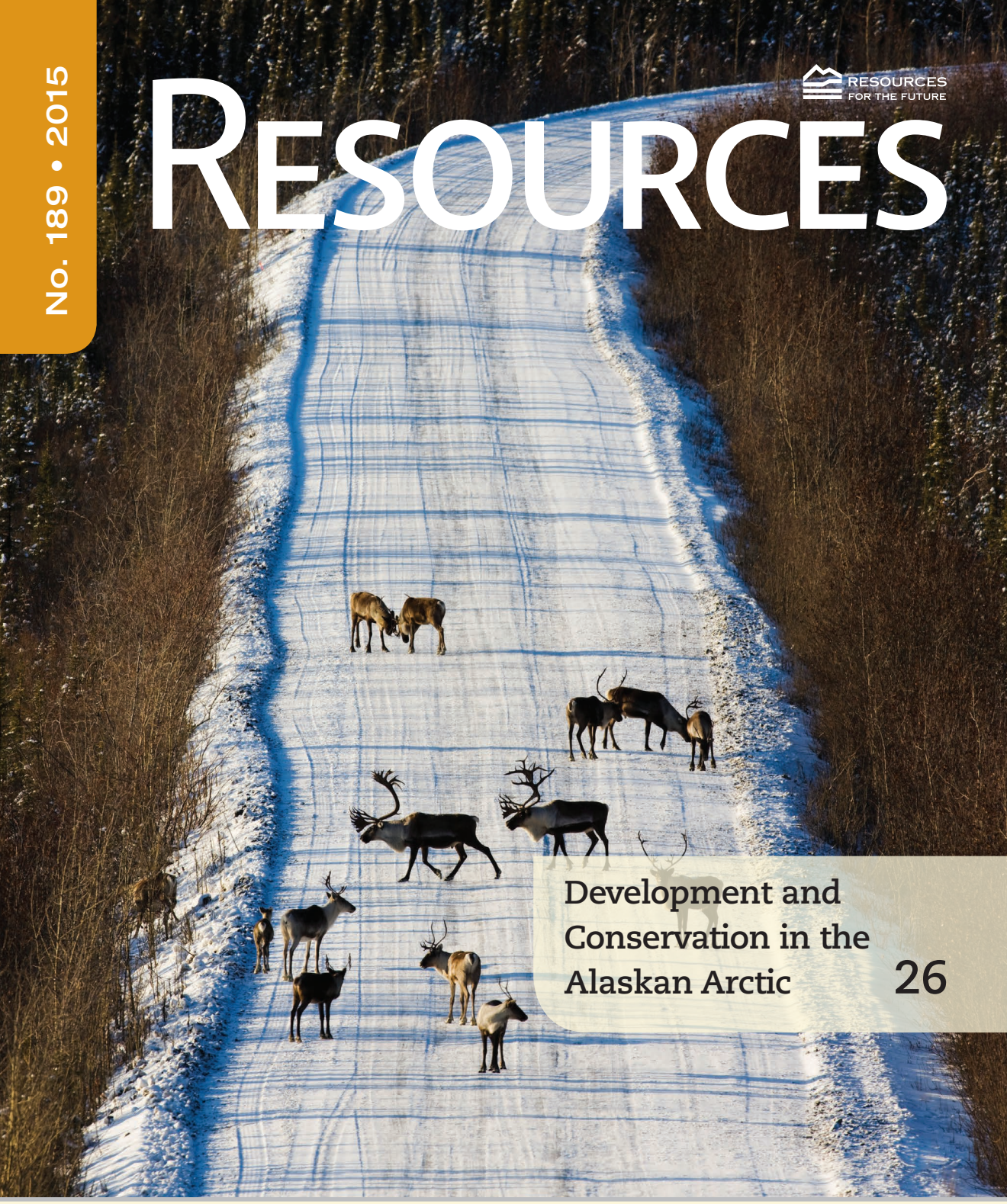
No. 189 • 2015

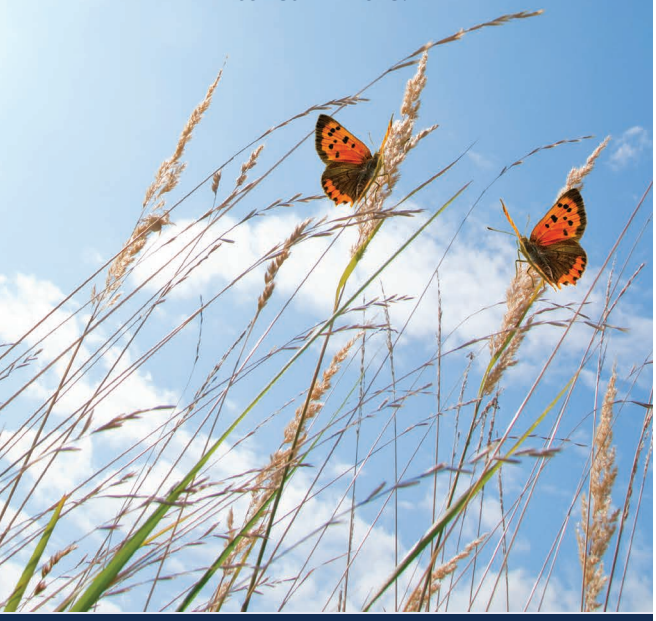
Resources

Resources for the Future



Every gift **matters.**

Support RFF through your workplace matching gift program. Contact your personnel office to learn more.



RESOURCES
FOR THE FUTURE

www.rff.org/support

CHARITY NAVIGATOR

Network for Good.

Resources

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

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

Officers
Phil Sharp, *President*
Lea Harvey, *Vice President for Development and Corporate Secretary*
Molly K. Macauley, *Vice President for Research and Senior Fellow*
Terri O'Brien, *Vice President for Finance and Administration*

Board of Directors
Richard Schmalensee (Chair), James Asselstine, Vicky A. Bailey, Paul F. Balser, Anthony Bernhardt, Trudy Ann Cameron, Red Cavaney, John M. Deutch, Elaine Dorward-King, Daniel C. Esty, Linda J. Fisher, C. Boyden Gray, David Hawkins, Rick R. Holley, Peter R. Kagan, Sally Katzen, Rubén Kraiem, Robert B. Litterman, Wilhelm Merck, Richard G. Newell, Henry Schacht, Robert N. Stavins, Joseph L. Stiglitz, Mark R. Tercek, Sue Tierney; Chair Emeriti: W. Bowman Cutter, Darius W. Gaskins, Jr., Robert E. Grady, Lawrence H. Linden, and Frank E. Loy

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

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

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

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

MIX Paper from responsible sources FSC® C006849

PRINTED WITH SOY INK

Cover photo: An important food source for some Alaska Native communities, caribou from the Porcupine herd in the Arctic National Wildlife Refuge cross a highway in the Yukon. © Theo Allofs/Corbis

Contents

No. 189 • 2015

departments

features

Contents

No. 189 • 2015

features cont.

In This Issue

Joseph E. Aldy is an assistant professor of public policy at the John F. Kennedy School of Government at Harvard University, a visiting fellow at RFF, and a faculty research fellow at the National Bureau of Economic Research. His research focuses on climate change policy, energy policy, and mortality risk valuation. From 2009 to 2010, Aldy served as the special assistant to the president for energy and environment.

Aldy

RFF Visiting Fellow **Stephen P.A. Brown** is a professor of economics at the University of Nevada, Las Vegas. He has conducted inquiries into domestic and international energy markets, energy security policies, climate policy, public finance, government performance, and regional economic growth. Prior to joining RFF, Brown had a 27-year career at the Federal Reserve Bank of Dallas.

Brown

Joel Darmstadter is an economist and senior fellow at RFF, which he joined in 1966, following an earlier stint in the corporate sector and at several research organizations. Specializing in the economic and policy aspects of energy and the environment, 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

David J. Hayes is a distinguished visiting lecturer in law at Stanford Law School. He is also a visiting senior fellow at the Center for American Progress. From 2009 to July 2013, he was the deputy secretary and chief operating officer of the Department of the Interior in the Obama administration, where he focused on energy, climate change, conservation, and Indian issues.

Hayes

Hannah Kamen is a student at the University of Rochester, where she is pursuing undergraduate degrees in economics and environmental studies. She was an RFF research intern during the summer of 2014.

Alan Krupnick is co-director of RFF's Center for Energy and Climate Economics and a senior fellow at RFF. His research focuses on analyzing environmental and energy issues, in particular, the benefits, costs, and design of pollution and energy policies, both in the United States and in developing countries.

Krupnick

Kuwayama

RFF Fellow **Yusuke Kuwayama**'s research focuses on the economics of environmental regulation, with an emphasis on water resources and ecosystems. His work seeks to understand how the interaction between economic and natural systems affects the efficiency of policy instruments to regulate environmental externalities.

Lloyd

Carol Lloyd is vice president of engineering at ExxonMobil Upstream Research, where she leads the corporation's worldwide engineering research function and the application of differentiating and proprietary technology in support of ExxonMobil's global upstream operations. She chairs the Arctic Research Coordinating Subcommittee of the National Petroleum Council.

Katrina McLaughlin is a research assistant at RFF.

Palmer

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

Paul

Anthony Paul is a center fellow at RFF's Center for Energy and Climate Economics. His research focuses on the power sector in the United States and related issues of regulation, economics, and the environment. He is the lead developer of the RFF Haiku Electricity Market Model.

Pizer

RFF University Fellow **William A. Pizer** is a professor at the Sanford School of Public Policy and a faculty fellow at the Nicholas Institute for Environmental Policy Solutions at Duke University. His current research examines public policies to promote clean energy, the competitiveness effects of climate policy, and the design of market-based environmental policies. From 2008 until 2011, he was deputy assistant secretary for environment and energy at the US Department of the Treasury.

Richardson

Nathan Richardson is an assistant professor at the University of South Carolina School of Law and an RFF visiting fellow. A lawyer by training, he focuses his research on energy and climate policy, particularly regulatory tools available under US law. He has examined environmental liability, environmental federalism, and the relationship among law, regulatory institutions, and policy design.

On the Frontiers of Climate Policy

For more than 60 years, experts at RFF have been analyzing the economic impacts of environmental and climate policies. This year, in particular, we are engaged on the frontiers of several important climate-related policy decisions at the regional, national, and international levels.

One conversation under way is focused on the significant commercial developments in the US Arctic, from fishing and shipping to oil and gas exploration. Scientists find there are observable consequences of global warming in the region, so new development—particularly of oil and gas—brings both opportunities and challenges. In this issue, articles by former deputy secretary of the Interior David J. Hayes and Carol Lloyd of the National Petroleum Council explore how we balance this development with protection of the Arctic's pristine environmental assets, while ensuring that local communities reap the benefits.

On the national level, some of our scholars are focused on EPA's Clean Power Plan—the first policy that will significantly reduce emissions from the existing fleet of power plants across the United States. Many of the most important policy choices will be made by state governments, which will decide how to meet the federally set goals. Most of the technology and policy options available as compliance mechanisms are not new to the states or the electric utilities. A number of these options are outlined in this issue by RFF's Karen Palmer and Anthony Paul, who have been working extensively with various stakeholders.

Finally, RFF is engaged in the coming international climate negotiations to be held in Paris at the end of the year. A key question is how to compare nations' pledges and efforts to ensure a fair and measurable outcome. RFF Visiting Fellow Joe Aldy of Harvard and University Fellow Billy Pizer of Duke have been tackling this question and, in this issue, suggest a series of metrics to guide a comparative analysis of the national action plans.

