufacturers. But failure to move forward might end a century of user-fee financing of transportation, just when it is most needed and most technically feasible. ■

# CONNECTING AMERICANS TO THE GREAT OUTDOORS

Margaret Walls and Juha Siikamäki



**AMERICA'S SCENIC AND NATURAL RESOURCES** have always been a source of national pride, but the evidence is mixed, if not downright missing, about how often we go outdoors, where we go, and who among us goes. Some argue that the popularity of nature recreation is steadily declining, and the author Richard Louv has even coined the term "nature deficit disorder" to describe the suggested lack of exposure to nature as a condition with a broad range of harmful consequences, in particular to kids, including health problems associated with a lack of physical activity and especially the rise in child obesity.

**A**ND THERE'S NO LACK OF CONCERN AT THE HIGHEST LEVEL: This April, President Obama signed a formal memorandum, launching the America's Great Outdoors Initiative. The primary goal is to "reconnect Americans, especially children, to America's rivers and waterways, landscapes of national significance, ranches, farms and forests, great parks, and coasts and beaches." Later this year, a cabinet-level report will be submitted to the president with a review of existing federal government and other conservation programs and a recommended strategy for achieving the initiative's goals.

We'll have to wait and see how the report addresses two emerging, linked trends that are especially relevant to the initiative. First, there has been a marked change in federal spending toward conservation, away from lands purposed for recreation and toward farmland, wetlands, and wildlife habitat. In addition, there has been a move to purchase easements (deed restrictions on land uses) on private land, where public access is often limited. Second, there is a growing shift toward private land conservation, marked by the enormous growth in land trusts over the past 20 years, in both their sheer numbers and the amount of acreage protected.

While conservation of this type may yield a variety of benefits—including wildlife habitat preservation, protection of prime farmland, management of stormwater runoff, and maintenance of view sheds—the extent to which such efforts connect Americans to nature is debatable. Private lands, even those covered by easements, are, generally not open to the public, and a significant portion of the lands protected by federal conservation programs are far from where the majority of Americans live.

So where to go from here? Should the new initiative lead to a shift in priorities, especially funding priorities? If the goal is to reconnect Americans to nature and the outdoors—and this may be a worthy goal for a variety of reasons ranging from health, environmental stewardship, and for children, basic science and nature education—what is the best use of the government's limited financial resources?

### AMERICANS OUTDOORS

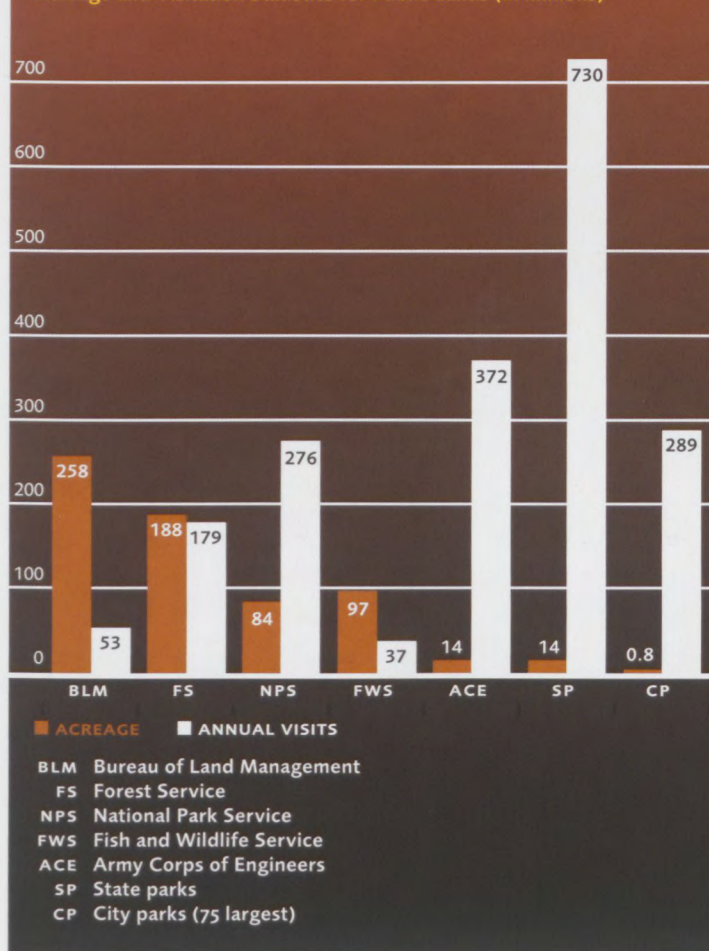
A variety of data and statistics can shed light on the degree to which Americans are connected to the outdoors. We discuss here two main sources: visitation statistics for public lands and annual time-use survey data.

Various types of public lands exhibit a remarkable consistency in visitation trends: from the late 1970s, total annual visits have remained relatively constant while visits per capita show a slight decline. This is true for lands managed by the National Park Service, Army Corps of Engineers recreation sites (which have the highest number of visitors of any federal sites), Bureau of Land Management (BLM) lands, and state parks. National wildlife refuges may be the exception to the rule: although data are available only since 1994, the

number of total refuge visits and visits per capita show a small but steady rise over time. Interestingly, many refuges are located much closer to cities than are national parks and other federal lands. With 80 percent of the U.S. population living in urban areas, understanding the opportunities for and activities of this segment of the population is critical. Unfortunately, systematic and comprehensive data on local and urban park use are unavailable. The few data that exist, from the Trust for Public Land's Center for City Park Excellence, show visits to city parks to be quite high. The 75 largest city parks in 2007 hosted 289 million visitors on just 800,000 acres of land. In contrast, the National Park Service had about the same number of visitors on 84 million acres of land, and the 14 million acres of state parks—known as highly visited natural areas—attracted 730 million visitors (see Figure 1). But more comprehensive and detailed data on urban park use are needed.

