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RESOURCES FOR THE FUTURE

RESOURCES

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

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

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In This Issue

Joel Darmstadter is an economist and senior fellow at RFF, which he joined in 1966, following earlier stints in the corporate sector and several research organizations. Specializing in economic and policy aspects of energy and the environment, he has written, coauthored, and contributed chapters to numerous books and journal articles. He has appeared as an expert witness before congressional committees, been a consultant to several government agencies, and served on a number of National Research Council panels.

Darmstadter

Alan J. Krupnick is director of RFF's Center for Energy Economics and Policy and a senior fellow at RFF. He works with the full complement of researchers to establish and carry out the center's research agenda. His own research focuses on analyzing environmental and energy issues, in particular, the benefits, costs, and design of pollution and energy policies, in both the United States and developing countries. His primary research methodology is in the development and analysis of stated preference surveys.

Krupnick

Anne Riddle is a graduate student in the Agricultural and Resource Economics Department at the University of California, Davis, and a former research assistant at RFF.

Roger Sedjo is a senior fellow and director of RFF's Forest Economics and Policy Program. His research interests include forests and global environmental problems, climate change and biodiversity, public lands issues, long-term sustainability of forests, industrial forestry and demand, timber supply modeling, international forestry, global forest trade, forest biotechnology, and land use change.

Sedjo

RFF Research Director and Senior Fellow **Margaret A. Walls**'s current research focuses on issues related to urban land use, ecosystem services, parks, and energy efficiency. She has analyzed transferable development rights programs for managing land use in urban fringe areas, assessed the value of different types of parks and open space, and investigated energy efficiency issues in buildings.

Walls

Welcome to Our First Annual Digital Issue

At RFF, we continually are exploring creative ways to use digital technology to enhance our engagement with our communities. The information revolution is profound and changing not just the way we communicate but also our research efforts themselves—whether analyzing large spatial datasets, carrying out public surveys via online interfaces, or collaborating with colleagues across the globe in real time.

The new digital landscape allows us to distribute more content to more people in new formats and with greater accessibility. Our annual digital-only edition of *Resources*, available online and to our subscribers with iPad, iPhone, and Android mobile devices, is just one part of this effort.

Our events, for example, are now available through a high-definition, live-streaming video that allows viewers off-site to ask questions during the event via Twitter. The full video of the event is always available on our website. Here are a just a few of our recent events you can watch online:

» Findings from RFF's Initiative "Managing the Risks of Shale Gas Development" (June 27)

» The Role of a Carbon Tax in Tax Reform and Deficit Reduction (June 26)

» Responding to Ecological Loss: The Promise and Limits of Ingenuity (May 6)

RFF's blog, *Common Resources*, provides a forum for our researchers to comment on current policy developments and recent advances in their fields and elaborate on aspects of their research. The blog contributions are a welcome complement to the core analyses carried out at RFF. You also can stay up-to-date with RFF through Facebook, Twitter, and RSS feeds.

The digital revolution has made it easier to communicate with audiences across the globe. In fact, nearly half of the visitors to the RFF website come from outside the United States. As environmental challenges become more inescapably global in nature, we look forward to using new technologies to help us communicate and collaborate across borders.

Our digital edition of *Resources* is evolving as we experiment with new features to improve accessibility and make the most of the content. We welcome your feedback on things that you think are working, not working, or missing that you would like to see in the future. Drop us a line at resources@rff.org—we'd love to hear from you.

Phil Sharp, President
sharp@rff.org

The Best of COMMON RESOURCES

RFF's blog, *Common Resources*, was launched in 2012 to provide expert commentary on current debates about environmental and natural resource issues. Join the conversation at www.common-resources.org.

"Like the federal government, many states are large landowners. And they frequently require users of those lands, including oil and gas operators, to follow rules that go beyond general state regulations. **Few in industry criticize states for doing this. So why criticize Washington for doing the same thing?**"

Nathan Richardson and Alan J. Krupnick. "Fracking on Federal Lands: Stewards, Not Regulators." May 22, 2013.

"It is a clear embodiment of the president's new attitude: **Do something on climate, with or without Congress, come hell and probably more high water.**"

Daniel F. Morris. "Using Executive Action to Promote Climate Change Adaptation." March 19, 2013.

"Regulators and the public, when hearing from a specific expert, should ask **'Who do you work for?'** just as often as they ask **'What do you know?'** when trying to build their own panel of diverse advice."

Alan J. Krupnick and Hal Gordon. "Shale Gas Priorities? I'd Like to Use a Lifeline." February 8, 2013.

"The **wind production tax credit** is a bad way to cut carbon because it **leads to lower electricity prices and more electricity consumption**, offsetting some of the emissions reductions it achieves."

Joshua Linn and Clayton Munnings. "Do Renewables Policies Promote Valuable Investments?" January 11, 2013.

"**Altering market prices to recognize true costs**—to individuals' health, the environment, and the economy—**is not an incentive**. **It's a correction**—without it markets and market outcomes are flat wrong."

Heather L. Ross. "Econ 101: The Price Is Not Right." October 10, 2012.

"Initially, as the rate rises so, too, does revenue, but then at some point **higher tax rates begin to generate lower revenues**. The reason is textbook economics. At some point, the base erodes to practically nothing and **the tax self-extinguishes**."

Raymond J. Kopp. "Ezra Klein, Grover Norquist, and Carbon Taxes." September 17, 2012.

"Taken at face value, the 'clean energy promotes economic development' claim implies that the government should raise the cost of energy even if doing so produced no environmental benefits. If such a policy sounds absurd, it is because **the only reason to impose this cost on ourselves is because environmental benefits exceed that cost—not because there are no costs**."

Timothy J. Brennan. "The Democratic Platform: Green Jobs—Really?" September 7, 2012.

"My own view is that **a consistent source of money dedicated to parks and public lands** with a fixed share to states **is appropriate and needed**. But a dialogue should be started about how best to allocate such funds to yield the greatest value."

Margaret A. Walls. "Tough Times for the Land and Water Conservation Fund (LWCF)." July 20, 2012.

"I personally welcome **less frequent use of the word 'sustainability.'** The word is vague, too all encompassing, and screams liberal intelligentsia. It's not totally empty, but **its value is limited, and it's easy to co-opt.**"

James W. Boyd. "Sustainability Paranoia Rears Its Head." June 5, 2012.

A Year in Review

From carbon taxes to shale gas, from state parks to environmental regulations, 2012–2013 was a remarkable year for research, analysis, and outreach at RFF. Below are a few samples of the contributions RFF researchers made in the past year.

RFF researcher Alan Krupnick at the November First Wednesday Seminar on the future of fuel

THE FUTURE OF FUEL

The cost-effectiveness and greenhouse gas emissions of unconventional and traditional fuel options, for both cars and heavy-duty trucks, were the topic of new work and presentations by RFF researchers throughout the year.

The Energy Efficiency Paradox and Trucking

Past Trends of Fuel Consumption and GHG Emissions from Heavy-Duty Trucking

The Future of Fuel: Toward the Next Decade of US Energy Policy

FUNDING FOR PARKS

RFF researchers explored and discussed creative approaches to funding America's state and national park systems.

Building a More Sustainable Future for America's National Parks

Dedicated Funds for State Parks: Designing the Right Approach

CONSIDERING A CARBON TAX

Researchers at RFF sought to answer questions from industry and government officials about how a carbon tax in the United States could impact the environment and the economy. The following questions, among others, helped to frame this work (read more on pages 26–31).

» *How does a carbon tax compare with other policies to reduce greenhouse gases?*

Choosing among Carbon Mitigation Policies: Carbon Tax, Emissions Trading, or Traditional Regulation

Comparing Action on Climate Change in a Post-Kyoto World

» *What are the economic effects?*

Economic Effects of Carbon Taxes

Taxing Carbon: Potential Deficit and Emissions Reductions

» *What can be done to reduce the impacts on energy-intensive, trade-exposed (EITE) industries?*

Options for Mitigating Adverse Carbon Tax Impacts on EITE Industries

Ensuring Competitiveness under a US Carbon Tax

» *Do tax interactions outweigh international carbon leakage?*

Climate Policy and Fiscal Constraints: Do Tax Interactions Outweigh Carbon Leakage?