The international community has its eyes set, in particular, on the United States, where the record on climate policy over the past decade has not been considered aggressive or adequate. Indeed, critics of US policy are asking whether there is political support in the United States to back up our government's pledges. In my view, political support is growing, as seen in public opinion polls, state actions, and changing public discussion. But the proof is in the pudding.

RFF is not in the business of advocacy or lobbying, but we have done—and will continue to do—extensive analysis of the policy options for addressing climate change.

Phil Sharp, President
sharp@rff.org

P.S. On a personal note, I want to acknowledge that RFF Vice President for Finance and Administration Ted Hand recently retired after 35 years of service. All of us at RFF wish him well and deeply appreciate his work in building an effective and financially sound institution.

Pits versus Tanks: Comparing Storage Methods for Fluids Used in Fracking

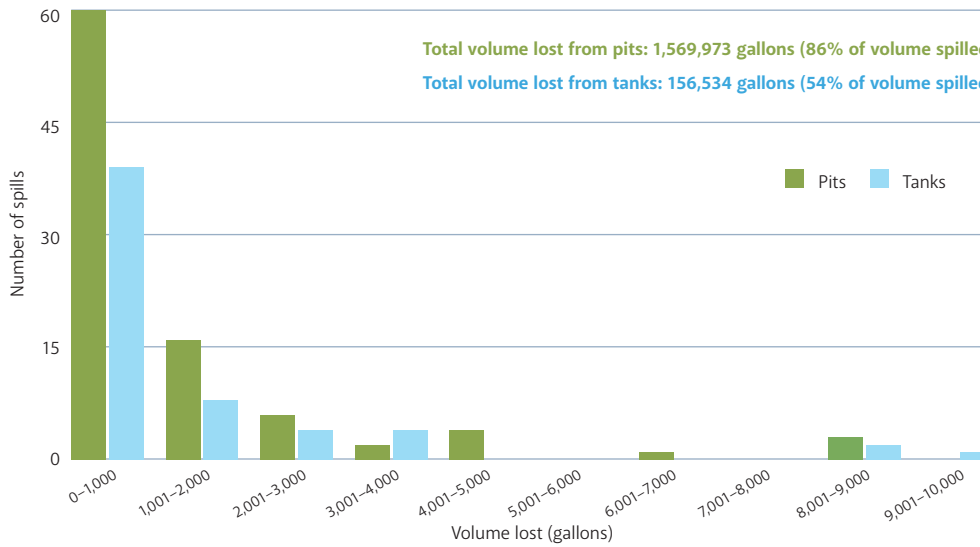
The extraction of shale gas using hydraulic fracturing (fracking) requires the use and storage of large amounts of freshwater, fracking fluids and flowback, and "produced water"—a highly salinized combination of water and chemicals that exists in shale formations and is forced out of the ground as a by-product of gas extraction. Except for the freshwater, these fluids can contain heavy metals, radioactive substances, and other contaminants that are highly damaging if released into the environment. For this reason, the fluids are typically stored in lined, open pits in the ground or in sealed tanks.

A 2013 RFF survey of experts identified the storage of fracking wastewater in pits—and its potential to leak into surrounding rivers and streams—as a priority environmental risk that is not being addressed adequately by industry or government. Some have argued that storage tanks are a better choice than pits because they provide a "closed system" and can greatly reduce the possibilities of spills. New research by RFF's Yusuke Kuwayama, Alan Krupnick, Skyler Roeshot, and Jan Mares examines whether this assertion is true. They find that tanks are not necessarily a fail-safe alternative.

Kuwayama and colleagues extracted data from the online spill database of the State of New Mexico Oil Conservation Division to catalog the reported volume of fluids used in fracking and other oil and gas production activities that was spilled and not recovered from pits and tanks, from 2000 to 2014. In Figure 1, they show that although most pit and tank spills lost less than 1,000 gallons, both storage methods have resulted in

Figure 1. Number of Spills from Pits and Tanks by Volume Lost (New Mexico, 2000–2014)

Spills totaling 10,000 gallons or less



some larger-scale spills (6,000 to 10,000 gallons). Furthermore, the figure omits a handful of even larger spills, including six spills from pits that were larger than 100,000 gallons. Notably, spills from pits occurred twice as often as spills from tanks, while also losing over 10 times as much fluid over the study period—1,569,973 gallons versus 156,534 gallons. But the researchers caution that what is spilled matters, too.

An examination of the data on the types of fluids spilled showed differences between the spills from pits and tanks (Figure 2). Reporting on tank spills included fluids such as acid, gelled brine, and unspecified chemicals. Pit spills showed higher frequencies and volumes of produced water, drilling mud, and brine water, and less frequency (but significantly more volume) of crude oil. The differences in types and volumes of fluids spilled suggest that a one-size-fits-all approach to regulation is unlikely to be cost-effective.

The researchers also looked at the causes of the spills. Tanks seemed to be more vulnerable to lightning strikes, vandalism, and fire, which were not reported as spill causes for pits. Information on the causes of spills could be valuable for policymakers in deciding whether pit and tank storage regulations should be adjusted. It also may help natural gas producers understand what voluntary actions they could take to reduce the occurrence of these spills.

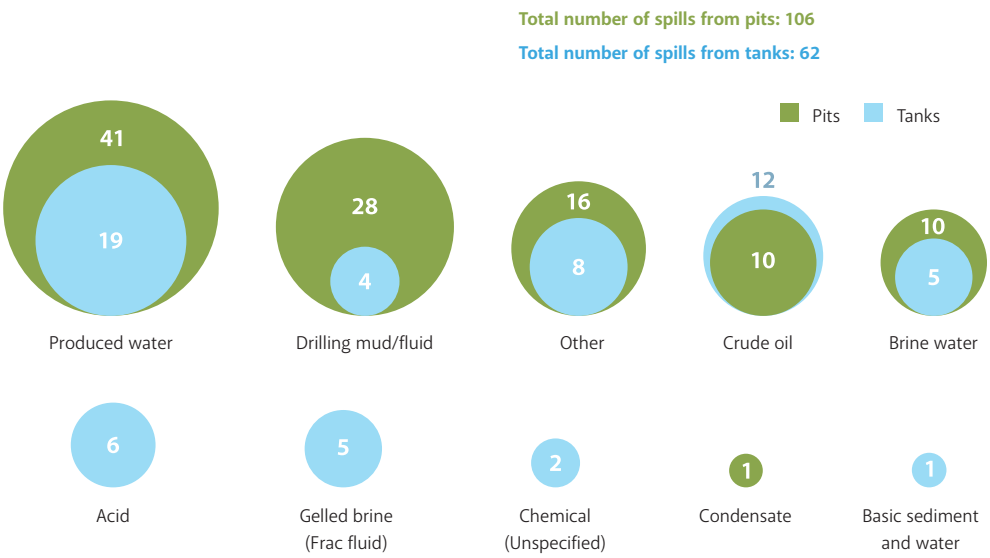
Finally, the researchers note that New Mexico's system is a good example of the transparency that is needed for stakeholders and the public to better understand the potential environmental impacts of fracking. However, more research is needed to fully understand the health and environmental impacts of related spills and the cost-effectiveness of implementing spill safeguards. ●

FURTHER READING

Krupnick, Alan, Hal Gordon, and Sheila Olmstead. 2013. *Pathways to Dialogue: What the Experts Say about the Environmental Risks of Shale Gas Development: Overview of Key Findings.* Washington, DC: RFF.

Kuwayama, Yusuke, Alan Krupnick, Skyler Roeshot, and Jan Mares. Forthcoming. Onsite Storage of Wastewater from Shale Gas Development: Risks and Mitigation Options. Discussion paper. Washington, DC: RFF.

Figure 2. Number of Spills from Pits and Tanks by Material (New Mexico, 2000–2014)



Highlights from Recent Events at RFF

Assessing State Goals and Challenges under EPA's Clean Power Plan www.rff.org/CPP

"[An emissions trading program] keeps bureaucrats like me from [deciding] the most cost-effective thing to do [and] which technologies to choose. It sends the right kind of signals to the market to figure out how to reduce emissions. This regulation has essentially been open season for innovation, and that's how it should be viewed."

David Cash, Commissioner, Department of Environmental Protection, Commonwealth of Massachusetts, on concerns about using an emissions trading program under Section 111(d) of the Clean Air Act. October 14, 2014.

Making Nature Useless? Global Resource Trends, Innovation, and Implications for Conservation www.rff.org/nature

"More people living in cities, rather than spread all over the countryside, allows for more of our landscapes to return to nature and make habitats for non-human animals and species. This has been a real tidal shift in the environmental movement of the last 40 years."

Michael Schellenberger, President, The Breakthrough Institute, on the key drivers of decoupling conservation from consumption. November 5, 2014.

Nobel Laureate Mario Molina on Understanding Climate Risk www.rff.org/Molina

"You cannot tell that any one event—like Hurricane Sandy or a particular flood—was caused by climate change. But that's the wrong answer to the wrong question. What seems to be clear is that the intensity of a good fraction of these events has indeed been affected by climate change, and that comes from measurements."

Nobel Laureate Mario Molina, Director of the Mario Molina Center for Energy and Environment in Mexico City, on the effect of climate change on extreme weather events. November 12, 2014.

Carbon Cap and Trade in China: From Experimentation to Nationalization? www.rff.org/Chinacapandtrade

"These pilot [programs] are just one component of a larger policy package, both for climate and air quality. [It includes] energy saving targets, coal caps, economic restructuring, the emissions trading pilots, air quality goals, and renewable energy targets. It's important not just to evaluate these policies in isolation but also to look at how they interact with one another."

Jeremy Schreifels, Senior Policy Analyst, US Environmental Protection Agency, on understanding the relationships among China's climate policies. December 3, 2014.

Clockwise from top: David Cash (right) with RFF President Phil Sharp; Mario Molina; Michael Schellenberger; Jeremy Schreifels; Holger A. Kray; and Trigg Talley (right) with RFF University Fellow William Pizer

How Will Climate Change Affect Our Global Food Supply? www.rff.org/foodsupply

"In the past five years [at the World Bank], there hasn't been a single conversation with senior government leaders where the threat of climate change is not the main topic. Be it last week in Nicaragua, the week before in Jamaica, before Christmas in Serbia—there's no agricultural operation going to the board at this point in time that is not climate-informed."

Holger A. Kray, Lead Agriculture Economist, Agriculture Global Practice, World Bank Group, on the integration of climate change concerns into the World Bank's ongoing work. January 28, 2015.

Toward a Global Climate Agreement: Comparing Countries' Levels of Effort www.rff.org/comparability

"We're seeking a durable agreement in 2015 that can serve as the architecture for commitments, not just in the immediate 2020 period, but for successive commitments in the years beyond. This would mean we would be able to focus on what specific actions countries take, rather than revisiting the balance of the architecture every time we come back to the table."

Trigg Talley, Deputy Special Envoy for Climate Change, US Department of State, on the ideal design of an international climate agreement. February 4, 2015.