National data on time use are underutilized for the study of outdoor recreation and yield some unique insights. Data from six nationally representative time-use surveys conducted between 1965 and 2007 show that time spent in outdoor recreation and physically active leisure in general has increased substantially in the long run—

**FIGURE 1.**  
Acreage and Visitation Statistics for Public Lands (in millions)





from about 0.9 hours per person per week in 1965 to 2 hours per person per week in 2007—but that most of the increase occurred by 1993; since then the numbers have declined. The participation rate—that is, the percentage of the population that participated in outdoor recreation on any given day—rose sharply between 1965 and 1985 but has held steady since then.

Our analysis of the data yielded several interesting demographic findings. For one thing, men spend about 70 percent more time in outdoor pursuits than women. For another, more education tends to lead to more time spent on outdoor recreation. And households without children spend more time in outdoor recreation than those with children.

One of our most important findings has to do with leisure time availability: the more leisure an individual has, the greater the likelihood she participates, and the more time she spends, in outdoor recreation. Overall, a 10 percent increase in leisure time leads to about a 6.5 percent increase in time spent in outdoor recreation. Some experts have argued that a decline in the availability of leisure in recent years, particularly leisure that comes in large blocks of time, has led to a decline in visits to national parks and other sites located far from population centers.

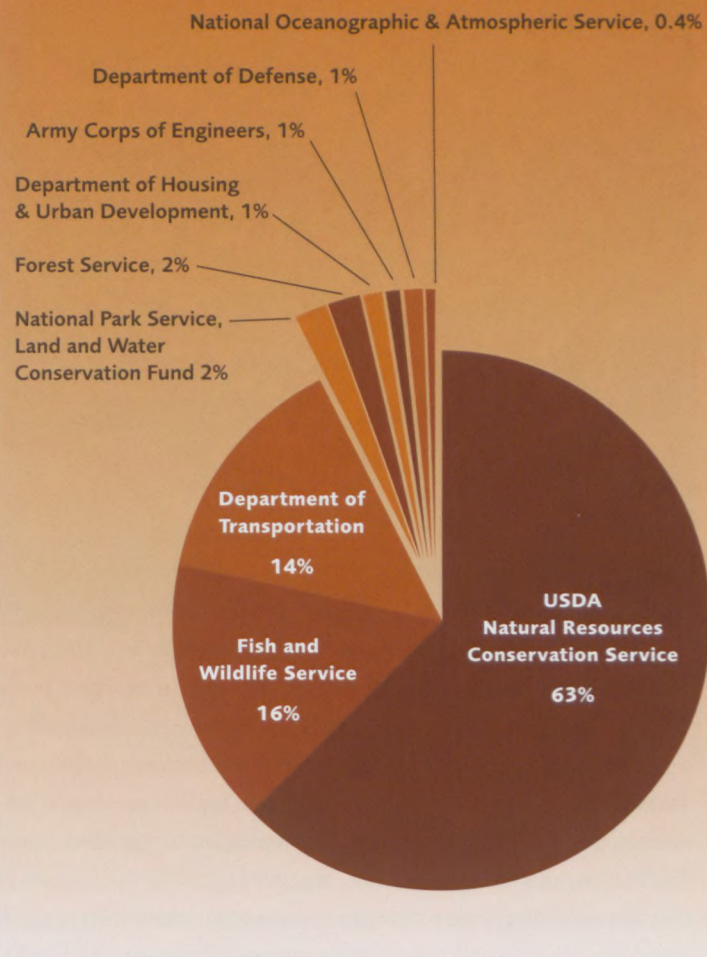
#### GOVERNMENT FUNDING

Many of the public lands that support outdoor recreation were created with an important source of federal funding, the Land and Water Conservation Fund (LWCF). Initiated in 1965, the fund has permanently protected over 7 million acres of land through direct acquisition, either by the federal government or by state and local governments that receive LWCF grant money. Substantially more has been statutorily protected through development projects built with LWCF funds. For the first 15 years of the program, annual LWCF appropriations averaged \$1.23 billion in inflation-adjusted 2008 dollars; 54 percent of that money went to state grants. Since the early 1980s, however, appropriations have declined significantly as has the share going to states. LWCF appropriations in FY2008 totaled \$255 million, with less than 10 percent of that going to states. State grants currently are so low that many states do not bother applying for them. Funding has also been diverted to other uses besides land acquisition in recent years.

As the LWCF has declined in importance, the entire landscape of funding for conservation and recreation has shifted. Over 30 other programs besides the LWCF now exist at the federal level for funding land conservation activities, many initiated in the 1990s and 2000s (Figure 2). The programs deal with habitat conservation and restoration, development of trails, urban parks, wetlands, forests, and farmland and are managed by nine different agencies. They are funded in a variety of ways and the money is spent in different ways. The bulk of it, however, is spent on the programs specified in the Farm Bill. The Department of Agriculture received nearly 63 percent of the

**FIGURE 2.**  
Funding for Federal Conservation and Recreation Programs by Agency

Note: Data are from FY2008. All sources available in Walls, Darley, and Siikamäki (2008).



money spent on conservation-related activities in FY2008, and the Conservation Reserve Program (CRP) was the largest single federal program, with a nearly \$2 billion annual budget. It is important to point out that the CRP keeps land in private landowners' hands, does not permanently protect land from development, and does not require landowners to allow public access. (A program in the most recent farm bill provides some funding to encourage that.) The Fish and Wildlife Service accounted for 16 percent of all spending in FY2008; most of this money goes toward habitat protection, particularly for migratory birds. The Department of Transportation's Recreational Trails and Transportation Enhancements programs received 14 percent of all conservation and recreation appropriations in FY2008.