» *What role can a carbon tax play in reforming the US tax code?*

Comprehensive Tax Reform and Climate Policy

Tax Reform: Impact on US Energy Policy

» *How will consumers be affected by a carbon tax?*

Answering Questions about a Carbon Tax: How New Natural Gas Supplies Impact the Electricity Sector

RFF's Dallaw Burtraw and Leonard Shabman at the December First Wednesday Seminar on the merits of market-based environmental programs

ENVIRONMENTAL REGULATIONS AND MARKETS

RFF researchers examined the costs and benefits of environmental regulations and market-based policies, hosting workshops about the impact on the electricity sector and how to improve future policy design.

Whither Markets for Environmental Regulation of Air, Water, and Land?

CSAPR & MATS: Is Coal Doomed?

Carlton Owen of the US Endowment for Forestry and Communities at the October First Wednesday Seminar on the Forest Health Initiative

BIOTECHNOLOGY AND GEOENGINEERING

RFF hosted several events, convening a range of experts to discuss the economic impact of labeling genetically modified foods, the role that biotechnology can play in improving the health of forests, and the potential implications of geoengineering.

Agricultural Biotechnology and the Environment: Perspectives on the Next 10 Years

The Next Decade in Forest Health and Policy: A Role for Biotechnology?

Geoengineering: Time for Some Gentle Experimentation

SHALE GAS DEVELOPMENT

RFF researchers examined how shale gas development can impact US energy security and presented findings from the first survey-based, statistical analysis of shale gas experts to identify the environmental risks most frequently cited as priorities for further regulatory or voluntary action.

Hydraulic Fracturing: Bridge to a Clean Energy Future?

Shale Gas: Twelve Pathways to Dialogue

presentation video article or paper

What the President's Climate Plan Means for Natural Gas

If President Obama's recently announced climate plan can ever get out of the blocks—by no means a given with the legal challenges coming—natural gas is likely to be the big winner in the electricity fuel mix, at the expense of coal, and may also make further inroads against oil in the US transportation fleet.

Because of the much lower carbon emissions of natural gas relative to coal per kilowatt hour of electric generation, any policy limiting carbon dioxide (CO_2) emissions from the electric sector—as President Obama is calling for—is likely to benefit natural gas. A problem with embracing natural gas as a bridge to a low-carbon future has been uncertainty about the amount of methane emitted in gas production, processing, and distribution. However, a host of new studies are helping to reduce this uncertainty, and the best information available shows that such emissions are well under the amount that would make the life-cycle global warming potential of gas equal to that of coal. Further, the president's plan rightly creates a federal task force to develop a strategy for dealing with methane emissions throughout the economy—including massive amounts from agriculture—putting the pressure on all such producers, not only the politically unpopular oil and gas industry.

Natural gas also should be a winner against climate-friendly nuclear fuel for at least the next five years, if for no other reason that it would take that long to get a new plant fully permitted, built, and online. And renewables, for all their new support from the president's plan, start from such a low fraction of electricity generation that it will still take many years and some technological breakthroughs before they can make significant inroads against gas. Indeed, because of cheap natural gas prices, the time it takes and the breakthroughs may be longer still in coming.

For all the scaremongering of those opposed to any climate change plan, the shale gas revolution has made it far less costly than it would have otherwise been to reduce greenhouse gases from the electricity sector. The economics and practice of shale gas production have made natural gas more abundant in the marketplace and therefore much cheaper—as well as making its price less responsive to increases in demand that would arise from implementing President Obama's plan.

RFF researchers Dallas Burtraw and Matt Woerman estimate in a forthcoming paper that a tradable performance standard for coal and natural gas with a marginal cost of $33 per ton of CO_2 could achieve emissions reductions of 340 million tons in 2020—about 5 percentage points of the president's Copenhagen pledge of a 17 percent reduction from 2005 levels. This cost is less than the administration's 2020 social cost of carbon estimate of $40 per ton. And in previous work, Butraw and Woerman estimated that the United States is set to achieve another 10 percent of this reduction under existing policies and technology changes, including expanded use of natural

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gas. President Obama's new plan for utilities could efficiently close this remaining gap.

Turning to the transportation sector, more than half of all new refuse trucks run on natural gas, and demand is growing for liquefied natural gas to fuel long-haul trucks. Whether natural gas is a climate change winner over diesel fuel is still an open question, but backing out oil from the energy mix has been a goal of every US president since Nixon, at least.

The president's plan has positives and negatives for the natural gas upstart in transportation (currently at only 1 percent share of transportation fuels). On the positive side, the president endorsed natural gas as a transport fuel. Less clear is his call for tighter fuel economy standards for trucking. If manufacturers can increase diesel fuel economy at relatively low cost, this might give an advantage to diesel. How natural gas trucks are credited for their lower carbon emissions is also important.

All in all, the president's plan is good for reducing greenhouse gases and good for natural gas, relative to the status quo. Even so, implementing a carbon tax on all sectors of the economy, or even just the electricity sector, would save costs by allocating emissions reductions where they are cheapest to obtain. Given the plan's benefits to natural gas and relatively benign position on oil, the oil and gas industry ought to get behind it, while simultaneously signaling their preference for a carbon tax. ● —Alan J. Krupnick

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

FURTHER READING

Burtraw, Dallas, and Matthew Woerman. 2012. US Status on Climate Change Mitigation. Discussion paper 12-48. Washington, DC: RFF.

Preserving Blue Carbon to Limit Global Climate Change

An Interview with Juha Siikamäki

Resources sat down with RFF Associate Research Director and Fellow Juha Siikamäki to discuss his recent work on how protecting coastal mangroves, salt marshes, and sea grass meadows may prevent billions of tons of carbon dioxide emissions from entering the air. In an excerpt from that interview, he emphasizes the importance of incorporating blue carbon into climate policy and describes the conservation challenges ahead.

RESOURCES: What exactly is blue carbon, and why is it important?

JUHA SIIKAMÄKI: "Blue carbon" refers to carbon that is stored by coastal and ocean environments. Recently, the main focus of the conservation community has been on three different kinds of blue carbon ecosystems: mangroves, salt marshes, and sea grasses. These areas are generally known as carbon sinks. We know that these areas preserve a considerable amount of carbon, but the storage capacity is under threat due to development.

Their storage capacity is especially significant relevant to their total area. It turns out that the total area—for instance, of mangroves—is relatively small. It's only about 1 percent of the total area of tropical forests. But on a per-acre basis, the amount of carbon stored in mangroves is multiple times the amount of carbon stored in tropical forests.

RESOURCES: How did you decide to focus on blue carbon storage?

SIIKAMÄKI: For a long time now, we've known that natural systems provide a significant storage capacity for carbon. Recently, there's been a great deal of discussion and research on tropical forests, focusing on reducing emissions from deforestation and forest degradation (REDD).

It turns out that, according to most estimates, we can avoid emissions at a relatively low cost by preventing deforestation. It's less costly to avoid emissions from tropical deforestation than, for example, reducing emissions from an industrial source with fossil fuel combustion. It seems like a win–win strategy.

We've also known that coastal areas are extremely valuable for many reasons. They provide ecological functions; they're important for fisheries; they're important for water quality, storm protection, recreation, and so on. We've also known that they contain a considerable amount of carbon, but we haven't known exactly how much.

The big challenge with coastal conservation is that coastal areas have become especially attractive for development. Coastal areas have been converted for many purposes: agricultural development, tourism, residential development, industrial development, and even fisheries development. And coastal development can create very high returns. The idea is that maybe blue carbon will help strengthen the case for coastal preservation.

Missing from this debate was any information on the economic potential of avoiding carbon emissions by protecting coastal environments. Exactly how much carbon do these areas store? How much is the carbon worth? How costly would it be to preserve these areas? Our goal when we started this research was to find out to what extent, from an economic perspective, there might be justification for preservation of coastal areas.

RESOURCES: How do you determine how much carbon is stored by mangroves?

SIIKAMÄKI: We started out from a satellite-based map of mangrove areas globally. Across the 140,000 square kilometers of mangroves that have been identified throughout the world, we divided those areas into small locations—roughly 5.5 by 5.5 miles in area. For each plot, we developed an estimate of mangrove biomass above and below ground. That gave us an estimate of the carbon stored in the biomass. Additionally, we developed estimates of the amount of soil carbon in mangroves. A lot of natural science goes into answering the question.