© Resources for the Future

Resources available online: presentation video paper

Getting Past the "Yuck" Factor: Recycled Water in Florida and Other States

Yusuke Kuwayama and Hannah Kamen

With record-setting droughts plaguing the western United States and growing populations increasing the demand for water across the country, many communities have been seeking out new sources of water. One strategy that has been gaining popularity is water reuse, which involves using treated wastewater for industrial production, the augmentation of drinking water supplies, irrigation, and other purposes.

Further adoption of water reuse would not be just another drop in the bucket. A recent report by the National Research Council (2012) estimates that reusing all of the municipal wastewater that is discharged into oceans or estuaries could supply 6 percent of total US water use and 27 percent of all residential, commercial, and industrial uses—those that can be supplied most readily with treated wastewater. Water reuse also offers the benefit of reducing the volume of wastewater discharged into surface water, which may lead to improved ambient water quality outcomes.

However, most communities have yet to adopt reuse as a water management strategy. Issues surrounding water reuse, particularly related to the conversion of wastewater for potable purposes, have been increasingly covered by the popular press with a focus on the "yuck" factor as a potential barrier to further adoption. Indeed, survey-based studies have shown that public support for water reuse initiatives generally wanes as the likelihood of individual contact with reused water increases.

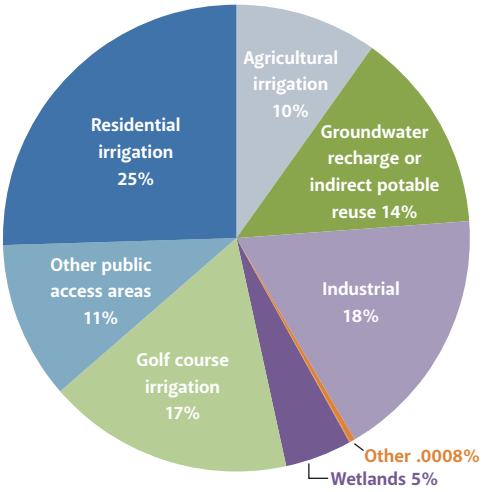
As a result, many questions remain regarding the future of water reuse. What could more widespread adoption of water reuse look like? What types of communities are more likely to adopt water reuse? What economic sectors would use recycled water?

A Pioneering Approach in Florida

We are able to start answering some of these questions by turning to Florida, which, together with California, has been a pioneer in the adoption of water reuse practices. According to the Florida Department of Environmental Protection, the state's capacity to recycle water nearly tripled between 1992 and 2012. If Florida were to reuse all of the wastewater it could, that volume would represent 67 percent of the state's wastewater treatment capacity. In 2012, 486 reuse facilities were operating in the state, with a total reuse capacity of 1,711 million gallons per day. Of this capacity, on average, about 725 million gallons were actually being used per day.

Florida's capacity to recycle water nearly tripled between 1992 and 2012.

Figure 1. Uses of Recycled Water in Florida in 2013



Source: Florida Department of Environmental Protection 2014.

Figure 1 illustrates how recycled water was used in Florida in 2013. Recycled water was used to irrigate 321,340 residential yards, 548 golf courses, 961 parks, and the grounds at 328 schools. In addition, recycled water was used for irrigation on 14,056 acres of agricultural land for edible crops—primarily oranges, grapefruits, and tangerines—and 24,752 acres of other crops. Significant amounts were also used for industrial purposes and the recharging of aquifers. Less than 1 percent was used for toilet flushing, decorative fountains, commercial laundry, cleaning of roads and sidewalks, vehicle washing, and the making of concrete.

Some may be concerned that the 14 percent of recycled water in Florida designated as "groundwater recharge or indirect potable reuse" (IPR), could eventually be used to supply drinking water. IPR involves releasing recycled water post-treatment into natural surface water or groundwater sources as a means of augmenting freshwater supply. It differs from direct potable reuse (DPR), in which recycled water is introduced directly into a potable water distribution system. Both DPR and IPR require advanced treatment processes, such as membrane filtration and reverse osmosis, but by discharging treated water into surface water or groundwater prior to reuse, IPR uses environmental buffers such as rivers, lakes, and aquifers to naturally purify the water.

Despite these rigorous treatment processes, research reinforcing the safety of reuse technology, and assurances of water quality by authorities at local levels, the yuck factor associated with public perception of potable water reuse is real. Although people often favor water reuse as a general concept, attitudes change when potable reuse projects become more tangible and are proposed in specific communities. However, these public perception hurdles are not immovable. Research has shown that public acceptance of water reuse is higher when information about the protection of water quality and public health is effectively communicated, when communities have a high level of confidence in public authorities, and when people are aware of ongoing water supply problems.

In the case of Florida, public policy played an important role in encouraging the adoption of water reuse. State policymakers have established the promotion and encouragement of water reuse as a formal objective. Elements of the Florida Administrative Code and Florida statutes that address water reuse focus on coordination and educational activities, and five water management districts develop rules to implement water reuse programs authorized by the state. Florida has further promoted water reuse within areas known as "water resource caution areas," which have current or projected water supply problems as determined by the Florida Department of Environmental Protection. Within the water resource caution areas, reuse of reclaimed water is required. The water management districts may limit the quantity of freshwater

that the municipalities and utilities can withdraw or, more directly, require implementation of specific types of reuse activities.

The Economics of Recycled Water

One interesting characteristic of recycled water is that it generates different levels of socioeconomic benefits depending on its end use. End uses, in turn, are associated with different required levels of treatment and thus different costs. For example, people are generally willing to pay much less for water used to flush toilets or irrigate parks than for drinking water. But it generally costs less to treat wastewater to irrigation standards than to potable quality.

Because the costs and benefits of recycled water are a function of its end use, the expansion of recycled water as an alternative to freshwater poses an unfamiliar challenge to regulators and researchers. Historically, water resource economists have studied the optimal allocation of freshwater of uniform quality, recommending that it be directed toward its highest-value use. However, when water is available in differing levels of quality, it may make sense to avoid high-value uses, such as augmenting drinking water supplies, given the potentially high cost of recycling technology. Instead, it may be best to treat the recycled water for use in a sector with less stringent standards for quality—agricultural irrigation, for example—even if the societal value of a unit of water in this sector may be lower. ●

FURTHER READING

Dupont, Diane P. 2013. Water Use Restrictions or Wastewater Recycling? A Canadian Willingness to Pay Study for Reclaimed Wastewater. *Water Resources and Economics* 1: 61–74.

Florida Department of Environmental Protection. 2014. 2013 Reuse Inventory. Tallahassee, FL.

Hartley, Troy W. 2006. Public Perception and Participation in Water Reuse. *Desalination* 187(1–3): 115–126.

National Research Council. 2012. *Water Reuse: Potential for Expanding the Nation's Water Supply through Reuse of Municipal Wastewater.* Washington, DC: National Academies Press.

© iStock.com

A View of the Environmental Policy Landscape from Outside the Beltway

An Interview with Paul Portney

In 2005, former RFF president and senior fellow Paul Portney ended his 33-year stint at Resources for the Future and headed west to become the dean of the Eller College of Management at the University of Arizona. He discussed how this move changed his perspective on environmental policymaking and the challenges posed by inequality, climate change, and water availability in a recent conversation with RFF Communications Director Pete Nelson.

PETE NELSON: When you left RFF, was it your sense that the timing was right with respect to broad shifts in the environmental policy and economic landscapes?

PAUL PORTNEY: At the time, I felt like there was less interest in the kind of objective analysis that RFF specializes in than there had been at any previous time in Washington because of an increasingly dysfunctional policy milieu at the national level. Related to that, I began to believe that it might be easier to make changes through the business community than through the political system. So the opportunity to be a business school dean was more attractive to me than would have been the opportunity to head a public policy program or something like that at a university.

I found that at the University of Arizona—and I think at all business schools—business students are increasingly interested in finding a way to make a good life for themselves while also doing good things for the country. That's really refreshing. Business schools around the country have social venture programs and talk more about corporate social responsibility than they ever did before. Marketing and finance are still the principal reasons people get an MBA, but, increasingly, there is a lot of student interest in clean energy, water resources, and other environmental issues.

NELSON: Once you moved to Arizona, how did your view of the landscape of environmental policy writ large in America expand beyond a Washington perspective?

PORTNEY: Going out West gives you a different perspective on things. People don't live and breathe what happens in Section 502b, Subsection c of an environmental regulation. They have bigger things on their plate: " How am I going to make a living, grow my business, and keep my house at a time when the economy is cratering?" After all, when I started as dean, the economy was just beginning to melt down.

There also is a bigger appreciation in the West for land use issues than environmental regulatory policy issues. Arizona, in particular, is a big agricultural state. It's also a big mining state. So when I talked to people

or read the papers there, they were more concerned with whether the Rosemont Copper Mine would get permitted than with power plant regulation or water pollution controls.

But it's also the case that had I moved to California from Washington, my experience would have been different because California is much more engaged in environmental regulation—more so than even Washington now. In Arizona, they still have that frontier mentality. "The least government we can have is the best" is the sentiment of many in Arizona. I recently retired and moved to California, and I really went from one extreme to the other.

NELSON: You mentioned the economic meltdown, and it strikes me that one of the conversations we've had over the last year or so at RFF concerns the issue of economic inequality and the fact that people are reluctant to reach into their pockets and pay for public goods when they are struggling to make ends meet. At the same time, many of the environmental solutions that might make sense on the economist's blackboard can have regressive consequences. How do you see this intersection between inequality and the need to safeguard the environment today and for future generations?

PORTNEY: I think one of the real challenges that the environmental advocacy community faces is that if inequality persists or gets worse, it's going to be hard to maintain the same kind of public support for environmental protection measures as was the case, say, between 1970 and 2000.

For people who care about continuing to protect the environment, we have to find a way to ease the burden on not just those in the bottom income bracket but increasingly even those at the lower middle part of the spectrum. Over the last 15 years, income per capita for those in the middle has stagnated or even decreased a little bit.

If inequality persists or gets worse, it's going to be hard to maintain the same kind of public support for environmental protection measures as was the case, say, between 1970 and 2000.

I'm on the board of a small, publicly traded electric utility in the Midwest in Missouri, and we are finishing up two major investments: putting a new air quality control system on a coal plant and replacing coal units and a couple of inefficient gas units with a combined cycle unit at another plant. Together, those two investments will cost the company $300 million and may increase electricity rates—I don't know—10 percent, let's say. That's in a relatively poor part of the country. I think people are going to be more sensitive to this kind of thing in the future and are going to be asking, "Well, what's this going to cost?" Their support will be partially conditional on that cost.

NELSON: That becomes an ethical problem and also a political problem. The idea that if you tax an environmental "bad" people will use less of it has come into wide acceptance. But so often the response from policymakers is "You know, I love market-based approaches. Now if you can just do it without increasing the prices voters face, we have a deal."

PORTNEY: I think that's true, and I think that's why when you hear discussions about, say, a carbon tax, the conversation usually goes "Okay, great; we're going to tax carbon. What taxes are we going to reduce?"

A carbon tax would have to be revenue neutral in able to make it politically palatable—certainly to almost all Republicans and maybe to some Democrats, too. If you want a carbon tax, for every dollar in carbon tax revenue that you expect to raise, you're going to have to reduce other taxes—whether on labor or capital or corporate income—by just as much. So it's definitely a challenge. My concern is if you look at the prospects for the US budget in the years ahead, we're going to need some revenue "positivity," not just neutrality.