In addition to federal funding programs, many states have created their own conservation funding programs and tax incentives over the past 20 years. Our research identified 79 programs in 43 states totaling \$3.3 billion in FY2008. In addition, 15 states provide income tax credits for conservation land or easement donations. With one exception, all of the tax credits have been adopted since 1999.

Finally, at the local level, many communities have turned to the voters with referenda. In 2008, \$8 billion was approved for a variety of conservation spending programs.

### IN PRIVATE HANDS

Conservation land trust is the catch-all term for a nonprofit and non-governmental organization that acquires and protects land from development. Although the earliest land trusts were established in the 1800s, they have emerged in recent years as central actors in land conservation. They work to protect wilderness areas, historically important areas, wildlife habitat and natural areas, and working farms and forests.

Land trusts obtain real estate from landowners who sell or donate conservation easements, or by outright purchases of property. They include large organizations such as the Nature Conservancy and the Audubon Society, but many are formed by relatively small organizations operating at community, state, or regional levels. According to the Land Trust Alliance (LTA), nearly 1,700 local land trusts operated in the United States in 2005, the most recent year for which data are available. The number has increased gradually, nearly doubling during the last 10 years. The land area protected has increased more rapidly, from about 6 million acres in 2000 to 12 million acres in 2005—nearly the size of the state of Maryland (see Table 1).

Much of the increase in the areas protected by local land trusts comes from the growing use of easements and other contractual arrangements rather than through direct purchases. As of 2005, only about 14 percent of the total area conserved by local land trusts is in their ownership; the rest is under conservation easements (53 percent) or has been protected by other means (33 percent), such as acquisition by other organizations or agencies. An easement purchase poses a smaller financial burden for a land trust than a purchase of land itself, thus the movement toward easements is understandable. As with the shift in federal funding, though, these lands are not usually a substitute for the kinds of projects supported by the LWCF.

### SETTING PRIORITIES FOR THE FUTURE

As the America's Great Outdoors Initiative moves forward, it will probably do so in an era of fiscal austerity. Large new spending programs are unlikely without dedicated sources of revenue. This makes priority setting especially important.

In our view, two things are needed in order to establish those priorities. First, we need better information about and analysis of the extent of the "nature deficit" problem. On the one hand, polls routinely show that Americans value land conservation and protection of open space. The high approval rate of voter referenda—76 percent have passed since 1990—supports that view. But how does this square with the fact that an average person probably spends less and less time in outdoor pursuits? Second, we need to review our current programs—federal, state, local, and private—and carefully catalogue what we're getting for our money and where the gaps lie. Does the mix of farmland, wetlands, trails, and parks seem to be in balance? What about the geographic distribution of protected lands? What about the distribution between private lands and public? And to what extent are we providing funds for management of the lands we have versus acquisition of more? Operations and maintenance budget shortfalls have been well documented.

Since the quality of our open spaces and recreation lands may be as important as the quantity, revisiting this aspect of spending is critical. Much of our outdoor recreation policy and infrastructure was shaped already decades ago, and it may be time to realign them to better reflect today's needs. But before we can do so, we must better understand what those needs are. ■


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TABLE 1.  
Total Acres in Local, State,  
and Regional Land Trusts in  
2000 and 2005

Conservation method	2000		2005		Increase 2000–2005	
	ACRES	PERCENT	ACRES	PERCENT	ACRES	PERCENT
Ownership	1,219,632	20	1,703,212	14	483,580	40
Easements	2,514,545	42	6,245,969	53	3,731,424	148
Other means	2,322,447	38	3,940,928	33	1,618,481	70
<b>Grand total</b>	<b>6,056,624</b>	<b>100</b>	<b>11,890,109</b>	<b>100</b>	<b>5,833,485</b>	<b>96</b>

Source: Land Trust Alliance 2006



# *Abundant Natural Gas Could Mean a Paradigm Shift in U.S. Energy Markets and Policy*

STEPHEN P.A. BROWN

In recent years, the outlook for U.S. natural gas markets has changed dramatically. As recently as 2008, most forecasts showed the United States growing increasingly dependent on imports of liquefied natural gas (LNG). But some new assessments show that North America is awash in natural gas resources, with estimates of shale gas resources more than doubling since 2007, while estimates of conventional natural gas resources remained steady.

This paradigm shift began more than a decade ago with the gradual development of new technologies that provided access to resources that were previously considered too expensive to produce. Low-cost coalbed methane in the San Juan Basin of Colorado and New Mexico was first. Next came new techniques for the development and production of natural gas in tight sand formations in western Wyoming. Finally, several major shale gas fields were opened up: the Barnett shale in Texas, Horn River (British Columbia), Marcellus (Pennsylvania, New York, and West Virginia), and Haynesville (Arkansas and Louisiana).

Greater shale gas resources promise big changes in U.S. energy markets, including permanently lower natural gas prices and increased self-sufficiency in natural gas. More natural gas will also enhance opportunities to reduce carbon dioxide (CO<sub>2</sub>) emissions and increase energy security by substituting natural gas for other fuels, such as coal and petroleum. In some cases, the increased use of natural gas would require new technology and infrastructure development.