RESOURCES: How could blue carbon be incorporated into REDD programs?

SIIKAMÄKI: In principle, the same general framework would work, especially for mangroves. Mangroves are forests. So in that sense there would be a natural fit under the REDD umbrella.

A few important differences exist between tropical forests and coastal environments, however. In particular, most of the carbon in tropical forests is stored in the living trees and their roots. When we talk about coastal ecosystems, especially mangroves, the situation is very different. The biomass stores carbon, but most of the carbon is stored in the soil as a result of hundreds of years of accumulation and sequestration.

From the REDD perspective, the difference is quite critical. Rules for other tropical forests do not allow accounting for soil carbon—so REDD effectively rules out mangroves. One of the key next steps to consider is to find ways of accounting robustly for the soil carbon in coastal environments.

There has been a good bit of work in this area recently. In fact, there is a new voluntary carbon standard designed specifically for accounting for carbon in wetlands.

RESOURCES: In some of your previous research, you noted that targeting forests for conservation purely based on carbon storage may lead to missed opportunities to save areas rich in plant and animal species. Can you explain how we can combine the goals of forest carbon sequestration and biodiversity preservation?

SIIKAMÄKI: The basic dilemma here is that the areas that are most attractive for preserving carbon may not be the same areas that would be most attractive for preserving biodiversity. There's some overlap, but these different goals can significantly impact the kinds of areas that we would target for conservation.

In the context of mangroves, the difference is actually less critical. It turns out that even by focusing on carbon sequestration, we can preserve quite a bit of biodiversity. And the same is true if we focus on biodiversity preservation—the carbon sequestration benefits would be quite significant.

There is an additional cost of adding biodiversity conservation criteria into carbon-focused programs, but we find it's quite minimal—around a few dollars per ton of carbon dioxide. To put that in context, we estimate that without any additional emphasis on biodiversity, blue carbon emissions could be avoided at less than roughly $10 per CO_2. To assess the economic potential, we compared this to the cost of emissions reductions from industrial sources. We used an estimate of $10 to $20 per ton of carbon dioxide. That's roughly the market price from the European Union Emissions Trading Scheme, which is the biggest market for carbon emissions permits and offsets.

By focusing on carbon sequestration in mangroves, we can preserve quite a bit of biodiversity. And the same is true if we focus on biodiversity preservation—the carbon sequestration benefits would be quite significant.

RESOURCES: What are some of the major challenges for conserving blue carbon areas in developing economies?

SIIKAMÄKI: There are many challenges. Fish and shrimp farming, for example, are major drivers of mangrove conversion. One of the main challenges with aquaculture is that it's extremely productive. It creates very high returns. Competing against those returns is difficult. But we find that in many cases, solely focusing on carbon probably would justify the preservation of those areas. That's a striking result.

In developing countries, you start dealing with issues related to institutional capacity and governance—the kinds of issues that demand attention when thinking about potentially implementing large-scale conservation programs. One might need to focus on building capacity and developing protocols for monitoring and managing conservation areas. Much work needs to be done at a practical level before one can think about effectively implementing conservation programs.

RESOURCES: What are the next steps to link blue carbon preservation to climate change mitigation policies?

SIIKAMÄKI: Our work clearly suggests that these areas are of significant value in the context of avoiding emissions. There certainly is a case to be made that a serious effort should be put in place to incorporate them into climate policy via a REDD-like framework.

Another next step is to start thinking about pilot projects in different locations. Through process, we'll learn a great deal and identify other issues that still need further consideration. For example, what locations are most attractive? How do you deal with issues related to institutional capacity? There are many concerns, but I do think the evidence is sufficient to move ahead with more advanced policy development and to experiment with actual projects. ●

Listen to a podcast of the full interview at www.rff.org/SiikamakiQA.

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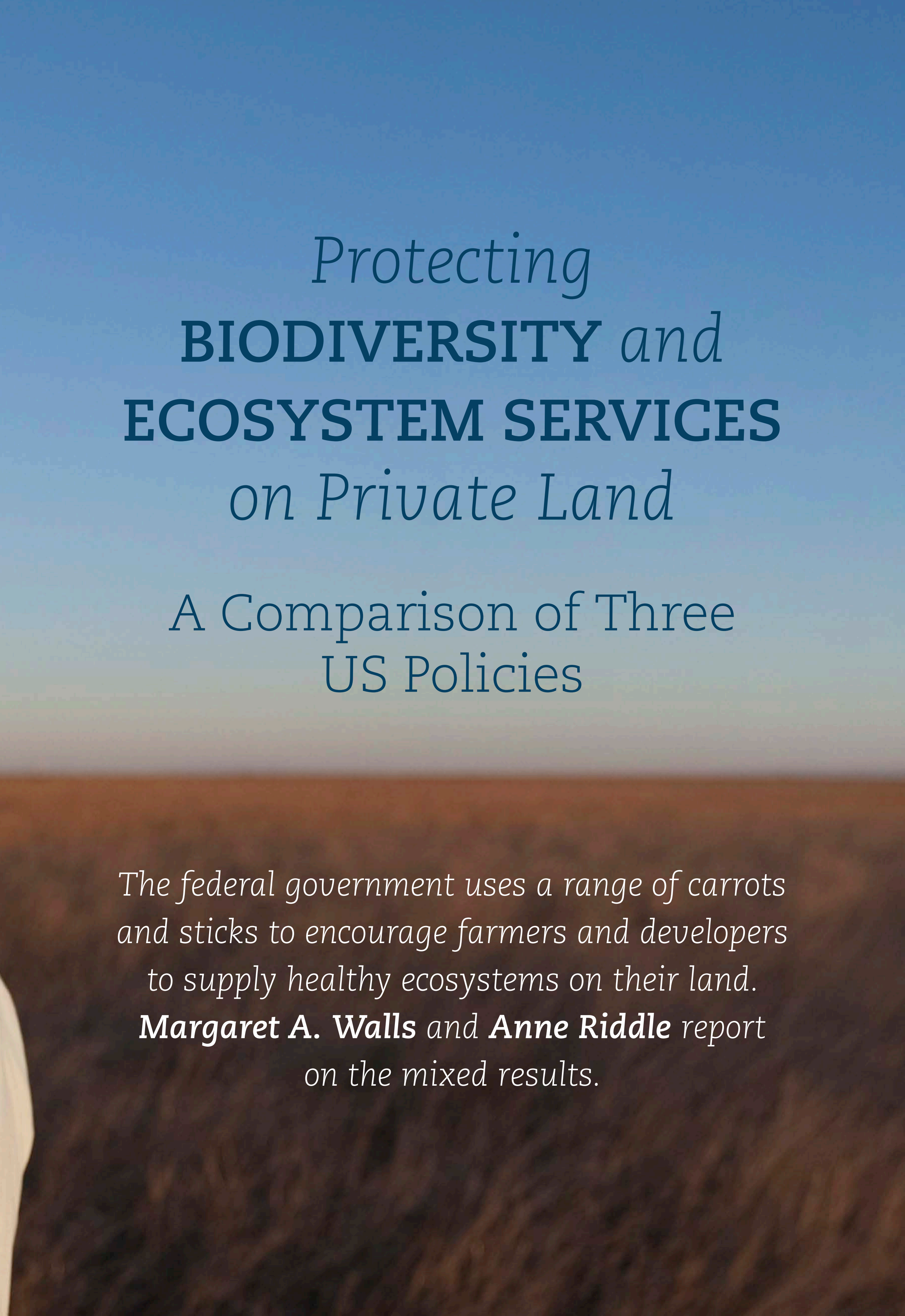

Protecting **BIODIVERSITY** *and* **ECOSYSTEM SERVICES** *on Private Land*

A Comparison of Three US Policies

The federal government uses a range of carrots and sticks to encourage farmers and developers to supply healthy ecosystems on their land. ***Margaret A. Walls*** *and* ***Anne Riddle*** *report on the mixed results.*

With about 60 percent of land in the United States under private ownership, engaging so many diverse landowners to protect their forests, marshlands, grasslands, and other natural areas—and the animals that live in those landscapes—can pose a significant challenge for federal regulators. Conserving these plant and animal species, however, provides the biodiversity necessary for the healthy functioning of ecosystems that, in turn, generates numerous benefits to society—from recreation to flood protection to clean air. Often incentives do not exist for private landowners to conserve and provide these benefits, which are not valued in markets.