This goes to the previous point that we were discussing: in the past when people felt like they were getting wealthier, they might have been willing to support measures that would increase environmental costs to them. That gets to be a much tougher sell now.

The good news is that RFF is well ahead of the game, as far as I'm concerned, on a carbon tax and most environmental issues. I can hardly claim to be objective, but RFF has done a terrific job of becoming a resource, including to people implementing policies under the Regional Greenhouse Gas Initiative in the Northeast and the cap-and-trade system in California. The locus of power for environmental regulation has shifted to the states, and I think RFF has become a valued resource for them in the same way that it has been for those policymakers in Washington who care about independent, high-quality analysis.

NELSON: In 2007, you wrote a popular policy commentary for RFF asserting that the two biggest environmental problems facing the United States and the world are climate change and vanishing open space. Do those still stand to you as the biggest challenges?

PORTNEY: Yes. I haven't changed my point of view on that although I would amend it slightly. I would add that water availability will be a third major issue in the years ahead. This may be a function of having spent nine years in Arizona and now having lived in California for what will be a year at the end of May.

We've had more than a decade of severe drought in the West. RFF has worked on water issues for a long time, going back to Chuck Howe, who directed the Water Resource Program from 1965 to 1970, and continuing with Kenneth Frederick, who joined RFF as a senior fellow soon after. The policy prescription that Ken and others put forward is that we have to price water more sensibly. We can't just give it away to farmers or anyone else. It's the right policy, but, again, it will make water more expensive. In Arizona and California, where water bills can be very high, that is going to be a tough sell. But I think that's the way we're going to have to go, and I have a greater appreciation for water availability than I did before moving west. ●

The locus of power for environmental regulation has shifted to the states.

Should We PRICE CARBON *from* FEDERAL COAL?

Alan Krupnick, Nathan Richardson, Joel Darmstadter, and Katrina McLaughlin

Conversations in the United States about policies to reduce emissions from fossil fuels have generally focused on a number of "downstream" approaches that target the end or intermediate users of fossil fuels. Notably, the US Environmental Protection Agency's proposed Clean Power Plan (CPP) addresses emissions from existing electric power plants, and fuel economy standards are reaching for a 50 percent reduction of carbon dioxide (CO_2) emissions from the transportation sector.

As an alternative to developing a large number of these downstream policies, an "upstream" approach—targeting fossil fuels as they come out of the ground—might be more efficient. Forty percent of US coal is produced on federal land managed by the Bureau of Land Management (BLM). Because coal is the most carbon-intensive of fossil fuels, and because our research shows a significant discrepancy between the price of coal from federal lands and the estimated global damages of coal, federal coal seems like a logical target for launching an upstream carbon pricing policy.

In new research, we examine whether BLM could—and perhaps should—impose an upstream carbon charge on this production. Such a policy would signal the Obama administration's intent to reduce CO_2 emissions (especially beyond what may or may not be achieved via the CPP). And it would set the precedent for a future, more substantive upstream charge on emissions, broadly applied to all coal and fossil fuels.

Our legal analysis reveals that the case for BLM having the statutory and regulatory ability to increase royalty payments on new coal leases is stronger than the case against. We refer specifically to new leases because BLM probably could not impose a charge on all production at once but rather only on new leases or as current 20-year leases

© iStock.com

expire and are renewed. Our confidence in BLM's legal position does come with a non-trivial disclaimer: BLM is charged by law with balancing multiple uses of federal lands, including mining (and the associated generation of federal revenue). Although the courts will generally defer to BLM's balancing of uses, climate-driven policy that would stop new federal coal mining (or nearly so) would invite tough judicial scrutiny in response to the inevitable lawsuits.

However, whereas the legal case for an upstream carbon pricing program under BLM seems fairly strong, the economic case appears noticeably weaker. Because most government coal leases have only one bidder, bid prices for the land might be reduced to account for the greater royalty rate. At the same time, depending on the competitiveness of the coal market, operators on federal land might have to absorb the carbon charge in lower profits. Both cases would result in no change in the coal price (and therefore no internalization of the related climate externalities). The effectiveness of a significant charge upstream also would be weakened because 60 percent of US coal is not produced on federal lands. That said, market demand for non-federal coal would likely rise if a significant carbon charge were implemented on federal coal, partly mitigating any price increases.

Interactions with downstream policies also must be carefully considered. Notably, double-counting must be avoided. Two prominent policies are the CPP and the Mercury and Air Toxics Standards (MATS) program. The CPP would internalize at least part of the climate change externalities from coal, so care must be taken that the combined policies don't put too high a premium on coal prices. At the same time, a rise in the coal price from a carbon charge might make the goal of the CPP easier to attain. As for MATS, reducing mercury emissions could become more expensive because the cheapest approach to reducing mercury relies on low-sulfur coal, much of which is on federal land.

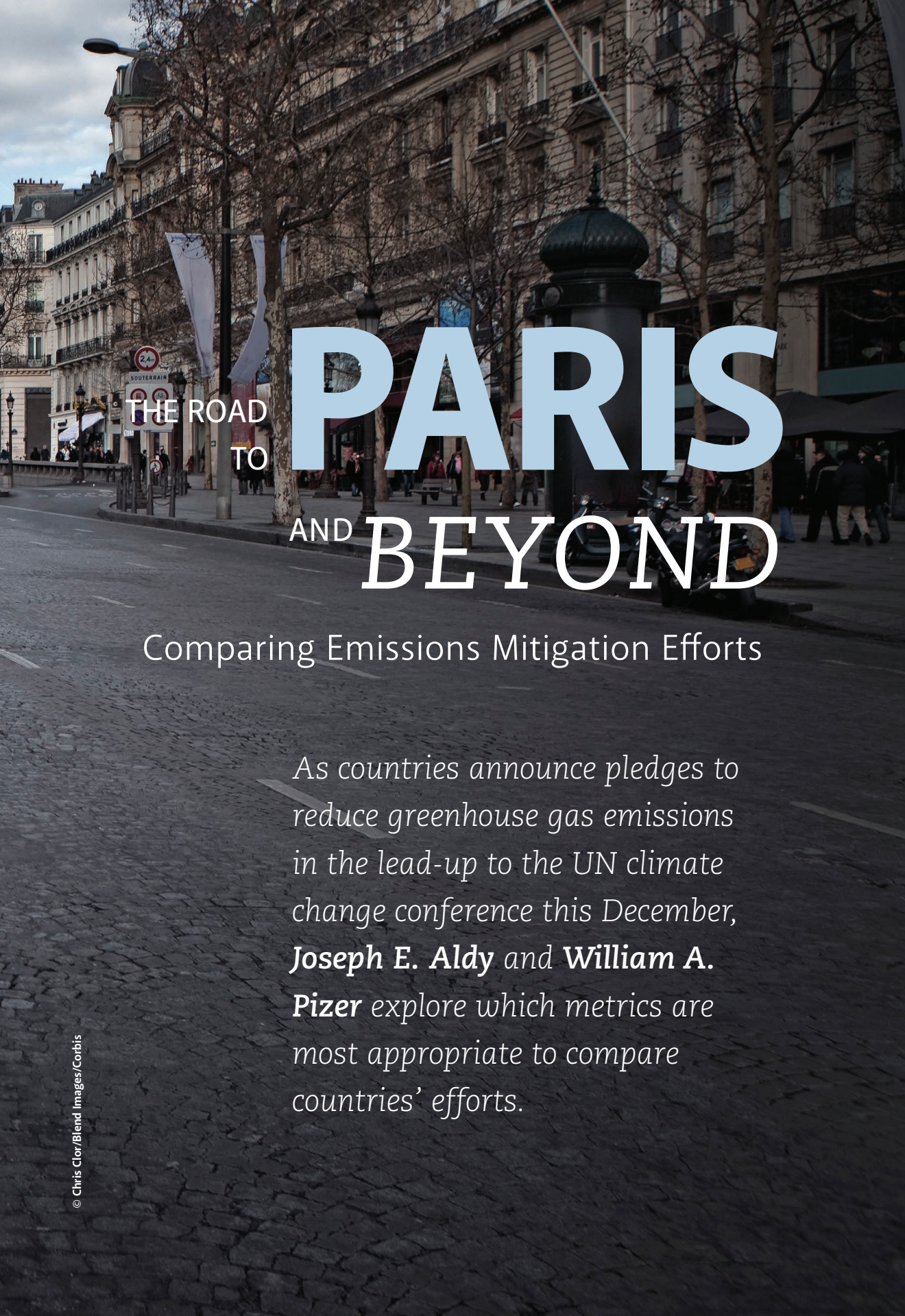
We did not focus on the appropriate size of the ultimate carbon charge in our research, but suppose one used as a starting point the social cost of carbon estimates developed by an interagency working group for the federal government to use in calculating the climate benefits of rulemakings. In this case, using the midrange of these estimates for 2020 of about $46 per ton of CO_2, the carbon charge would be more than $90 per ton of coal, far above the current price of federal Powder River Basin coal ($12 per ton). Without a long transition period, this approach could be highly disruptive to the coal market, the electricity market, and the economy as a whole.

As an alternative, BLM could incorporate a carbon charge even earlier than the leasing stage, applying it to its planning processes. This promising option is less likely to endanger BLM's multiple use mandate. The Council on Environmental Quality's newly revised draft guidance under the National Environmental Policy Act (NEPA) says that federal agencies should include climate change considerations in their planning efforts. In theory, BLM could examine a parcel of land that could be used for coal development—or for grazing or as a wildlife reserve—and consider a carbon charge in determining whether the land should be put up for coal leasing. ●

This article originally appeared on RFF's blog, *Common Resources*. It has been lightly edited for *Resources*.

FURTHER READING

Krupnick, Alan J., Joel Darmstatder, Nathan Richardson, and Katrina McLaughlin. 2015. Putting a Carbon Charge on Federal Coal: Legal and Economic Issues. Discussion paper 15-13. Washington, DC: RFF.



THE ROAD TO PARIS AND *BEYOND*

Comparing Emissions Mitigation Efforts

As countries announce pledges to reduce greenhouse gas emissions in the lead-up to the UN climate change conference this December, ***Joseph E. Aldy*** *and* ***William A. Pizer*** *explore which metrics are most appropriate to compare countries' efforts.*

© Chris Clor/Blend Images/Corbis

This year, countries will pledge to reduce their greenhouse gas emissions as part of the negotiations leading up to the UN climate change talks in Paris in December. These pledges will take on many different forms: targets as a percentage of year 1990 or 2005 emissions, percentage improvements in the ratio of carbon dioxide emissions to GDP, percentage abatement versus a "no-policy" reference case, renewable power goals, energy efficiency goals, afforestation goals, and more. Understanding the comparability of the pledged mitigation efforts will play a critical role in the negotiating process.

Such understanding is essential to build confidence among countries and to have a common interpretation of how pledges expressed in different forms stack up against one another. Similar efforts among similar countries would likely be seen as a "fair" deal, likely a necessary condition for broad participation now and increased ambition in the future. In addition, comparable costs of mitigation efforts across countries could represent a relatively cost-effective agreement and help level the playing field internationally for energy-intensive industries.

Comparing efforts requires metrics. Yet official agreement on specific metrics and a comprehensive policy surveillance mechanism is a tall order. To help inform the difficult task ahead, we have developed a set of three basic design principles and illustrate how an array of metrics might satisfy them. Because no single metric does well in meeting all the principles, we recommend a portfolio approach that assesses countries' estimated emissions levels, emissions abatement, carbon and energy price effects, and costs of implementation.