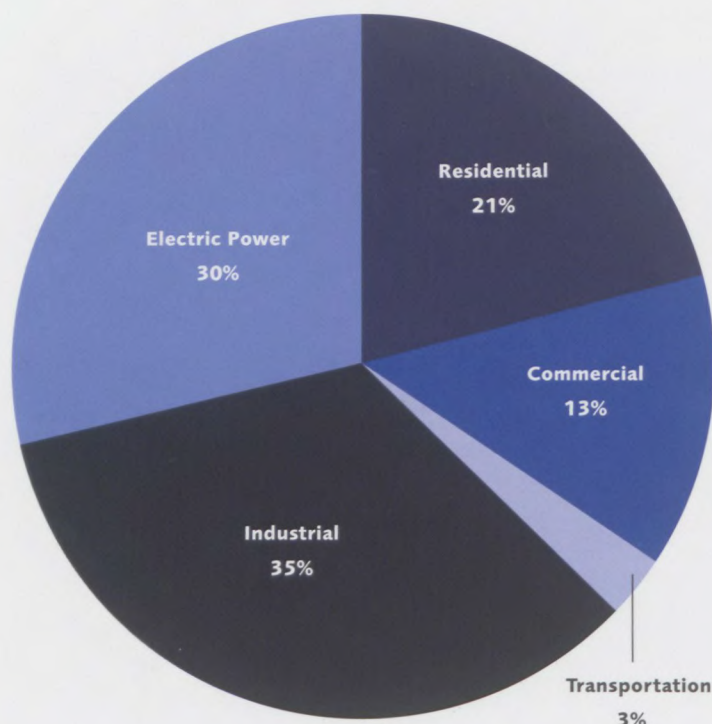
Although estimates of shale gas resources are favorable, considerable uncertainty exists because the industry cannot yet well predict how resources in the ground translate into future yields. In addition, numerous environmental concerns have been raised about its development and production. A cautious approach would be to design any climate or security policy in a way that is robust across different projected futures.

## *Advances in Technology*

Although natural gas has been produced at low rates from shallow, permeable shale formations in Appalachia, Michigan, and Colorado for decades, the oil and gas industry also has been long aware of the natural gas resources trapped in deep shale formations. Ranging 5,000 to 10,000 feet below the surface, deep shale gas formations are characterized by low permeability that naturally impedes the flow of natural gas out of the formation through the borehole to the surface and raises production costs.

What has changed is the development of a new combination of horizontal drilling and fracturing techniques that greatly increase access to deep shale gas formations and yield high rates of natural gas production. Horizontal drilling involves first drilling downward then turning to create a long, horizontal bore through the underground structure holding natural gas. This horizontal borehole increases exposure of the resource to an outward passage. After the horizontal borehole is created, the next step is hydraulic fracturing—

FIGURE 1.  
U.S. Natural Gas Consumption by Sector, 2008



which is most commonly accomplished by forcing a combination of water, sand, and chemicals into the borehole. This procedure further opens up the structure and increases the natural gas flow into the horizontal borehole, in which the gas collects before it is brought to the surface.

### *Environmental Concerns*

Although estimates of shale gas resources are rosy, the industry has limited experience in actually producing shale gas and cannot yet well predict how resources in the ground translate into future yields. Environmental concerns and the prospects for additional environmental regulation add to the potential uncertainty about future shale gas production.

The organic and inorganic chemicals used to supplement the fluids used in hydraulic fracturing and the contaminants in the associated water produced with the natural gas are among the primary concerns. The industry has resisted disclosing their chemical additives for proprietary reasons, but the natural contaminants include various salts (mostly sodium chloride) and benzene (a powerful industrial solvent thought to be carcinogenic). If these chemicals or contaminants are accidentally spilled or leak into groundwater as a result of faulty preparation of the drill hole, the harm can be severe. Similar problems arise in the context of deepwater drilling for oil and natural gas, as the recent horrendous oil spill in the Gulf of Mexico attests.

Although the Obama administration has instituted a six-month moratorium on deepwater offshore oil exploration, the development of shale gas resources is mostly regulated by state environmental and resource agencies. In a move that was widely anticipated, New York State recently banned the development of shale gas resources in the watershed that provides much of New York City's drinking water. Drilling in most other areas continues under varying state regulations.

EPA is taking steps toward registering and regulating the chemicals used in hydraulic fracturing. Industry sources variously say that should EPA regulation materialize, it could have no effect, could slightly increase the cost of producing natural gas from shale formations, or could completely shut it down. The likely effects could vary greatly by area.

### *U.S. Awash in Natural Gas*

Natural gas already plays an important role in U.S. energy use, and it is widely used throughout the economy. Ranking second only to oil, natural gas accounted for nearly 25 percent of total U.S. energy consumption in 2009. While oil and coal usage is concentrated in transportation and electric power, respectively, natural gas is used across a variety of sectors in the U.S. economy. The industrial sector is the largest, accounting for nearly 35 percent of total natural gas consumption (as shown in Figure 1). The electric power sector accounts for nearly 30 percent. The residential and commercial sectors account for 21 percent and 13 percent, respectively, and a small amount is used in the transportation sector.

Greater natural gas supplies could considerably enhance the fuel's role in the U.S. energy mix. As might be expected, a larger supply would yield lower projected natural gas prices (Figure 2), resulting in a strong gain in U.S. natural gas consumption—nearly 11 percent above a baseline scenario in 2030 (Figure 3). The biggest jump would be in the electric power sector, which shows 22.5 percent greater use of natural gas, due primarily to the substitution of natural gas for other energy sources. Some of the gain would come from increased electricity use brought about by lower electricity prices.

### *International Implications*

According to my analysis, more abundant shale gas supplies could put the United States in a position of being a net exporter of natural gas by 2030, rather than a net importer, as is projected by the U.S. Energy Information Administration. Between now and then, U.S. natural gas imports would be substantially lower than previously projected. Even if the United States does not become a net exporter of natural gas, its reduced imports are already having profound effects on the world natural gas market.