The federal government uses a wide range of approaches to encouraging the development of ecosystem services on private land. To learn what works best, we compared three important programs: the Endangered Species Act, a strict command-and-control regulation; the voluntary Conservation Reserve Program, which compensates landowners for protecting property from agricultural uses; and Section 404 of the Clean Water Act, which prohibits damage to wetlands unless individuals or firms buy credits that fund the creation or protection of equivalent wetlands elsewhere.

Research by economists suggests that the Conservation Reserve Program has been successful at protecting ecosystem services on privately owned farmland—and has done so in a relatively cost-effective way because it creates financial incentives for landowners to set aside ecologically important lands for protection. By contrast, the Endangered Species Act creates perverse incentives for private landowners to preemptively reduce habitat to avoid burdensome requirements of the law. Wetlands mitigation banking, described later, is the closest option to a true payment-for-ecosystem services approach, but it has been plagued with difficult monitoring problems.

The Endangered Species Act

Signed into law 40 years ago, the Endangered Species Act prohibits landowners from modifying properties designated as critical habitat for threatened species unless they create a habitat conservation plan and obtain a special permit from the federal government. Studies have shown that the critical habitat designation has a negative effect on property sales and property values, providing a strong incentive for landowners to avoid it.

The Conservation Reserve Program is generally credited with being the single most important factor in the recovery of many North American waterfowl populations.

In North Carolina, for example, researchers Dean Lueck and Jeffrey Michael found that some forest landowners in the 1990s preemptively harvested timber on their land to reduce the habitat of the endangered red-cockaded woodpecker. Other studies have documented that the mere listing of a species can discourage private landowners from participating in conservation efforts. For example, property owners within range of habitat of the endangered Preble's meadow jumping mouse revealed in surveys by Santa Clara University psychologist Amara Brook and colleagues that they often would refuse to give biologists

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permission to conduct research on their land.

Perhaps as a result, the benefits of the law are murky. Since the law's enactment in 1973, fewer than 50 of the nearly 2,000 species listed as endangered or threatened have been removed from the list. Law professor Jonathan Adler of Case Western Reserve University reports that as of July 2008, the Fish and Wildlife Service (which administers the Endangered Species Act in conjunction with the National Oceanic and Atmospheric Administration) could identify only 21 species recoveries, as some of the delistings are due to data errors or extinctions. No one has attributed any species recoveries directly to the regulation of habitats on private land.

The Conservation Reserve Program

Many experts have pointed out that the essential flaw in the Endangered Species Act is that it penalizes landowners—rather than rewards them—for having critical habitat on their lands. In contrast, the Conservation Reserve Program, signed into law in 1985 as part of the Food Security Act, pays farmers to implement approved conservation practices and retire agricultural land that provides ecosystem services.

The Conservation Reserve Program is by far the largest federal conservation program. At nearly $2 billion per year, it accounts for approximately one-third of all land conservation spending by the federal government. In 2009, 32 million acres of land were enrolled in the program, approximately 8 percent of all cropland in the United States.

Farmers voluntarily enroll parcels of land in this program by submitting proposals to engage in a set of proposed conservation practices. Government agents score the offers based on an index of environmental benefits and costs. In contrast to the destructive preemptive practices documented in response to the Endangered Species Act, farmers interested in the Conservation Reserve Program plant trees and wildlife cover in order to increase the likelihood that their bids will be accepted.

Five years after the program's implementation, Economic Research Service researchers Edwin Young and Tim Osborn estimated the program had provided surface water quality improvements and habitat conservation on the order of $5 billion to $10 billion. The Conservation Reserve Program is generally credited with being the single most important factor in the recovery of many North American waterfowl populations, and in 1999 Peter Feather and colleagues at the Economic Research Service concluded that the program generated recreational benefits of $555 billion annually.

The Clean Water Act

Officially established in 1995, the wetlands mitigation banking program of the Clean Water Act takes the idea of paying for ecosystem services one step further. Whereas payments in the Conservation Reserve Program come from the government, the banking program sets up a true market for ecosystem services with exchanges between private agents that lead to land conservation.

Section 404 of the Clean Water Act prohibits the discharge of dredge or fill materials into any US waters unless permitted by the Army Corps of Engineers. For every authorized discharge, the permit holder must avoid and minimize (to the greatest extent practicable) any adverse impacts to wetlands, streams, and other aquatic resources. If impacts are unavoidable, compensatory mitigation is required—that is, replacement of the lost wetland and its associated functions.

As an alternative to undertaking their own mitigation, permit holders can purchase offsets from a wetlands mitigation "bank"—a wetland that a government agency, corporation, individual, or nonprofit organization has restored, established, enhanced, or preserved and then set aside to compensate for future conversions of wetlands for development activities. When the permit holder approaches the mitigation bank for a purchase, the bank quantifies the wetland functions or acres restored or created in the transaction and calculates the value of the credits needed. The permit holder then purchases the appropriate number of credits from the bank. After the transaction, the bank becomes the party responsible for meeting requirements under the law concerning long-term management of the land, site protection, and defense of easements.

The market-based nature of wetlands mitigation banks gives them great appeal, and they have become a mainstream way to meet the requirements of the Clean Water Act.

The market-based nature of wetlands mitigation banks gives them great appeal, and they have become a mainstream way to meet the requirements of the Clean Water Act. Compared with on-site mitigation, or even mitigation off-site through individual one-on-one transactions with landowners, purchases from an established wetlands bank may be easier and have lower transaction costs. And by generating competition and bargaining in market exchanges, the market in wetlands credits should help to bring down the costs of meeting the Clean Water Act's Section 404 requirements.

Unfortunately, the wetlands mitigation program has failed to live up to its promise. The program is plagued by unfinished and substandard projects, and studies have found that only about 20 percent of sites met the ecological equivalent of the displaced wetland. In some locations, banks are not meeting the definition of wetlands but rather are just general conservation areas. Of the true wetlands held by banks, many have been found to be in poor condition.

Even with these setbacks, the program is protecting more wetlands than would be achieved with no policy at all. However, the benefits of wetlands are highly site-specific, making it difficult to conduct an overarching benefit–cost analysis of the wetlands mitigation banking program. Whether these benefits exceed the costs is unclear.

Conservation Banks and Green Infrastructure

"Conservation banks"—natural lands set aside to protect rare habitat and support endangered species—were established to operate the same way as the wetlands mitigation banks, but for the purpose of meeting the habitat requirements under the Endangered Species Act. This idea is still in its infancy. However, in an era of strained public budgets, the conservation banking idea and market-based approaches to conservation in general may have great appeal. Many communities are facing high costs to meet the US Environmental Protection Agency's Total Maximum Daily Load restrictions on nitrogen, phosphorus, and sediment pollutants in local streams and rivers, for example. Municipal stormwater systems and combined sewer-stormwater systems are expected to need significant and costly upgrades to meet the requirements. Protection of drinking water supplies in some cities is also a major concern. Green infrastructure investments focused on land conservation (such as protecting land around a watershed to provide natural water filtration) may prove to be viable and low-cost options for attaining some of these environmental objectives. Similar green options for flood protection (such as protecting from development natural areas that can hold rainwater overflows) have been advocated as well. Many communities are also realizing the recreational, aesthetic, and habitat cobenefits provided by natural lands.

The wetlands mitigation bank experience highlights an important lesson as regulators consider new conservation programs focused on ecosystem services: it is often difficult to accurately measure, monitor, and enforce these programs in a way that optimally provides these nonmarket goods and services. Still, there is cause for optimism. The Conservation Reserve Program has been successful at protecting ecosystem services on privately owned farmland, and it is doing so in a relatively low-cost manner. Questions remain about the program—whether an improved design could increase net benefits and how demand for biofuels may lead to reductions in the amount of land in the program—but it still remains one of the better-designed ecosystem services programs in the United States. ●

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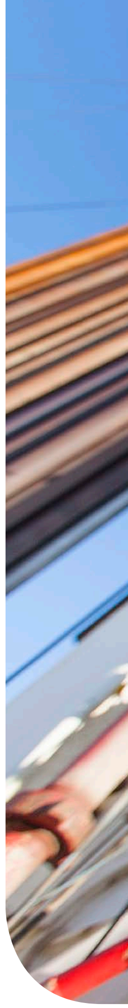
ENERGY INDEPENDENCE— ***What Then?***



In a series of posts from RFF's blog, Common Resources*,* ***Joel Darmstadter*** *and* ***Roger Sedjo*** *consider the significance of achieving energy independence in the United States.*

"By around 2020, the United States is projected to become the [world's] largest oil producer"—so states the International Energy Agency in its *World Energy Outlook 2012*, issued November 12 and quickly echoed by media around the world. In the process, the United States is expected to overtake Saudi Arabia in that lead role and, coupled with Canada and its burgeoning oil sands output, is likely to ensure North America becoming "a net oil exporter around 2030."