Similar efforts among similar countries would likely be seen as a "fair" deal, likely a necessary condition for broad participation now and increased ambition in the future.

Principles for Choosing Comparability Metrics

We identified three principles to help pinpoint which metrics to use in comparing nations' mitigation efforts.

1. Comprehensive. First, an ideal metric would be comprehensive, characterizing the entire effort actively undertaken by a country to achieve its mitigation commitment. Such a metric would clearly reflect all climate-related policies and measures—and exclude non-policy drivers of climate outcomes. It should take on similar values for countries undertaking similar mitigation efforts.

2. Measurable and replicable. Second, a metric should be measurable and replicable. The ability to replicate a given metric without subjective assumptions, using available public information, enhances the credibility of review. An emphasis on observable characteristics of effort—such as emissions levels, energy and carbon prices, and/or the use of particular zero-carbon technologies—also creates an incentive for countries to undertake actions that can be measured this way. This further facilitates transparency.

3. Universal. Third, metrics should be universal. Given the global nature of the climate change challenge, metrics should be constructed for and applicable to as broad a set of countries as possible.

US President Barack Obama meets with leaders of Brazil, China, India, South Africa, and other nations during the climate summit in Copenhagen in December 2009.

© Pete Souza/White House/Handout/The White House/Corbis

In practice, there will be trade-offs among principles in identifying and constructing metrics. For example, changes in emissions levels over time may be measurable and universally available in all countries, but this measure may not comprehensively represent mitigation effort. Mitigation cost may be a more comprehensive measure of effort but is not easily measured.

Comparability Metrics: Emissions, Prices, and Costs

Mitigation efforts can be measured many different ways, and the nations of the world are far from agreeing on a single way to do so. But the strengths and weaknesses of popular metrics begin to emerge when we examine how they stack up against our basic principles. These metrics fall into three general categories: those that focus on emissions, prices, and costs. Emissions (and other physical measures) are typically the outcomes that matter for the environment. Energy prices reflect the economic incentives to reduce emissions and energy use. Carbon prices and energy taxes reflect the particular incentives created by government policies. Cost metrics measure useful economic resources diverted away from current consumption and non-climate investment and toward abatement.

1. Emissions. An early comparability metric was emissions relative to 1990 levels, as specified in the Kyoto Protocol (see the box on page 22). More recently, the United States, Japan, and a handful of other countries have focused on emissions relative to 2005 levels. Ultimately, choices among such metrics come down to each country's interest in achieving a more favorable baseline. Changes in emissions over time may have nothing to do with effort. One popular approach to dealing with the particular influence of economic activity is to focus on emissions intensity, or tons of carbon dioxide emissions per GDP. Prior to the 2009 Copenhagen talks, China and India each proposed emissions goals structured as percentage reductions in the ratio of emissions to GDP. Such metrics can ensure that a country is neither penalized as a climate laggard simply because of faster economic growth nor rewarded simply because of economic decline.

Comparable Effort in International Climate Negotiations

The concept of comparable effort has evolved over the past several decades in international climate change negotiations. The 1992 UN Framework Convention on Climate Change and the 1997 Kyoto Protocol set emissions targets for developed countries and established the first and most enduring notion of comparability: emissions relative to a 1990 base year. By defining quantitative emissions limits this way, particularly in the Kyoto Protocol, negotiators effectively defined effort as the percentage reductions in emissions relative to 1990. This turned out to be a simplistic and potentially misleading approach that fails to distinguish between intentional reductions and those achieved by chance. For example, Russia's emissions have remained well below 1990 levels since the Kyoto agreement due to the state of its economy, not a broad and effective emissions mitigation program.

The term "comparability of effort" first emerged explicitly in the text of the 2007 Bali Action Plan, which noted that the concept should guide consideration of developed countries' emissions mitigation efforts. Then, at the 2009 UN climate talks in Copenhagen, the European Union and Japan each announced a willingness to implement more ambitious domestic emissions targets if other developed countries committed to "comparable" reductions. But different countries held different perspectives on how to measure and compare effort—and whether to also include the pledges by the fast-growing emerging economies, such as China and India. To promote the transparency of these mitigation pledges and facilitate a better understanding of effort, the Copenhagen Accord and the 2010 Cancun Agreements called for "international consultations and analysis" and "measurement, reporting, and verification"—review mechanisms comprising reporting, technical analysis, and a period of consultation with other parties.

The emerging international climate architecture reflected in decisions at the 2014 Lima climate talks further advanced the concept of pledge and review, building on the Copenhagen model. A number of countries, including the United States, have already tabled their mitigation pledges, referred to as "intended nationally determined contributions" (INDCs) in the negotiations, and more are expected to do so over the course of this year. The Lima Call for Climate Action notes that, through this pledge process, countries may submit additional information, including data, analysis, methods, and descriptions of implementation policies that may promote the transparency and credibility of countries' INDCs.

This evolution illustrates how economics can inform the implementation of the concept of comparability of mitigation effort. In the 2009 Copenhagen Accord and in what is expected for Paris, countries' emissions mitigation pledges take on different forms. A negotiator can no longer do a simple accounting like the one required in the 1997 Kyoto talks. Instead, economic data and analysis will be necessary to determine the credibility of countries' pledges.

Table 1. Metrics and Principles for Comparing Emissions Mitigation Effort

METRIC	PRINCIPLE		
	Comprehensive	Measurable and replicable	Universal
Emissions levels	No; a poor estimate of effort because it conflates natural trends	Yes; public domain data for energy and fossil carbon dioxide available	Yes for fossil carbon dioxide data, which exist for all countries; additional work needed for all greenhouse gases
Emissions intensities	Better than emissions levels, as it controls for economic trends, but a noisy signal	Yes; public domain data for energy and fossil carbon dioxide available	Yes for fossil carbon dioxide; additional work needed for all greenhouse gases
Emissions abatement	Yes; most comprehensive among emissions-related metrics	Challenging; requires modeling tools/subjective choices to determine counterfactuals	No; few modeling platforms evaluate more than 10 countries
Carbon prices	No; captures effort per ton, but says little about the quantity of tons or aggregate effort	Explicit, yes; implicit requires detailed analyses	No, given few explicit carbon pricing policies; modeling tools necessary for implicit carbon prices
Energy prices and taxes	No; inadequate for non-energy emissions; fails to account for non-market regulatory instruments	Yes, but unclear how to aggregate	Yes, but requires more detailed data collection than currently in public domain
Abatement costs	Yes; best measure of effort	Challenging; requires modeling tools/subjective choices to determine counterfactuals and model costs	No; few modeling platforms evaluate more than 10 countries

Unfortunately, emissions intensity as a measure of mitigation effort is confounded by several issues. Growing countries tend to experience a decline in emissions intensity, owing to technology improvements and changing economic structures rather than deliberate mitigation effort. It is difficult to know what level of intensity improvement represents effort versus growth effects. Also, faster growing countries typically experience a faster decline. This makes it difficult to compare countries growing at different rates. It also means that countries growing faster or slower than expected will find it easier or harder, respectively, to meet a target. One could instead compare levels of emissions intensity, rather than trends, but this involves the problematic conversion of local currencies into a single currency.

In recent years, regulators in some developing countries have become more interested in emissions goals specified as percentage reductions from a forecast level in a future year. Although it is more comprehensive than other emissions metrics in theory, calculating emissions forecasts in practice requires subjective judgments. If the government setting the goal also makes the forecast, it has an obvious incentive to project a high forecast in order to make the

target seem more ambitious than it is. Even if the forecast is unbiased, comparing a goal with forecast emissions is only more comprehensive in a prospective analysis. Retrospectively, comparing observed emissions with a forecast can still confuse mitigation effort with other non-mitigation events that affect emissions. A comprehensive retrospective metric would compare observed emissions with an analysis of emissions that would have occurred absent mitigation policies.

2. Prices. An observed carbon price bears a direct connection to effort, as it measures the economic incentive to reduce emissions created by a country's mitigation policies. It also reflects marginal cost. Comparing carbon prices across countries measures the degree to which a country is undertaking more or less expensive per-ton mitigation efforts. Because countries implement domestic carbon taxes and tradable permit markets in their local currencies, comparisons will require the use of currency exchange rates—and raise questions about appropriate conversions, similar to comparisons of emissions intensity. Moreover, carbon prices will not reflect mitigation efforts associated with non-price policies—such as efficiency standards and renewable mandates—and most carbon prices are not applied to all of a country's emissions. A country also may undermine the effectiveness of the carbon price by adjusting taxes downward for firms covered by the carbon price, through so-called fiscal cushioning.

Alternatively, one could consider implicit (or "effective") carbon prices that estimate the average cost of abatement associated with a specific climate policy or collection of policies. Such implicit prices have the advantage of potentially being applied to a broader set of policies but the disadvantage of not being directly observed. Instead, they are produced by model simulations. Implicit prices also do not reflect actual impacts on energy prices, which are often the focus of those concerned about economic competitiveness.

This leads us to consider energy directly. Energy prices are transparent and measurable with high frequency. Energy prices permit a net assessment of all price-based policies (including carbon pricing) and thus can mitigate concerns that a country engages in fiscal cushioning and speak directly to competitiveness concerns. But this would again fail to capture effects from non-price regulations and be a poor measure of effort for countries with significant non-price policies, including the United States.

3. Costs. Ultimately, concern about the costs of combating climate change represents one of the most—if not the most—significant impediments to serious action by countries around the world. Costs also are closely aligned with most economists' notion of effort. A metric to compare effort based on costs—expressed as a share of national income or per capita—could examine whether comparable countries bear comparable costs from their actions. A metric based on the cost of actual policies would have the potential disadvantage of rewarding costly but ineffective policies. A complementary metric could examine the cost of achieving the same emissions outcome but using the least-costly policy. This would highlight the potential advan-

We recommend a portfolio of metrics, mirroring how analysts describe the health of the macroeconomy with a suite of statistics.

tages of some policies (that reduce more emissions with lower mitigation costs) over others. Estimating costs, however, requires economic assumptions and detailed modeling frameworks for evaluating economic changes in specific sectors and national economies.

A Portfolio Approach

No single metric scores well against all the principles. Those that are easily measured—emissions levels and intensity compared to historic levels—do not discriminate between effort and happenstance. Prices provide an observable snapshot for certain policies but not others. Emissions abatement and abatement costs probably best represent effort but require subjective assumptions and modeling to estimate. Credible differences in opinion over assumptions will produce different results, complicating any comparison and reducing confidence. The necessary modeling tools are also quite limited outside the largest developed and developing countries.

With this in mind, we recommend a portfolio of metrics. Such an approach would mirror how analysts describe the health of the macroeconomy with a suite of economic statistics that includes GDP, the unemployment rate, the inflation rate, and interest rates.

Reviewing Pledges on the Road to Paris and Beyond

Analyses that compare climate change pledges and actions across countries are increasingly relevant as we transition to unilateral pledges of domestic action and policy within international negotiations. The emerging architecture calls for countries to state what they intend to do, form views about the adequacy of each other's efforts, and react accordingly as they implement policies and make further pledges in the future.

No single metric comprehensively measures effort, is easily measured, and is universally available for all countries. Moreover, each country will prefer measures that improve its appearance. This makes it unlikely that an official metric will emerge. Instead, countries will advertise and utilize the metrics they prefer. Analysis is necessary to translate among metrics, particularly those that are harder to measure.