Suppliers around the world had been gearing up to supply LNG to the United States—by developing new liquefaction facilities, export terminals, tankers, import terminals, and regasification facilities. But abundant supplies and depressed prices in the U.S. natural gas market have kept out and will keep out nearly all of that LNG. Natural gas producers worldwide are facing substantial pressure to reduce prices below those set in existing contracts indexed to crude oil prices.

### Pursuing Climate Policy

We might expect more abundant natural gas to reduce overall U.S. CO<sub>2</sub> emissions because the emissions from natural gas are about 45 percent lower per Btu than coal and 30 percent lower than oil. But markets don't always conform to our expectations. In the absence of federal regulation to reduce such emissions, abundant natural gas supplies seem likely to have little effect on U.S. CO<sub>2</sub> emissions. While lower natural gas prices push coal out of the way, some zero-

carbon (nuclear and renewable) electric power sources also would be displaced. In addition, market interactions reduce projected prices for all energy resources. The combined effect is to boost the projected energy consumption for 2030 by slightly more than 1 percent and the projected CO<sub>2</sub> emissions by slightly less than 1 percent.

With a federal climate policy in place, however, abundant natural gas could moderately lower the cost of reducing CO<sub>2</sub> emissions by displacing more coal from the electric power sector and limiting gains in the projected use of nuclear and renewable power generation (Figure 4). These changes translate into a reduction in climate policy costs that amounts to about \$30 million in 2012 and rises to about \$300 million in 2030.

### Climate Policy Outside the Power Sector

Opportunities for switching between natural gas and higher-carbon fuels (mostly oil products) currently seem to be limited in the transportation, industrial, residential, and commercial sectors. Conse-



**FIGURE 2.**  
U.S. Natural Gas Prices

- Historical
- Without Abundant Shale Gas
- With Abundant Shale Gas

Sources: EIA and NEMS-RFF Projections



**FIGURE 3.**  
U.S. Natural Gas Consumption and Production

- Historical Consumption
- Consumption with Abundant Shale Gas
- Consumption without Abundant Shale Gas
- Historical Production
- Production with Abundant Shale Gas
- Production without Abundant Shale Gas

Sources: EIA and NEMS-RFF Projections

quently, reducing CO<sub>2</sub> emissions in those sectors seems likely to depend more heavily on energy conservation, and introducing a low-carbon policy in the absence of other changes could reduce rather than increase their projected natural gas consumption.

Changes in these sectors could enhance the use of natural gas in the pursuit of climate policy, but there are challenges to overcome. In the transportation sector, the deployment of new technology is required. For example, heavy trucks might use LNG instead of diesel fuel. The greater use of electric or plug-in hybrid autos would allow the substitution of electricity generated with natural gas for gasoline. These technologies are less affordable and lack a supporting infrastructure, such as LNG refueling stations and electric vehicle charging stations.

For the industrial sector, the conventional wisdom is that “everyone who can switch from oil to natural gas has done so.” In the residential and commercial sectors, a lack of infrastructure makes it difficult for the few using heating oil to switch to natural gas. Easing any and all of these barriers could enhance the role of natural gas use in climate policy in ways that are not currently foreseen.

### Pursuing Energy Security

Without increased shale gas resources, the United States was on a path to increased dependence on imported natural gas—both through pipelines from Canada and LNG cargos from around the world. Expectations of increased LNG imports suggested the United States was facing small but growing energy security issues related to the potential disruption of its natural gas supplies. Greater re-

liance on domestic shale gas sources reduces such concerns.

Using domestic natural gas supplies to further enhance U.S. energy security depends mostly on displacing oil consumption. Oil consumption exposes the United States to security externalities that are associated with the economic losses arising from the oil price shocks that result from disruptions in world oil supplies. The possibilities and obstacles for using natural gas to displace oil to enhance energy security are the same as for climate change.

### Uncertainty and Policy

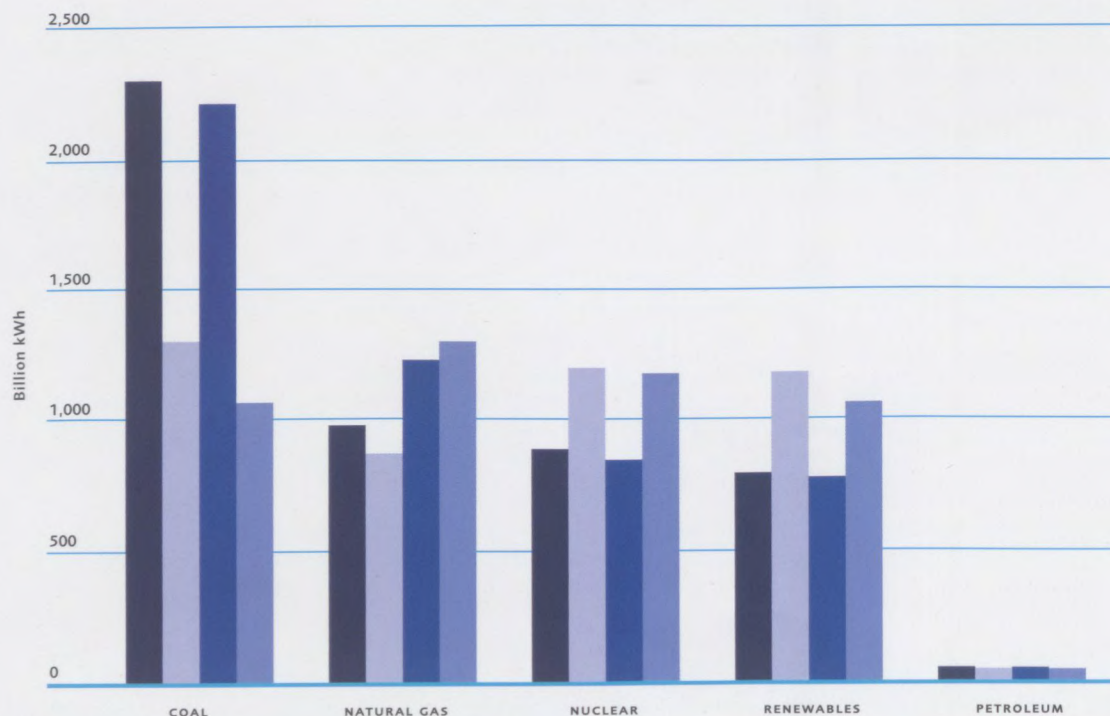
Uncertainty about shale gas resources has implications for climate and energy security policy because policies that mandate the use of specific fuels or technologies require accurate predictions about future resource availability and technology change to be cost-effective. However, policies that provide pricing, such as cap-and-trade systems or taxes, do not require such accurate predictions.