Thus, the long-cherished goal—especially in the political domain—of US oil self-sufficiency may, before too many years, provide the missing link in the country's energy profile. That said, the implication of zero oil imports may not represent the unalloyed blessing for the US economy that it is often, and reflexively, portrayed to be.

Zero Oil Imports: Benefits and Lurking Uncertainties

Zero US oil imports—a goal of various US administrations since at least the Nixon era—promise to relieve, at least to some extent, security concerns associated with dependence on foreign oil sources. Additionally, the pure economic benefits to America are likely to be substantial. However, environmental and geopolitical concerns will create uncertainties that confound political decisionmaking.

Projections of US oil independence are largely the result of new technologies—particularly hydraulic fracturing ("fracking")—which, already dramatized by the enormous expansion of natural gas supplies in recent years, make huge oil resources previously locked in shale deposits acces-

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sible at costs competitive with world oil market prices. Continued improvements in energy efficiency are a contributing factor in these projections. An implication of this turn of events is that production-decline predictions of "peak oil"—if that concept has merit—will be pushed back by at least several decades. Recent innovations, in essence, have given the United States a significant increase in its exploitable natural resource base (see the box on page 25 for a more detailed look at these developments).

The direct and indirect economic benefits for both employment and incomes are likely to be substantial. Higher incomes will have positive and pervasive ripple effects, including, as with natural resources generally, the ability to utilize these newly exploitable resources to generate economic rents, royalties, and governmental tax revenues.

Although significant influence over world oil prices from these new resources seems unlikely given their incremental contribution to global supply, any reduction in prices would benefit consumers in the United States and worldwide. US consumers may receive an extra benefit from domestically produced oil since transport costs associated with imports will not be incurred.

Given this relatively idyllic oil situation, where might the uncertainties be lurking? There are costly disruptions associated with development surges that occur on resource frontiers as a sort of "gold rush" replay takes hold, though enlightened planning could help make these conditions transitory. Fort McMurray—the heart of Alberta's oil sands boom—is experiencing just such trauma,

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as are parts of North Dakota with extensive drilling in shale formations.

More generally, the bounty of newly exhaustible resources could sustain the fossil fuel era beyond the point where more climate-friendly energy resources might have been expected to kick in. At the very least, this could intensify tensions with advocates promoting an accelerated shift to renewable resources. On the other hand, it could buy time and thereby also strengthen the pursuit of carbon capture and sequestration technology if reinforced by a concurrent determination to internalize environmental spillover effects in the price of the resource (more on this later).

There are significant geopolitical uncertainties associated even with North American oil self-sufficiency. It is often argued that US policy in the Middle East is driven by concerns and threats related to oil production. Would this change substantially if North America were to achieve oil self-sufficiency, not to mention become a net oil exporter? One can make the case that oil self-sufficiency would reduce the sensitivity of US policy to that part of the world. Nevertheless, in a worldwide oil market, major disruptions in foreign oil supplies would create worldwide oil shocks and price instability from which neither the United States nor Canada would be immune. However, self-sufficiency ought to at least provide North America with a buffer from such shocks and reduce the need for impulsive policy reactions.

Trade Implications of North American Energy Independence

The prospect of North American energy independence has numerous implications given the strong relationship between the United States and Canada. The long shared border, common resource-producing regions, democratic institutions, culture, language, and military interests all play their parts. Interconnected electric transmission flows give the two countries a joint incentive to ensure integrity of the grid. And overall, trade and investment undergird strong economic ties.

The United States currently imports 2.4 million barrels per day from Canada, its leading oil supplier at 26 percent of overall imports. Conversely, the overwhelming share of Canadian oil exports goes to the United States. Even though US oil imports from other regions will continue, that closely intertwined connection can only become more pronounced in the years ahead, with

Canada further raising its share of a sharply declining volume of total US oil imports.

At the same time, rapidly expanding output of Canadian oil sands (which may approach 5 million barrels per day by the mid-2020s) will prompt Canada to seek additional markets for its exports. A significant part of the controversial Keystone XL pipeline's throughput could be oil in transit, for refining in foreign trade zones, rather than destined for US consumption. Although not an unusual practice in international commerce, this has already provoked a hostile reaction from environmental groups and will test the US commitment to free-trade principles.

This rapidly changing continental energy picture also prompts a consideration of the associated environmental consequences, taken up next.

mitigated and managed through regulatory policy initiatives.

The two new sources of energy for North America—the Canadian oil sands and the fracking of shale oil and gas—present both new environmental challenges and new opportunities. Even at current oil sands output of close to 2 million barrels per day—let alone the increases foreseen over the course of the next several decades—there are significant environmental challenges facing both oil producers and governmental authorities charged with crafting environmental policies.

Extraction of the energy content (called "bitumen") of the Canadian oil sands is by mining or in situ. While mining currently dominates the recovery process, in situ will begin to be dominant within a few years as the bulk of reserves are deep underground.

It is often argued that US policy in the Middle East is driven by concerns and threats related to oil production. Would this change substantially if North America were to achieve oil self-sufficiency?

Energy Independence and the Environment

The development of natural resources often disturbs the natural environment. Fossil fuels—coal, petroleum, and natural gas—are all extracted via mining or drilling and are commonly associated with environmental damages. Additionally, the use of fossil fuels for energy is associated with environmental damages, particularly air pollution and greenhouse gas (GHG) emissions—a precursor to global warming. Nevertheless, the benefits of this energy are essential to the high standard of living in North America, and environmental damages are generally accepted by society as a nonmarket cost of energy production that needs to be

Either way, managing wastes constitutes a major challenge. As one of us (Darmstadter) wrote in a 2010 backgrounder for RFF, tailing ponds "must be isolated and monitored for at least a decade to ensure the integrity of surrounding soils and groundwater."

There are ecological worries, too. The deposits are in boreal forest, whose diversity and wildlife habitat represent a prized part of Canada's national endowment and where successful reclamation of disturbed lands is not yet a demonstrated fact. Preserving the Athabasca River, even as its waters are needed in waste-management operations, will also be a challenge.

The fracking process involves the use of explosive charges and the injection of sand, water, and chemicals to break up the rock and allow, not just gas or oil, but also the injected—and contaminated—fluids to be pumped to the surface. It is largely the fate of these waste fluids that has produced environmental anxiety. As of this writing, though short of definitive scientific and epidemiological findings, anecdotal evidence has led to suspicions pointing to the presence of chemical wastes in air, soil, and groundwater to which the public may be exposed as a result of the fracking process. These concerns have led to moratoria in some jurisdictions and pressure for tighter regulation.

> Anecdotal evidence has led to suspicions pointing to the presence of chemical wastes in air, soil, and groundwater to which the public may be exposed as a result of the fracking process.

It remains unclear when and whether these environmental concerns can be scientifically validated and, if they are, whether better regulation, better technology, or better policy can adequately address them.

That said, the large new sources of natural gas available with fracking also create environmental opportunities. The problem of energy self-sufficiency is confounded by concerns over carbon emissions associated with fossil fuel energy. In essence, the long-term problem involves the adequacy of energy fuels constrained by concerns over GHG emissions associated with that energy source.

On its face, progress toward North American energy self-sufficiency, particularly as it relates to fossil fuels and oil, appears to exacerbate the GHG environmental problem. However, this concern needs to be tempered—GHG emissions associated with natural gas are only about 50 percent of the emissions of coal per unit of energy produced. The most advantageous place to substitute natural gas for coal is in electrical power generating facilities. This substitution is already taking place as the price of natural gas declines sharply. The US Energy Information Administration has projected that coal's share of US electricity production could fall to 30 percent in 2035 (from 42 percent in 2011) as natural gas is substituted. Although at a lesser rate of replacement, substitution of natural gas for oil is also anticipated to occur in the transportation sector.