Compiling data and conducting this analysis of metrics will require a serious, transparent, and legitimate process. Although an official surveillance process may be years away, independent researchers can fill the gap. An array of metrics could be developed alongside data collected by existing international organizations to facilitate comparisons. Unofficial but independent expert analysis could further synthesize these data to estimate metrics that require forecasts and modeling. In turn, stakeholders and other users could provide feedback on the feasibility, integrity, and precision of available metrics and estimates. This would enable further refinement and improved estimates going forward. Given that Paris is just the beginning of an ongoing process of policy commitments, these refinements and improvements can ultimately feed into greater confidence and stronger ambition among all countries. ●

FURTHER READING

Aldy, Joseph E. 2014. The Crucial Role of Policy Surveillance in International Climate Policy. *Climatic Change* 126(3–4): 279–292.

Aldy, Joseph E., and William A. Pizer. 2014. Comparability of Effort in International Climate Policy. Discussion paper 14-62. Cambridge, MA: Harvard Project on Climate Agreements.

Fischer, Carolyn, and Richard Morgenstern. 2008. Metrics for Evaluating Policy Commitments in a Fragmented World: The Challenges of Equity and Integrity. Discussion paper 08-17. Cambridge, MA: Harvard Project on Climate Agreements.

AMERICA'S AWAKENING AS AN

Arctic NATION

David J. Hayes *explains why the time is ripe for the United States to become a global leader in striking a balance between economic development and conservation in the resource-rich and rapidly changing Arctic.*

The federal, state, and tribal institutions responsible for managing change in the Alaskan Arctic are searching to find the right balance between promoting new economic opportunities and honoring Alaska's deeply rooted conservation- and subsistence-based culture and values.

With sea ice melting at remarkable rates, lanes are opening up in the Arctic, inviting enterprising shippers to ply the no longer mythical Northwest Passage through Canada and Alaska or the Northern Route through the Russian Arctic. Business interests also are looking to get on the bandwagon as they seek to develop the Arctic's prodigious oil and gas riches—as well as new mining and fishing opportunities. Major cruise lines and ecotourists are not far behind.

The same profound climactic changes that are opening up the Arctic to business interests are impacting the centuries-old balance between the Arctic's Inupiat and Athabascan natives and the wildlife that they traditionally have relied on for food. Polar bears, walruses, and other species that depend on fast-disappearing sea ice are becoming more scarce, migration patterns for whales and caribou are changing, and long winters are yielding to fire-prone summers. Meanwhile, many small Alaska Native coastal villages that were long protected from erosion by sea ice are now losing ground—literally—with some villages like Kivalina and Shismaref facing an urgent need to relocate.

On the international stage, the eight Arctic nations that form the Arctic Council (the forum that brings together the nations that have lands in the Arctic region) are struggling to adapt to the new rush to the Arctic. The United States took over as chair of the Arctic Council in April for two years, and it has an opportunity to set the tone for how to manage these rapid and sometimes-conflicting developments in both Alaska and the international Arctic. Its success may hinge on whether it can bring its own house to order. Its best chance may be by adopting a science-based integrated Arctic management approach that coordinates the decisionmaking processes of the many federal and state government agencies involved in the Arctic, reaches out to all stakeholders, and pulls together the science relevant to planning and decisionmaking in the Arctic.

Economic Trends in the Arctic

Over the past 40 years, economic development in the Alaskan Arctic has revolved around oil. The discovery of world-class oil fields on state lands in the Prudhoe Bay region triggered construction of the Trans-Alaska Pipeline System (TAPS) in the 1970s and the subsequent and ongoing delivery of a major proportion of US oil production. Throughput in the TAPS pipeline has been on the decline since 1988 as North Slope fields have aged, leading to strong US interest in expanding drilling there and in offshore waters—and in building a natural gas pipeline that would bring the region's huge and currently shut-in natural gas supplies to both Alaskan and foreign markets.

Other Arctic nations also have been eager to develop oil and gas supplies in the region, with Norway and Russia leading the way. There are major questions about the safety of these exploratory activities, particularly those that are being conducted in ice-impacted waters, where an oil spill could have catastrophic consequences.

The opening of sea lanes brings the possibility of new mining activities in the Arctic. Alaska's Red Dog mine is one of the world's largest zinc mines, despite the absence of a deep-water port or other support facilities in the region. Many international mining companies have their eyes on potential

© George Steinmetz/Corbis

mineral development in Greenland, Russia, and Canada, among other Arctic nations.

At the same time, marine shipping activity is ramping up throughout the Arctic, coincident with the retreat of summer ice. Trips through the Bering Strait have doubled in the last 5 years, with more than 400 annual transits now the norm. But with no deep-water ports in the Alaskan or Canadian Arctic and virtually no near-shore capability to address a marine shipping accident, the US Coast Guard—which itself has no permanent station within 1,000 miles of the Arctic—is concerned that the Arctic nations are unprepared to handle the exploding maritime activity.

Arctic Communities Facing New Challenges

Climate change is the big story in the Arctic, which is among the fastest-warming regions on Earth. The mean annual temperature on Alaska's North Slope increased by nearly 5 degrees over the past 60 years, with much of that rise occurring recently. Over the next 30 years, the US Arctic's average annual air temperature is predicted to increase by an additional 4 degrees. The result, as discussed in a March 2013 report to the president, may be "a nearly ice-free Arctic Ocean before mid-century, and possibly before 2030."

The loss of sea ice and warming oceans threaten the continuing viability of sea ice–dependent species and also potentially impact phytoplankton production—a building block of Arctic food chains.

Just as the climate is changing Arctic seascapes and landscapes, it also is impacting traditional ways of life for Alaska Natives. Of special concern are the as-yet unknowable impacts that climate change will have on food security. Many Alaska Natives rely on the abundance and availability of local wildlife for subsistence.

It is too early to know where and how climate change will disrupt subsistence hunting opportunities, but some early indications are disturbing. For example, bowhead whales, a traditional source of food for several Arctic villages, appear to be adopting migratory paths that swing them farther offshore, increasing the danger of whale hunts.

Development pressures also pose a threat to subsistence practices. The Gwich'in people, who have occupied the town of Arctic Village and its surrounding lands for thousands of years, have long objected to oil development on the coastal plain of the Arctic National Wildlife Refuge because it is the central calving area for the Porcupine caribou herd, one of their primary food sources. Many Alaska Natives have objected to proposals to build additional roads into potential mining areas for fear that they will disrupt wildlife patterns. As these examples illustrate, there often is close alignment among the many Arctic residents who rely on nature to provide their food security and the incomparable conservation values that the Arctic's wild, largely intact natural ecosystems provide to the world.

Other communities and Native corporations in the Alaskan Arctic have been reaping economic benefits from oil development in the Prudhoe Bay region, prompting some Native voices and other residents to advocate for more oil and gas development in the region. Financial ties and dependencies are increasing. As a recent example, Shell Oil Company has entered into an arrangement that will enable certain Native corporations to participate financially in the offshore exploration activities it is conducting in the Chukchi Sea.

There is also hope that the development of new renewable energy infrastructure can play a big role for many of these communities, particularly for seaside towns that

Caribou from the Porcupine herd travel around their calving grounds on the coastal plain of the Arctic National Wildlife Refuge, Alaska.

© Steve Kazlowski/Science Faction/Corbis

have strong wind resources. Most remote communities in the Arctic rely entirely on diesel-fired generators for their energy. The fuel is dirty and expensive—costing $10 or more per gallon. The US Department of the Interior and the National Renewable Energy Laboratory have been teaming up with the Alaska Energy Authority and several nongovernmental organizations and companies to develop standardized, modular small-scale renewable energy system specifications that will bring down procurement and maintenance costs for new deployments. Known as the Remote Communities Renewable Energy Partnership, the effort holds the promise of bringing affordable renewable energy to off-the-grid villages in Alaska.

Moving toward an Integrated Arctic Management Approach

While there have been some bright spots, governmental institutions have had difficulty in responding in a thoughtful, coordinated manner to the heightened interest that many parties from all sides of the spectrum have in the rapidly changing Arctic. Within the federal government, 20 agencies play roles in the Arctic. Multiple state agencies also have jurisdictional interests, as do dozens of local, tribal, and native corporation entities. Project proposals are subject to a round robin of governmental reviews by agencies that typically focus on their narrow jurisdictional perspectives, frustrating project proponents and those concerned about how projects fit into the larger picture.

This conundrum came to a head in 2011 when Shell Oil Company complained that multiple federal agencies were not coordinating their reviews of its proposed offshore oil exploration activities. The president responded by setting up the Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska.

In its report to the president, the group pointed out the limitations of project-by-

project reviews in the Arctic and recommended adoption of a science-based, integrated Arctic management approach to decisionmaking. This would allow a broader view of how key decisions are made in the Arctic by soliciting input from residents, governmental officials, and other interested parties. And it would pull together relevant science so that good decisions can be made against a backdrop of a broader understanding of the area's needs and sensitivities.

The White House adopted this approach in its May 2013 national strategy document for the Arctic. The national strategy explained:

> *Natural resource management will be based on a comprehensive understanding of environmental and cultural sensitivities in the region, and address expectations for future infrastructure needs and other development-related trends. This endeavor can promote unity of effort and provide the basis for sensible infrastructure and other resource management decisions in the Arctic. We will emphasize science-informed decisionmaking and integration of economic, environmental, and cultural values. We will also advance coordination among federal departments and agencies and collaboration with partners engaged in Arctic stewardship activities.*

To date, the goals outlined in the national strategy have yet to be realized. The White House released an "implementation" document in January 2014 that described the work that many federal agencies have under way in the Arctic but did not attempt to prioritize or integrate related activities across agencies. This was followed earlier this year by the president's issuance of an executive order that set up the Arctic Executive Steering Committee, consisting of 23 senior White House and department and agency officials, chaired by the president's science advisor.

A drilling platform operated by ConocoPhillips in Cook Inlet, Alaska, produces natural gas.

© Mark Stadsklev/Design Pics/Corbis

These are well-intentioned efforts, but they fall short of the type of steps needed to make integrated Arctic management a reality. Integrated Arctic management will not be successful as an abstract, science-focused exercise that various federal agencies working in the Arctic pursue via the sharing of information and some cursory coordination of agency activities. Instead, it requires an overarching understanding and evaluation of the major decisions that are being faced in the Arctic. These include development-related decisions, such as whether and where deepwater port(s), oil and gas, mining, or tourism-related infrastructure should be sited in the Alaskan Arctic. They also include conservation-related decisions, such as how to best maintain the Arctic's high-functioning terrestrial and ocean-based natural systems that serve subsistence and conservation values.

Thus, the first question is, what are the major decisions that should or will be made over the medium to long term in the Alaskan Arctic, based on the hopes and aspirations of key stakeholders, particularly the region's residents? And for each of those likely or potential decisions, what is the relevant economic analysis and scientific information (including traditional knowledge) that is needed to make a sound decision? Is that information being developed within an appropriate time frame?

For decisions involving the siting of new infrastructure or other potential development activities, information is also needed regarding where such infrastructure and related activities would be best situated, given environmental sensitivities, economic realities, and the interests of key parties.