Pricing CO<sub>2</sub> emissions and the security externalities associated with oil dependence will give market participants an incentive to seek out the most cost-effective means for reducing CO<sub>2</sub> emissions and oil dependence, which makes such policies robust across different projected scenarios. If natural gas is as abundant as recent estimates of shale gas resources suggest, reliance on market-based climate policies will favor its use. If it proves less abundant, market-based policies will yield other means for reducing CO<sub>2</sub> emissions and oil dependence. Either way, a combination of policy and market incentives will yield the lowest-cost approach to reducing CO<sub>2</sub> emissions and oil dependence. ■

**FIGURE 4.**  
Electric Power Generation  
by Source, 2030

- Low Gas, No Climate Policy
- Low Gas, Climate Policy
- High Gas, No Climate Policy
- High Gas, Climate Policy

Source: NEMS-RFF Projections



**A**t this writing, the full scope of damages arising from the April 20 explosion of the BP *Deepwater Horizon* oil rig in the Gulf of Mexico—and the massive oil spill—are not yet known but have already far exceeded those from 1989's Exxon *Valdez* incident. How do you put a price on marine damages from events like these? Ecosystems produce wealth, but we often take that wealth for granted because it is freely available to us. But when ecological wealth is lost, people suffer. Gulf communities—in particular those that depend on fisheries and tourism—are painfully aware of this. However, ecological damages of this scale are also likely to trigger broader “ripples” of damage that will not be apparent for years.

In the recent words of Alaskan trustees working on the aftermath of the Exxon *Valdez* spill: “Through hundreds of studies conducted over the past 20 years, we have come to understand that the Prince William Sound ecosystem is incredibly complex and the interactions between a changing environment and the injured resources and services are only beginning to be understood.”

It is worth reflecting on why this is true. Many marine accidents result in damages over a wide geographic area (in the *Valdez's* case, 200 miles of shoreline were obviously affected, but measurable biological effects have been found over 1,300 miles of coastline) and over long time periods (20 years after the spill, fewer than half the species affected have recovered to prespill levels).

The effect on water quality of such a spill can have a range of side effects that develop over a period of years or decades. In the short term, oil spills will deplete herring and other cornerstones of the marine food chain. In turn, this effect on food stocks affects the viability of species dependent on them. These biological effects can take years to play out and, in turn, human uses dependent on these ecological endpoints may be affected for years as well.

### Legal Recourse

Marine vessel, terminal, and harbor operations can generate a range of legal damages arising from liability for response and cleanup costs, damages to private property, and damages to public natural resources. Public resources that can be affected include water quality, beach and other coastal recreational resources, coral reefs, commercial and recreational fisheries, sea grass beds, and habitats for bird and other animal populations. They are in the public domain, neither owned nor traded, but nonetheless clearly economically and socially valuable.

Liability for lost public goods and services is an established legal principle in this country. In U.S. waters, owners and operators can be held liable for natural resource damages (NRDs) and must “make



# How Do You Put a Price on Marine Oil Pollution Damages?

James W. Boyd

the environment and public whole" following a pollution event. In economic terms, this means calculating monetary damages equivalent to the social benefit lost as a result of a release, grounding, or other marine event.

At a conceptual level, NRDS require us to measure lost ecological wealth. Doing so requires knowing two things: how natural systems produce valuable biophysical goods and services, and the values of those goods and services.

Within ecology and economics, *assessment of ecosystem goods and services* is a growing area of inquiry. Broadly put, ecosystem services refers to the dependence of economic wealth and human well-being on natural systems. While the promise of a cohesive framework for assessing all types of damages is not yet realized, many scholars are working toward this goal through more rigorous conceptualization and communication of the links between changes in natural systems and effects on human welfare.

Such a framework is a powerful tool for calculating natural resource damages (and marine damages specifically). Lost ecosystem goods and services are the right metric to internalize social costs and make the public whole following a marine pollution or damage incident. Given this equivalence between damages and lost goods and services, the calculation of marine damages can and will hinge on the degree to which ecosystem goods and services can be understood and valued.

Widespread confusion exists over how to account for ecosystem goods and services that are lost or gained. Complex natural systems stymie the search for clear causal relationships between a spill and many of the damages they cause. This leads to legitimate disagreement over the magnitude of legal liability.