Partly due to the increasing role of natural gas—although also because of a sluggish economy—US GHG emissions have declined for several years. Indeed, some analysts suggest that emissions reduction targets for 2020, once viewed as unattainable, may be achievable in part due to the large role for natural gas. The huge increases in shale gas and oil production driven by fracking technology have changed the national mix of fossil fuels and promise to continue this shift into the future.

These trends should mirror a continued reduction in GHG emissions from electricity generation and, with a lag, in transport sector emissions. Furthermore, the shifting fuel mix in power generation will need not be driven by legislation or policy, but will be largely the outcome of the market's response to dramatically lower natural gas prices and the expectation that substantially lower prices would continue into the future.

Several concluding points deserve emphasis. New oil and gas supplies offer possibilities of moving North America to oil and energy self-sufficiency. Although environmental challenges associated with the development and use of fossil fuels persist, they appear manageable.

Will increased availability and use of natural gas diffuse pressures to develop non–fossil fuel solutions? In the longer run, fossil fuel energy likely will need to be replaced by less environmentally damaging renewables. Because the road to a major role for renewables is a long one, natural gas, while not perfect, could facilitate our transition to major reliance on non-emitting renewables. ●

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The Persistent Importance of Oil and the Surge in Natural Gas

In its 2002 *Annual Energy Outlook*, the Energy Information Administration (EIA) foresaw that US oil consumption would reach 8.5 billion barrels in 2010; in fact, consumption in that year amounted to only 7 billion barrels. Conversely, domestic oil production exceeded EIA's expectations by 8 percent.

These joint trends in consumption and production meant that net oil imports in 2010 amounted to 3.4 billion barrels, compared to the 5.2 billion barrels of imports projected almost a decade earlier. The oil import share of consumption—often seen as the iconic marker of dependency—had fallen to 45 percent, against the 55 percent figure projected 10 years before.

To understand the background to these—and some broader energy—trends, it helps to briefly recap some notable underlying developments during this 10-year period. In the energy picture as a whole, the most significant development has been the enormous expansion of production and estimated proved reserves of natural gas in shale formations. As a result, natural gas, rather than coal, has become the energy source of choice in new US electric power generation. Additionally, the United States is poised to become a substantial exporter of liquefied natural gas in a sharp reversal of the expectation a decade ago that it would need to import the fuel to meet a growing level of gas demand.

But the oil statistics reflect important advances of their own. These have occurred on both the supply and demand sides of the market. The prospectively "game-changing" development on the supply side is the emergence of large-scale shale oil deposits in the Bakken formation, centered on North Dakota. In 2009, Bakken's proven reserve additions of nearly 500 million barrels were the second-highest in the United States, with production running around 500,000 barrels per day.

While the oil supply-side trend has its basis principally in technological and geological progress, the steadily rising efficiency of energy utilization points to behavioral shifts by energy users in the energy marketplace. A manifestation of that development is a seemingly sustained fall in oil consumption per unit of the nation's GDP.

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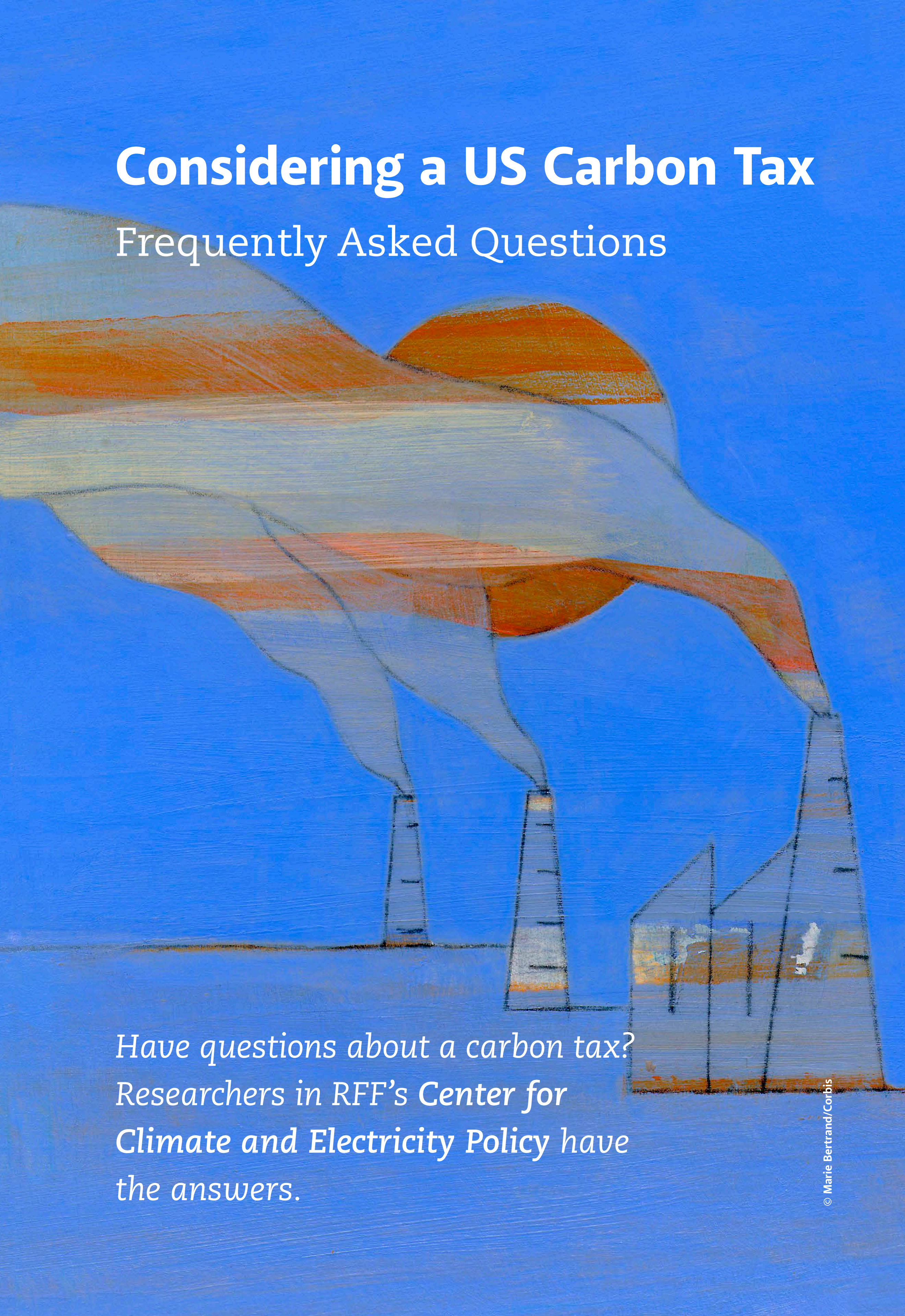
Considering a US Carbon Tax

Frequently Asked Questions



Have questions about a carbon tax? Researchers in RFF's ***Center for Climate and Electricity Policy*** *have the answers.*

For the past several decades, experts at RFF have helped decisionmakers understand climate policy challenges and assess the costs and benefits of possible solutions. This history gives RFF researchers a unique perspective in being able to objectively and comparatively assess the effectiveness of these policies.

As part of that body of work, RFF researchers have compiled a collection of frequently asked questions about the important design elements and potential economic impacts of a carbon tax policy. The questions in this excerpt address some of the foundational issues raised in extensive dialogues with policymakers, industry stakeholders, and academic experts. The answers reflect the latest findings of ongoing research at RFF to analyze options for US climate policy.

What Is a Carbon Tax?

A carbon tax is a tax imposed on releases of carbon dioxide (CO_2), which is emitted largely through the combustion of fossil fuels used in electricity production; industrial, commercial, and residential heating; and transportation.

A carbon tax may be a tax per ton of carbon or, more commonly, per ton of CO_2. A \$1 tax per ton of CO_2 is equal to a \$3.7 tax per ton of carbon because carbon constitutes roughly 3/11 of the weight of CO_2. Because CO_2 is usually the substance of interest rather than carbon itself, the usual meaning of a "carbon tax" is a tax on CO_2.