This type of truly integrated Arctic management decisionmaking presents a major governance challenge for the United States. At the federal level, many agencies have slices of relevant authority and expertise. It is unclear who would make high-level decisions for the Arctic and how they would marshal relevant economic and scientific information. The challenge is compounded by the imperative to fully include state, local, and tribal governments in the decisionmaking process—and by the enormous financial resources required to build new icebreakers, ports, and other infrastructure that a melting Arctic surely will need.

Perhaps the newly created Arctic Executive Steering Committee will step up and take on this role. The timing is right. Initial indications are that the United States is on the right path in terms of the focal areas for its chairmanship of the Arctic Council: the impacts of climate change in the Arctic, stewardship of the Arctic Ocean, and improvement of the economic and living conditions for Arctic residents.

What remains unclear is whether the US government will be successful in getting its own Arctic house in order and become a model for how development and conservation decisions should be made in the fragile, wild, and rapidly changing Arctic. ●

FURTHER READING

Alaska Arctic Policy Commission. 2015. *Final Report of the Alaska Arctic Policy Commission.*

Conley, Heather. 2013. The New Foreign Policy Frontier: US Interests and Actors in the Arctic. Washington, DC: Center for Strategic and International Studies.

Ebinger, Charles K., John P. Banks, and Alisa Schackmann. 2014. Offshore Oil and Gas Governance in the Arctic. Policy brief. Washington, DC: Brookings Institution.

Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska. 2013. *Managing for the Future in a Rapidly Changing Arctic—A Report to the President.*

The White House. 2013. National Strategy for the Arctic Region.

World Economic Forum Global Agenda Council on the Arctic. 2014. *Demystifying the Arctic.*

The Promise of US ARCTIC OIL & GAS POTENTIAL

A new study brings together diverse perspectives from government, industry, the environmental community, and Alaska Natives and finds that prudent drilling in the Alaskan Arctic is within reach. ***Carol Lloyd*** *reports.*

Drilling in the Alaskan Arctic is an important topic on the minds of environmentalists, policymakers, and those in the oil and gas industry. Opinions are strongly held and diverse. On one hand, some in the environmental community will say absolutely no drilling should be allowed. On the other hand, the US Department of the Interior issued exploration leases in 2008, Shell is mobilizing equipment to Alaska to progress its offshore exploration drilling program this summer, and other countries are moving forward with their own Arctic exploration and development. At the heart of the issue is the question of the risk of an oil spill in Arctic waters.

The National Petroleum Council brought together these very different perspectives constructively with the recently released report *Arctic Potential: Realizing the Promise of US Arctic Oil and Gas Resources*. The comprehensive technical report was completed in response to a request from Secretary of Energy Ernest Moniz, who asked, "What research should be pursued, and what technology constraints must be addressed to ensure prudent development of Arctic oil and gas resources?" The National Petroleum Council convened more than 250 Arctic experts from over 100 diverse organizations, including representatives from government, Alaska Native communities, the environmental community, academia, and the oil and gas industry. The study team held two technology workshops—one in Washington, DC, with representatives from the National Labs and other federal agencies, and one in Alaska, with academic, local, and Native representatives. The coordinating subcommittee, made up of 23 senior leaders from 20 organizations, met monthly over the last year to deliberate on Secretary Moniz's questions. The result is a 500-plus-page report, documenting the state of technology and research in six key areas related to the Arctic offshore: ecology, the human environment, ice characterization and measurement, technology for exploration and development, logistics and infrastructure, and oil spill prevention and response. The report was unanimously approved by the National Petroleum Council on March 27, 2015.

The study found that substantial recent technology improvements in the area of oil spill prevention make the risk of an oil spill in the US Arctic extremely remote. This technology, including subsea shut-in devices and

© iStock.com

capping stacks, was developed in response to the Deepwater Horizon tragedy. To date, a subsea shut-in device was installed on a well drilled in the Kara Sea in 2014, and another has been developed, tested, and demonstrated for planned use in the Canadian Beaufort. In addition, Shell has a capping stack available for planned drilling this summer in the US Arctic. These technologies are recognized as providing superior environmental protection compared with the current practice (of same-season relief wells) but are not yet fully accepted by all stakeholders in the United States as a replacement. The study recommends that the Department of Energy and Department of the Interior move forward with the analyses, investigations, and any necessary demonstrations to validate these technologies. The study also recommends that government agencies join an ongoing industry collaborative research program that has progressed testing of oil spill response technologies in Arctic conditions. This project has been under way since 2012, with participation from eight major oil and gas companies from around the world.

The study also found that the United States has substantial undiscovered oil potential, similar to Russia and larger than Canada and Norway. The majority of this potential is in relatively shallow water of less than 100 meters and can be safely explored for and developed using existing field-proven technology—technology that has already been deployed in the US Arctic and other Arctic regions. But although the study found no technology constraints to prudent development of US Arctic oil and gas resources, two regulatory constraints limit the pace of exploration—season length and lease terms. Regarding season length, the study recommends additional research to validate technologies available to safely extend the drilling season, such as was used successfully in the 1970s and 1980s in US and Canadian Arctic waters. Regarding lease terms, the study recommends that the Department of Energy and the Department of the Interior assess the current US lease length and terms, compared with those of other Arctic nations and compared with the time required for exploration operations.

Realizing the promise of US Arctic oil and gas resources will require public confidence that the opportunity can be pursued in a prudent manner, safely and while maintaining environmental stewardship. Public confidence can be improved through collaborative studies and research, as recommended in the report, on the topics important to all stakeholders: safe and responsible exploration drilling and oil spill prevention and response in an icy environment. The results of these studies should inform future regulatory and policy actions.

The National Petroleum Council's new report and the recommended research will promote good science for sound policy, and other nations have taken note. The Norwegian Ministry of Petroleum and Energy has requested permission to translate portions of the report for presentation to the Norwegian Parliament. ●

The executive summary and full report are available online at www.npcarcticpotentialreport.org.

Substantial recent technology improvements in the area of oil spill prevention make the risk of an oil spill in the US Arctic extremely remote.

Complying with EPA's

CLEAN POWER PLAN

Policy Options for States

Under EPA's proposed carbon dioxide regulations for power plants, states have a remarkable opportunity to craft individual compliance plans best tailored to their needs. ***Karen Palmer*** *and* ***Anthony Paul*** *offer insights on the most important considerations and effective approaches.*

Power plants are responsible for more than one-third of greenhouse gas emissions and a slightly higher share of carbon dioxide (CO_2) emissions in the United States. On June 2, 2014, in a landmark step toward a national climate policy, the US Environmental Protection Agency (EPA) announced the Clean Power Plan, its proposal for regulating CO_2 emissions from existing power plants under Section 111(d) of the Clean Air Act. The proposal plays an important role in the US Intended Nationally Determined Contribution, recently submitted by President Obama to the UN's climate negotiation process. A distinguishing feature of the plan is the central role of states.

The proposed Clean Power Plan embodies a federal–state partnership under which EPA sets emissions reduction goals and states make policies to meet them. Given the many potential regulatory paths open to states and the limited experience at most state air and environmental offices with regulating CO_2 emissions, the flexibility accorded to states under the Clean Power Plan presents a challenge. At the same time, it provides an important opportunity for states to choose from a variety of options that can be tailored to best suit their needs.

As part of the proposal, EPA has laid out four building blocks that it says comprise the "best system of emissions reductions" and that form the basis for each state's emissions rate goal as proposed by EPA. However, the proposed rule encourages flexibility by suggesting many potential mechanisms that states could use for compliance. In fact, states are free to

© Studioleng/Corbis

choose any regulatory approach that they can demonstrate to EPA will achieve the goals, whether employing a comprehensive approach through a single climate policy or a portfolio of policies that together can bring a state into compliance. Elements of a portfolio could be implemented in conjunction with a comprehensive policy; however, a comprehensive policy can address all sources of emissions and provide stringency sufficient for any level of emissions or emissions rate reduction without any other policy in place.

At a high level, the advantages of flexible, comprehensive policies are twofold: cost-effectiveness and administrative simplicity. These policies work by creating goals and incentives for emissions reductions or, in some cases, clean technology adoption. But they leave it to the market to find the least-cost way to achieve the desired environmental outcome. Comprehensive policies are also robust to unexpected changes in market conditions or technology costs because they do not pick a particular technology for reducing emissions. Administrative simplicity springs from the comprehensive nature of the policies; one policy alone is sufficient.

In our research, we examined three forms of incentive-based, comprehensive policies: a mass-based policy, a rate-based policy (which we also refer to as a tradable performance standard, or TPS), and a clean energy standard (CES). Each of these comprehensive policies imposes a cost and, in some cases, an electricity production (or consumption) incentive on different types of generators or consumers based on emissions, production, or consumption.

Setting State Goals: Rate versus Mass?

A state compliance plan may either retain the emissions rate-based goal published by EPA or convert it to a mass-based goal, essentially setting a limit on tons of CO_2 emissions. Each form of the goal has advantages and disadvantages.

A rate-based goal allows for flexibility in that emissions can automatically adjust to unanticipated changes in the amount of covered generation due to factors such as unusual weather trends or unexpected changes in population or economic growth. This flexibility would reduce the cost of reaching the goal in the case of faster-than-expected growth and enhance environmental benefits in the case of slower-than-expected growth.

A mass-based goal provides environmental certainty and would lead to outcomes opposite those of rate goals: greater environmental benefits under fast growth and reduced cost in the case of slow growth. It also offers relative simplicity in demonstrating compliance with a state's implementation plan because the state would simply show the mass of emissions produced, versus separately measuring emissions and generation (and potentially energy efficiency savings) components of an emissions rate target.

The main issue a state must consider when choosing between a rate- and a mass-based goal is the uncertainty about how the power sector will evolve between now and 2030. It is also important to recognize that the form of the state goal and the form of the policy to achieve that goal need not be the same. A state can combine a rate-based goal with a mass-based policy and vice versa.

Mass-Based Policies

A mass-based policy for emissions reductions (sometimes referred to as a cap-and-trade policy) is the most flexible type of policy to reduce CO_2 emissions. The basic mechanics of a mass-based trading policy are simple. A regulator chooses an emissions budget (cap) denominated in tons of CO_2, which is why we refer to this policy mechanism as mass-based. The budget can change over time and typically is structured to decline over time, creating increasing emissions reductions. At regular intervals, the government distributes, either through an auction or through direct allocation, a quantity of emissions allowances that typically, over the course of a year, equals the annual emissions budget chosen by the regulator. Each allowance corresponds to one ton of CO_2 emissions. Any covered generator that emits CO_2 must acquire an allowance for each ton of emissions and surrender to the government sufficient allowances to cover all of its emissions at the end of the compliance period. The allowances are fully tradable and generators with emissions greater than the number of allowances initially purchased at auction may acquire more allowances from others who have them in excess. Assuming that the regulator has chosen an emissions budget that is below the level of emissions that would occur in the absence of any program, the allowances will be scarce and acquire a positive price as they are purchased at auction or traded. A tighter budget will lead to higher allowance prices and therefore more emissions reductions than a looser budget. If states choose to join together, they can simply aggregate their state-level budgets to construct a multi-state budget.