But just because damages to food webs (and long-run fishery productivity) or coastal marshes (and their ability to prevent flooding) are difficult to precisely quantify does not mean those damages aren't real and economically significant. The discipline of treating natural systems as sources of wealth provides a guide to the kinds of information and analysis necessary to establish ecologically and economically defensible damages.

### Natural Resources in the Public Trust

Natural resource damages are physical damages to land, fish, wildlife, biota, air, water, and groundwater. They typically relate to adverse changes in the health of a habitat or species population and in the underlying ecological processes on which they rely. The analytical challenge is to convert these physical damages into the economic consequences of that damage. To do so requires understanding of the larger biophysical system of which the damaged resource is a part.

Liability for events that damage resources is established in the United States under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Oil Pollution Act

(OPA), and the National Marine Sanctuaries Act (NMSA). Earlier, the Deepwater Port Act of 1974 and the Clean Water Act amendments of 1977 introduced NRD liability to U.S. federal law. These statutes create a compensable monetary liability for damage, which in turn requires calculation of the monetary value of the damage.

Restoration, assessment, and settlement of NRD claims are undertaken by federal, state, and tribal trustees. Only governmental trustees can seek natural resource damages, though private plaintiffs—if they can show a concrete harm to a legally protected, collective interest in a resource—can compel action on the part of these trustees. Injury to a natural resource alone is insufficient to establish liability.

For example, under the OPA, the National Oceanic and Atmospheric Administration is the federal trustee for claims arising from marine injuries, while the U.S. Department of Interior is responsible for claims arising under CERCLA. Rules guide the agencies' respective NRD assessment procedures and act as a blueprint for the determination of appropriate restoration actions and damages.

In practice, calculation of natural resource damages has proven difficult and controversial. When economic value is lost in a market setting, damages can be based on production, inputs, inventories, sales, and price data. Pertinent economic data already collected by both private firms and governments are available as a basis for the damage calculation. NRDS, by definition, are damages to public goods for which market data are not available.

A further, and more serious, complication is the need to understand how physical damages to a given resource damage other parts of the biophysical system. For example, ship "groundings" that damage sea grass beds also damage the species that rely on sea grass for habitat. Similarly, oil spills don't just create oily beaches, they also disrupt a broader range of ecological processes that ultimately can affect wetlands, commercial fisheries, recreation, and species abundance for years to come, as news reports about the ruptured BP oil well in the Gulf of Mexico attest.

### Current Damage Assessment Practices

Government trustees understandably have found it difficult to measure lost ecosystem goods and services. As an alternative, agencies have focused on a more practical route to damages: namely, reliance on resource replacement cost as the measure of damages. For example, if an oil spill damages sea grass, the objective is to replace the sea grass. What does it cost to replace the sea grass? That "procurement cost" becomes the measure of damages. Superficially, this strategy avoids the need to measure lost social wealth, since the point is to simply "replace the wealth" via restoration. And clearly it is much easier to solicit restoration bids and use those monetary costs as a concrete focus in damage negotiations (as opposed to conducting a broad ecological and economic assessment of lost goods and services).





AP PHOTO/ERIC GAY

There are drawbacks to this approach, however, the most obvious being that replacement costs have nothing to do with the actual social damage that has occurred (the benefits of goods and services forgone). In some cases, replacement costs may vastly exceed the social damages they are meant to repair. In other cases, replacement costs may vastly underrepresent the social damages caused by the proximate injury.

A damaged sea grass bed or coral reef may be restorable at an estimable cost. But it is possible that the bulk of social costs arise from damages to other resources dependent on the sea grass or coral reef. If these resources are not replaced—as is generally the case—replacement costs may fall significantly short of the real social damage. In either case, replacement cost as the damage measure fails to achieve the main legal and economic principle in play: the desire to have polluters internalize the full costs of their behavior.

### Ecosystem Services Assessment

Ecosystem services are the benefits of nature to households, communities, and economies. The term is interpreted in a variety of ways but conveys an important idea: ecosystems are a tangible source of economic wealth. This is intuitively obvious and consistent with the entire concept of resources in the public trust. What is less obvious is how that wealth is to be measured.

Because environmental goods and services are not traded in conventional markets, economists lack information on the prices paid for those goods and services—we don't explicitly pay a price for the glorious view. Of course, just because something doesn't have a price doesn't mean it is not valuable; the challenge, then, is to get people to reveal the value they place on it.

There are two ways to carry this out. First, we can get people to

state their preferences by asking them questions designed to elicit value. Second, we can look to people's behavior and infer natural resource benefits from that behavior. Houses near beautiful scenery sell for more than houses without scenery, for example. When people spend time and money traveling to enjoy natural resources, they signal the value of those resources or reveal their preferences.

Determining the units or the quantities people place value on is another challenge. A grocery store is full of cans, boxes, loaves, and bunches; the number of these units bought yields a set of quantity measures to which prices can be attached. But public, nonmarket environmental goods and services don't come in convenient quantifiable units. Put another way, what are the physical damages that can be attached to economic losses?

Ecosystem services analysis explicitly demands a linkage between ecological outcomes and economic consequences. It is important to get the units right—or at least be able to clarify why we use the units we do. The challenge lies in disentangling complex natural systems into more discrete commodity units so that natural scientists and economists can use the same terms to describe ecological changes in the same way.

### Conclusion

Measuring ecosystem goods and services is not easy and it is often not practical except where funding for large-scale monitoring and statistical assessment is available. However, development of these methods is proceeding. When the physical and social sciences of ecosystem goods and services evaluation develop into a more mature phase, the implications for marine liability damages will be direct and material to plaintiffs, trustees, and the courts.

A positive outcome of the disaster would be the deployment of more comprehensive ecological monitoring of conditions in the Gulf and other marine systems.