The most common proposal for a carbon tax calls for the tax to start low and rise over time. There are many options for how this tax would be applied, all of which have different impacts (on overall cost, effectiveness of raising revenue and reducing CO_2, and so on) depending on what is taxed, where the tax is implemented, and how the revenue is used.

How Might a Carbon Tax Affect the Economy?

Various perspectives have been offered about how a carbon tax could affect the economy, and in-depth analysis on this topic is currently under way at RFF. Experts generally agree that how the tax is designed and how revenues are used will be the largest determinants of the effects of the tax on the economy.

A carbon tax would increase the cost of fossil fuels, encouraging companies to switch to currently more expensive (albeit cleaner) fuels and leading households and companies to reduce energy use. These factors could make the economy less dependent on fossil fuels and thus less vulnerable to energy price shocks.

Although a carbon tax could slow the growth of industries that emit large amounts of CO_2, the tax could also boost other industries, particularly clean energy. A carbon tax could slightly reduce economy-wide employment due to lower demand for workers in carbon-intensive industries and weakened incentives for labor force participation (because the tax would lead to higher prices, reducing workers' buying power).

A carbon tax could lead to overall economic growth in the United States if the tax revenues are used efficiently, such as by cutting other taxes or reducing the deficit. The amount of revenue raised depends on the level of the tax, how broadly it is applied, and other factors. Most experts suggest a tax of around \$25 per ton of CO_2, which would raise approximately \$125 billion annually.

Reducing personal and corporate income taxes would promote growth because these taxes distort employment, savings, and investment. The \$125 billion in annual revenues from a \$25 per ton carbon tax could allow federal personal income tax reductions of about 15 percent or corporate income tax reductions of about 70 percent, if all carbon tax revenues were used to replace current tax revenues. Alternatively, the federal deficit could be reduced by approximately $1.25 trillion over 10 years—about the same reduction that the 2011 Joint Select Committee on Deficit Reduction would have had to agree on to avoid mandatory spending cuts. Other ways that the revenue could be used to promote growth include funding essential infrastructure, basic research, or investments in human capital. Any of these uses—tax cuts, deficit reduction, or productive government spending—could promote growth.

However, if revenue is not recycled in an efficient way, the annual costs of a $25 per ton carbon tax would be substantially higher and could approach $50 billion, or about $90 per ton of CO_2 reduced.

Could Higher Energy Prices Hurt US Competitiveness?

A carbon tax could raise costs for industries that consume large amounts of energy, but some sectors are better positioned to recover the cost increases than others. In sectors that are both energy-intensive and exposed to international trade, such as metals and chemicals, product prices are driven by international market forces. Such industries could be disproportionately burdened if a carbon tax affects their operations but not those of their international competitors.

Effects on industry's production and employment depend on a number of factors, including the carbon intensity of producers, the degree to which they can pass costs to consumers, their ability to substitute with less carbon-intensive energy, the strength of competition from imports, and consumers' ability to substitute other, less carbon-intensive alternatives.

Various policy options may help offset these impacts. For example, because these industries tend to be capital-intensive, lowering capital taxes or enhancing depreciation allowances could reduce their costs. However, these measures are not usually well targeted. Another option is to reduce the burden of the carbon tax in these sectors. The challenge is to do so in a way that does not undo the incentives for reducing carbon intensity or seem to offer direct subsidies that violate World Trade Organization obligations.

Another option is to give firms a tax rebate based on their output. Per-output emissions above a sector-specific baseline would generate a tax liability, and emissions below the baseline would generate a refund. This would preserve most incentives for emissions reductions while reducing the overall tax burden. It makes the tax more complex, however, possibly creating opportunities for tax avoidance, rent seeking, or protectionism. This approach must be carefully designed, and preferential treatment must be phased out as trade partners undertake their own climate regulations.

How Might a US Carbon Tax Affect Global Carbon Emissions?

The primary environmental objective of a tax on carbon is to set a price that reflects the "real" costs such emissions impose—accounting for the damages that are expected to arise from global warming, including effects on agricultural productivity and human health, coastal inundation, and other changes. Experts suggest that of all the policy options, a carbon tax will produce the most efficient carbon reductions throughout the economy—whether from electricity production or transportation—because as a uniform price on CO_2 emissions, the tax is the same regardless of the source of the emissions.

Because the United States emits significantly more CO_2 than most other countries, reducing US emissions can contribute to reducing total global emissions. However, imposing a carbon tax or other policy to reduce emissions in one country can lead to increased emissions elsewhere—a phenomenon known as carbon leakage. This occurs for a variety of reasons. First, production of some carbon-intensive goods is likely to move abroad to avoid the tax. Second, reduced US demand for fossil fuels would result in lower global prices for those fuels, making them more attractive in unregulated countries. Research finds that, on average, a 10 percent reduction in carbon emissions in the United States would be partially offset by a 1 to 3 percent increase elsewhere.

> Most experts suggest a tax of around $25 per ton of CO_2, which would raise approximately $125 billion annually. A carbon tax could lead to overall economic growth if these revenues are used efficiently.

How Might a Carbon Tax Affect Energy Prices?

A carbon tax would increase energy prices—the amount of increase would depend on the size of the tax and the extent to which it is passed forward to consumers. For example, research shows that a tax of $25 per ton of CO_2 could add about 21 cents per gallon to the price of gasoline and about 25 cents per gallon to the price of diesel fuel. The price of natural gas could increase by about $1 per thousand cubic feet, the price of coal by about $40 per short ton, and the price of electricity by about 1.2 cents per kilowatt-hour.

Changes in energy prices would vary by region, depending on the source of electric power (and its carbon content) used in the region. Regions of the country that consume relatively greater amounts of fossil fuels, and coal in particular, could feel a greater price increase from the introduction of a tax on carbon. However, other regions of the country could bear much of the change in cost because electricity generated and goods manufactured with fossil fuels are transported to consumers across great distances.

In general, a carbon tax would tend to raise prices for everyone, but less so for those currently facing the highest prices. The West Coast and Northeast currently face some of the highest electricity prices in the country, largely because they have already made investments that have reduced the carbon emissions of their electricity production. In these regions, the price effect of a carbon tax would be modest and consumers would continue to pay the highest prices nationwide. The Midwest and Southeast stand to face the highest electricity price increases under a carbon tax, though these regions would still continue to pay the lowest electricity prices in the country.

How Might a Carbon Tax Rate Be Set?

There are several approaches that Congress might consider when setting a carbon tax rate: using the real cost of emissions, setting a price designed to achieve a revenue goal, or setting a price to achieve an emissions target.

The most common approach discussed

by experts is to set a tax equal to the real cost of emissions, basing the price on the global environmental damages from emissions, or the "social cost of carbon." The social cost of carbon is the discounted monetary value of future climate change damages due to additional CO_2 emissions (for example, the costs of adverse agricultural effects, protecting against rising sea levels, health impacts, species loss, risks of extreme warming scenarios, and so on).

For example, a recent US federal interagency assessment recommended a value of $25 per ton for 2015 (in 2010$) with the tax rate rising at a rate of about 2 to 3 percent per year in real terms (roughly reflecting growth in world output potentially affected by climate change). Research shows that a tax of $25 per ton of CO_2 would reduce emissions by roughly 10 percent per year (based on projections that energy-related CO_2 emissions would be about 5.5 to 5.8 billion tons annually for the next decade). Experts recommend that once in place, a carbon tax would need to be flexible so it can be updated in response to future learning about climate change.

Alternatively, there has been discussion about designing a carbon tax to achieve a revenue goal, in which case the rate would depend on fuel prices (for example, the price of natural gas relative to coal).

Some suggest setting a carbon tax to achieve an emissions reduction target. For example, a recent study by researchers at RFF and the National Energy Policy Institute suggests that a carbon tax reaching about $30 per ton of CO_2 by 2020 would be needed to reduce domestic, energy-related CO_2 emissions by approximately 10 percent. To achieve this, the tax should rise at approximately the risk-free rate of interest (near zero right now, but roughly 5 percent in the long run) to balance the value in today's terms of making adjustments in the future.