The insights and principles behind ecosystems services research are of immediate relevance to trustees who want to be in a position to calculate the most accurate damages possible (in order to serve the deterrent and compensatory goals of liability law). Assessment based around ecological endpoints will lead to more coordinated, comprehensive, and cost-effective biophysical and economic analyses of damages.

But it deserves emphasis that the ecological and economic damages caused by the BP *Deepwater Horizon* spill are likely to be very significant and far-reaching, even if they are difficult to calculate with precision. This leaves us with a knotty question for public policy and the courts: how do we appropriately penalize a polluter when we may never actually know the damages they caused? A meaningful penalty is surely called for. But given current scientific and economic knowledge, the scale of that penalty is more likely to be resolved by Congress than by scientists. ■

## In Memoriam

### Two RFF scholars, one a former chairman of the RFF Board of Directors, recently passed away

**M. Gordon "Reds" Wolman**, a pioneer environmental scholar and champion of interdisciplinary environmental education, died February 24, 2010, at the age of 85.

Wolman, who chaired the RFF Board of Directors from 1979 to 1987, was long recognized for his distinguished work on the evolution of rivers and their influence on land use, water resources management, floodplains, and urbanization. A native of Baltimore, Maryland, he was an outspoken advocate for restoration of a cleaner Chesapeake Bay.

Known by the nickname "Reds" because of his shock of carrot-hued hair, Wolman's re-

search provided fundamental understanding into the nature of riparian ecosystems. As a scientist at the U.S. Geological Survey in the 1950s, he and colleague Luna Leopold published pioneering studies on the new science of geomorphology, which examined landform evolution.

By measuring rivers' characteristics, their work made it possible to predict how natural and human-caused perturbations might affect river channels. Their 1964 book, *Fluvial Processes in Geomorphology*, cowritten with John Miller, is considered a seminal work.

As RFF chairman, Wolman guided the institution at a key period of the modern environmental movement as well as at a critical point in the history of RFF. He emphasized the importance of studying earth sciences, energy,

and ecological change from a quantitative rather than descriptive discipline, and brought a wide diversity of disciplines to the RFF staff.

At the April board meeting, a resolution was passed in honor of Reds' many contributions to RFF and the field.

"Reds successfully led RFF through a crucial period and helped it become a vibrant contributor of objective research that has a real effect

on policy," said Robert Fri, now a visiting scholar and president of RFF when Wolman was chair. "Believe me when I say that this outcome was often in doubt."

RFF Senior Fellow and Research Director

Molly Macauley recalls the values that Wolman inspired in younger researchers. "When I saw Reds in action, I found his humor, warmth, and intellectual agility a wonderful influence on my own work," said Macauley. "He eagerly tackled problems for which academic research could make a difference. I thought, 'When I grow up, I want to be like him'."

For many years, Wolman was a professor in the Department of Geography and Environmental Engineering at Johns Hopkins University, where his father also taught and who was regarded as one of the world's leading experts on clean water. Wolman was a member of the National Academy of Sciences and in 2006 was awarded the prestigious Benjamin Franklin Medal in Earth and Environmental Science.

**Lincoln Gordon**, a prominent political economist, foreign policy expert, and educator, died December 19, 2009, at the age of 96. Gordon served as an RFF senior fellow for several years during the latter portion of the 1970s.

Gordon was widely known as an expert on Latin America and served as ambassador to Brazil from 1961 to 1966. He later was president of Johns Hopkins University from 1967 to 1971.

His work at RFF, including coauthorship of the study *Energy Strategies of Developing Nations* (1981), focused on energy and national security, drawing in part on his experience as a consultant to the UN Atomic Energy Commission and as a White House economic adviser in the Kennedy and Johnson administrations.

In later years, Gordon was associated with the Brookings Institution. ■



M. GORDON "REDS" WOLMAN



LINCOLN GORDON

## 2010 RFF Interns



Every summer, interns come from around the world to work with the RFF research staff. Pictured from left: (back row) Meidan Bu (this year's Walter O. Spofford, Jr., intern), Julian Secomb, RFF President Phil Sharp, Erica Leavitt, Jenny Kim, and Nisha Deolalikar; (front row), Sarah Siedschlag, Karen Corey, Tara O'Shea, and Alexandra Mitukiewicz.

Not pictured: Evan Herrstadt, Kristjen Lundberg, Nick Magliocca, Natasha Plotkin, Yuna Sakuma, Karl Schurter, Lova Sun, Rich Sweeney, and Katie Whitefoot.

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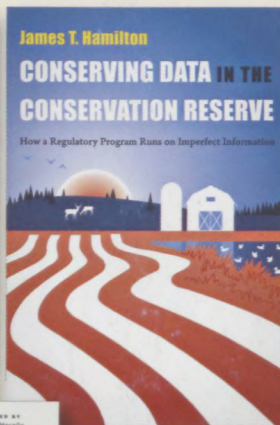
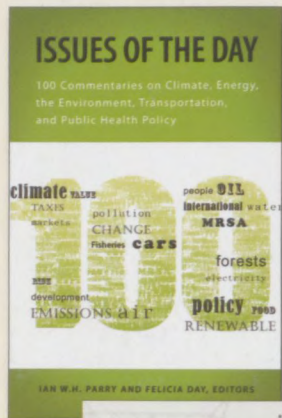
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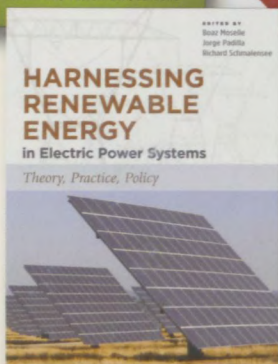
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