A carbon tax will produce the most efficient carbon reductions throughout the economy of all the policy options—whether from electricity production or transportation—because the tax is the same regardless of the source of the emissions.

How Might a Carbon Tax Be Implemented?

Various approaches could be examined when implementing a carbon tax. For example, one approach is to implement the tax "upstream"—that is, as an extension of existing fuel taxes already applied to petroleum refineries, coal mines, and natural gas operators. Such a tax would affect approximately 2,000 companies. Alternatively, the tax could combine taxes on transportation and home heating fuels with a downstream charge on power plants and major industrial facilities. However, this could increase administrative costs (as it would cover about 13,000 companies), would be less comprehensive (as small-scale emitters are likely too costly to include), and could possibly lead to greater pressure for exempting certain industries.

Congress may face several challenges in designing the tax. For example:

» Taxing only a limited share of carbon emissions—from a specific sector or only large sources of emissions—could significantly lower revenue. A $25 per ton CO_2 tax could raise less than $40 billion per year if applied only to the electricity sector, compared to $125 billion per year if applied to all emissions.

FURTHER READING

What Is a Carbon Tax?

- RFF Discussion Paper 11-46: The Promise and Problems of Pricing Carbon: Theory and Experience

How Might a Carbon Tax Affect the Economy?

- RFF Discussion Paper 12-27: Carbon Pricing with Output-Based Subsidies: Impact on US Industries over Multiple Time Frames
- RFF Discussion Paper 11-02: Moving US Climate Policy Forward: Are Carbon Taxes the Only Good Alternative?
- RFF Discussion Paper 03-46: Fiscal Interactions and the Case for Carbon Taxes over Grandfathered Carbon Permits

Could Higher Energy Prices Hurt US Competitiveness?

- RFF Discussion Paper 10-47: The Impact on US Industries of Carbon Prices with Output-Based Rebates over Multiple Time Frames
- RFF Discussion Paper 09-12: Combining Rebates with Carbon Taxes: Optimal Strategies for Coping with Emissions Leakage and Tax Interactions
- RFF Discussion Paper 08-37: Impact of Carbon Price Policies on US Industry
- Congressional Testimony, March 18, 2009: Competitiveness and Climate Policy: Avoiding Leakage of Jobs and Emissions

How Might a US Carbon Tax Affect Global Carbon Emissions?

- RFF Discussion Paper 10-47: The Impact on US Industries of Carbon Prices with Output-Based Rebates over Multiple Time Frames

How Might a Carbon Tax Affect Energy Prices?

- RFF Issue Brief 12-03: The Variability of Potential Revenue from a Tax on Carbon
- *Resources* 176: Is a Carbon Tax the Only Good Climate Policy? Options to Cut CO_2 Emissions

How Might a Carbon Tax Rate Be Set?

- RFF Discussion Paper 11-02: Moving US Climate Policy Forward: Are Carbon Taxes the Only Good Alternative?
- RFF Discussion Paper 08-26: A Tax-Based Approach to Slowing Global Climate Change

How Might a Carbon Tax Be Implemented?

- RFF Issue Brief 09-05: Should the Obama Administration Implement a CO_2 Tax?

» Exempting some sectors or categories of emissions sources may create perverse economic incentives that lower tax revenue while increasing greenhouse gas emissions. A carbon tax targeting the electricity sector but exempting manufacturing could result in an increase in on-site power generation at manufacturing plants.

» Increases in the tax rate would not necessarily lead to proportional increases in revenues. A higher tax creates incentives to use lower-carbon alternatives, reducing emissions and reducing carbon tax revenue. ●

Read the carbon tax FAQs in their entirety at http://www.rff.org/carbontax. The following experts have contributed their research to answer the FAQs: Joe Aldy, Tim Brennan, Dallas Burtraw, Jared Carbone, Carolyn Fischer, Ray Kopp, Molly Macauley, Richard Morgenstern, Daniel Morris, Karen Palmer, Anthony Paul, Nathan Richardson, and Roberton Williams. The answers reflect their individual research and informed opinions; however, they do not necessarily reflect the views of RFF as an organization.

A Look at What's Happening

INSIDE RFF PRESS

RFF Press publishes pioneering research in environmental economics and natural resource policy. Highlights from its 2013 catalog of new and key backlist titles include the following:

Constitutions and the Commons
The Impact of Federal Governance on Local, National, and Global Resource Management

By Blake Hudson
To be published November 15, 2013
Hardback: 978-1-61726-096-4
http://www.routledge.com/books/details/9781617260964

Environmental Regulation and Public Disclosure
The Case of PROPER in Indonesia

By Shakeb Afsah, Allen Blackman, Jorge H. Garcia, and Thomas Sterner
Published March 27, 2013
Hardback: 978-0-415-65765-5
http://www.routledge.com/books/details/9780415657655

Environmental Commodities Markets and Emissions Trading
Towards a Low-Carbon Future

By Blas Luis Pérez Henríquez
Published December 20, 2012
Paperback: 978-1-61726-095-7
Hardback: 978-1-61726-094-0
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Water Trading and Global Water Scarcity
International Experiences

Edited by Josefina Maestu
Published November 19, 2012
Hardback: 978-0-415-63821-0
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Carbon Capture and Sequestration
Removing the Legal and Regulatory Barriers

By M. Granger Morgan and Sean T. McCoy
Published June 21, 2012
Hardback: 978-1-61726-101-5
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Water Diplomacy
A Negotiated Approach to Managing Complex Water Networks

By Shafiqul Islam and Lawrence E. Susskind
Published June 20, 2012
Paperback: 978-1-61726-103-9
Hardback: 978-1-61726-102-2
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The Global Economics of Forestry

By William F. Hyde
Published May 18, 2012
Hardback: 978-0-415-51828-4
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Tapping Water Markets

By Terry L. Anderson, Brandon Scarborough, and Lawrence R. Watson
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Negotiating Environment and Science
An Insider's View of International Agreements, from Driftnets to the Space Station

By Richard J. Smith
Published March 2, 2012
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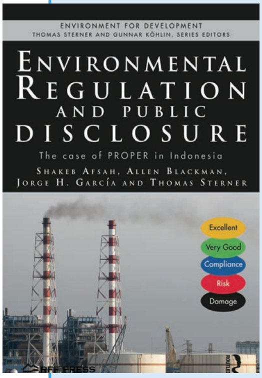
Hardback: 978-1-933115-70-2
http://www.routledge.com/books/details/9780415505482

The Roads from Rio
Lessons Learned from Twenty Years of Multilateral Environmental Negotiations
Edited by Pamela Chasek and Lynn M. Wagner

Published February 27, 2012
Paperback: 978-0-415-80977-1
Hardback: 978-0-415-80975-7
http://www.routledge.com/books/details/9780415809771



The Economics of Shame

This spring marked the publication of our RFF Press book about naming and shaming polluters. The title, *Environmental Regulation and Public Disclosure: The Case of PROPER in Indonesia*, is admittedly a bit owlish. But I think many will be interested in the contents—an in-depth case study of an innovative pollution control program in a poor country that has made a real difference.

My coauthors—Shakeb Afsah, Jorge García, and Thomas Sterner—and I have been involved in the design, implementation, and evaluation of PROPER for more than 15 years. We decided to pull together and flesh out what we have learned about the program because we believe that, having succeeded where many others have failed, it can and should serve as a model for other developing countries.

Environmental management in poor countries is quite challenging: severe pollution problems abound, regulatory institutions tend to be weak, and politicians get more mileage from promoting poverty reduction than pollution control. As a result, conventional command-and-control regulation often performs poorly.

PROPER has managed to sidestep some of these constraints by relying on public disclosure instead of enforcing regulatory mandates. It ranks thousands of companies' environmental performance using a five-color grading scale—gold for excellent, green for very good, blue for good, red for non-compliance, and black for causing environmental damage—and then disseminates these rankings via the press and Internet, thereby creating incentives for polluters to cut their emissions.

Our book is a multidisciplinary, wide-ranging exploration of the program. We present rigorous statistical analyses showing that it has helped raise the average rate of compliance with environmental regulations from 30 percent to 70 percent, and we identify the specific incentives that are responsible for this improvement. We also provide a comprehensive history of the origins and evolution of the program and detailed explanations of the methods and procedures on which it relies.

Try it; we think you'll like it. • —**Allen Blackman**

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