Rate-Based Tradable Performance Standards

A flexible rate-based system, which we will refer to as a tradable performance standard, sets an emissions rate standard that the regulated sector must meet on average. It obligates generators that emit at a rate above the standard to buy tradable allowances from those who make power at an emissions rate below the standard. Those generators that are cleaner than the standard are awarded allowances based on how far below the standard they are and how much they produce. For example, if the standard is set at 1,000 pounds per megawatt hour (MWh), a generator operating at 990 pounds per MWh would receive 10 allowances for every MWh produced. Generators that emit at rates above the standard are charged based on how far above they are and how much electricity they produce.

If states choose to join together under a TPS, all the cooperating states could adopt a uniform emissions rate goal, or there could be geographic differentiation, whereby states would retain their own emissions rate goals but allow interstate trading. However, if the cost-effectiveness benefits of state cooperation lead to reduced electricity prices and greater consumption, then emissions could rise as a result of cooperation. Emissions might also rise even if demand does not change, if generation gravitates to the states within the trading region that have the higher emissions rate goal.

The advantages of flexible, comprehensive policies are twofold: cost-effectiveness and administrative simplicity.

Clean Energy Standards

A clean energy standard is another form of comprehensive carbon emissions abatement policy. A CES is a portfolio standard, like a renewable portfolio standard (RPS), that stipulates a minimum percentage of power demand must be met by qualified clean energy technologies. A CES creates tradable clean energy credits denominated in MWh and awards them to a broader array of generation technologies with low carbon intensity than are credited under an RPS. Local distribution companies are obligated to hold a minimum percentage of credits based on sales. They buy the credits from the generators that earn them based on production.

The core difference between a CES and an RPS is the treatment of nuclear, natural gas, and coal or gas with carbon capture and storage. An RPS treats all these zero- and low-carbon generation technologies the same way as traditional coal-fired boilers: it gives them no credit. A CES can give equal credit to nuclear generation and renewable generation and credit each MWh of generation by natural gas at a lower rate. The crediting rates for clean generating sources can be set in different ways.

Technology-based crediting would provide a credit based on technology type, typically giving nonemitting generators a full credit per MWh, gas combined-cycle units a half credit, and coal and gas generators with carbon capture and storage 90 or 95 percent of a credit, respectively. These crediting rates are roughly concordant with the relative carbon intensities of the different generation technologies compared with that of a coal boiler.

Intensity-based crediting defines clean energy credits based on emissions performance relative to an emissions rate standard. This approach rewards emissions rate reductions within the natural gas generation fleet in addition to providing incentives for more generation from non-emitting sources.

A well-designed CES will share most of the properties of a TPS or mass-based policy that uses an output-based approach to allocating allowances. The main difference is that a CES goal is expressed as a percentage of electricity consumption (MWh), instead of in emissions or emissions rate terms, and the credits are denominated in MWh.

> It may be easier for states that want to work together to implement a joint mass-based policy than it is to combine multiple rate-based approaches.

Making the Policy Choice

The cost-effectiveness of each approach described here will depend on the extent to which the particular policy influences the range of relevant choices within the sector about the fuels and technologies used to produce electricity, as well as the level of electricity production itself. From a state's perspective, it also may depend on what policies neighboring states implement and the extent of power trading across state borders. All these issues are important for states to contemplate as they formulate their plans for compliance with the Clean Power Plan once the rule is finalized by EPA later this year.

Among the three policy options, a mass-based approach has many virtues, including ease of measuring compliance and

simplicity in administration. It also may be easier for states that want to work together to implement a joint mass-based policy than it is to combine multiple rate-based approaches. One consideration when designing such a policy is determining how to allocate the value of emissions allowances: to electricity producers, electricity consumers, or government for purposes outside the electricity sector.

Economics research suggests that using the revenue from such a policy to offset distortionary taxes on capital and labor may be the most efficient policy. The opportunities for such efficiency-enhancing tax reforms have been studied extensively in the federal context but less so at the state level. The government also may choose to use allowance revenue to pay for research and development related to clean energy technologies or to refund the value to consumers in a way that is divorced from energy consumption choices. Several of the options for allowance allocation that are popular for distributional or political reasons affect economic incentives within the power sector, with implications for cost-effectiveness and incidence of the policy. This makes the allocation of allowance value an important consideration. ●

FURTHER READING

Palmer, Karen, and Anthony Paul. 2015. A Primer on Comprehensive Policy Options for States to Comply with the Clean Power Plan. Discussion paper 15-15. Washington, DC: RFF.

FALLING OIL PRICES

Implications in the United States

Stephen P.A. Brown *tells us what the steep decline in world oil prices means for the US economy, energy security, and the environment.*

Although they have increased since hitting bottom in January, world oil prices are nearly $50 per barrel lower than in June 2014 as of this writing in March. The futures market shows the drop will be sustained but with gradual increases over the next five years. The decline in oil prices is the result of both weak demand and increased supply. World oil market participants gradually realized that weak economic activity in China, Japan, India, and Europe lessened oil demand. At the same time, the world oil market saw growing supply, particularly from US shale oil production.

As a result of lower crude oil prices, US gasoline prices were lower in January 2015 than they had been in more than six years. With crude oil prices rising and recent disruptions in US refinery operations, however, gasoline prices have risen by about 50 cents per gallon since January, with seasonal gains of about another 20 cents per gallon expected by Memorial Day. Despite the recent gains, oil and gasoline prices remain well below their mid-2014 values, and those lower prices should prove a mild stimulus to US economic activity, although the economic effects are likely to be uneven across the country. Energy security may be reduced, and oil-related pollution is expected to increase.

Effects on US Gasoline Prices

The reduction in crude oil prices should translate to an average of nearly $1.30 per gallon reduction in US pump prices for gasoline in 2015. Taking into account the effect that disruptions of US refinery operations have had on prices, average pump prices are likely to be only about $1.15 lower in 2015 than in mid-2014.

The futures market for crude oil shows a slight upward trajectory. If that trajectory is sustained, a simple regression model based on the relationship between pump prices for gasoline and for crude oil prices shows that US pump prices for regular gasoline should be expected to average about $2.41 per gallon in 2015. They were $3.69 per gallon in June 2014.

If we take into account the normal seasonal variation in gasoline prices and the recent disruption of refinery operations in the regression model, we see a slightly different picture. Gasoline prices are higher in the summer months than the winter months. We should expect to see a high of about $2.72 per gallon in April 2015, and a price of about $2.43 per gallon in December 2015. The average price for 2015 should be about $2.56 per gallon.

The reduction in crude oil prices should translate to an average of nearly $1.30 per gallon reduction in US pump prices for gasoline in 2015.

Will Reduced Oil Prices Be Sustained?

We have seen two episodes of sharp oil price declines in the past 30 years. World oil prices took sharp dives in 1985–1986 and again in 2008. Except during the Gulf War in 1990, the 1985–1986 decline in oil prices was generally sustained until 2002, when a stronger global economy began driving solid increases in world oil demand. By contrast, the sharp oil price drop in 2008 followed a sharp increase earlier in the year. By mid-2009, oil prices were a little higher than they were in 2007.

The conditions associated with the 2014 drop in world oil prices appear to be similar to those associated with the 1985–1986

© iStock.com

drop. In both 1985–1986 and 2014, the effects of higher oil prices encouraged oil conservation, which gradually eroded oil consumption. For the 1985–1986 oil price drop, dramatic gains in North Sea oil production and new oil discoveries elsewhere finally led to a realization that oil supplies were much more abundant than was previously thought. In similar fashion, for the 2014 oil price drop, dramatic gains in US shale oil production, gains in Canadian oil sands production, and oil discoveries elsewhere led to the realization that world oil supplies, once again, were much more substantial than previously thought. As the market finally realized these changes would lead to a sustained increase in oil supply that would outstrip the expected growth of world oil demand, the world price of oil plunged dramatically.

One difference that separates 2014 from 1985–1986 is Saudi Arabia's behavior. In 1985–1986, Saudi Arabia attempted to maintain higher oil prices by cutting its production. So far, Saudi Arabia has not cut its production.

Although world oil supply is greater than previously thought and the expected trajectory of world oil prices is lower, the increase in these global resources does not change the fact that crude oil is a nonrenewable natural resource. As such a resource is used, its price is expected to increase moderately over time. The crude oil futures market is consistent with such expectations, showing gradual increases through the end of 2020.

Effects on the US Energy Industry

As the result of lower oil prices, the US energy industry will see reduced income. Because US natural gas and coal prices no longer seem to be closely linked to those for crude oil, the effects of falling oil prices will be mostly confined to oil producers. In addition to seeing reduced income, oil producers whose total costs of production are above $75 to $80 per barrel will gradually reduce their production. Within the United States, such high-cost producers are likely to be found among the companies operating in the newly developed shale oil areas in Texas, North Dakota, and Wyoming. As prices strengthen gradually over the next decade, however, these higher-cost producers will gradually boost their production.

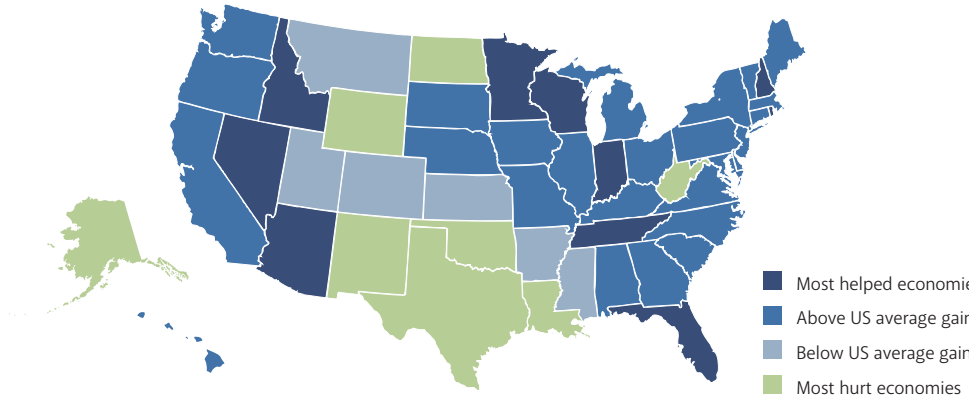
The economies of eight states—Alaska, Louisiana, New Mexico, North Dakota, Oklahoma, Texas, Wyoming, and West Virginia—will be hurt by lower oil prices.

Effects on US Economic Activity

The reduction in oil prices provides US consumers with what amounts to an annual increase in disposable income of $320 billion (about 1.8 percent of US GDP) through reduced prices for gasoline, diesel fuel, other petroleum products, and goods and services produced using petroleum products. The average US household will see a raw gain that amounts to $2,480 per year.

Some of the increase in consumer spending power will be offset by reduced income for US oil producers. Because the United States now produces more than two-thirds of its oil consumption, only $103 billion of the increased consumer spending power comes from foreign oil producers. The rest comes from domestic oil producers.

Figure 1. Effects of Lower Oil Prices on Economic Activity in the United States



Source: Based on Brown and Yücel 2013.

Taking into account the income losses for US oil companies, the net gain in US income will amount to $816 per year for each household. The average propensity to consume is around 90 percent, so the average US household could spend around an additional $734 per year. Because low-income households spend a greater percentage of their income on energy consumption and are less likely to own stocks in oil companies, such households will see larger gains and spend more. High-income households will spend less. The overall effect should amount to a onetime increase in US GDP of about 0.6 to 0.9 percent.

Uneven Economic Effects across the United States

The economic effects of lower oil prices will be uneven across the United States (Figure 1). According to research I conducted with Mine Yücel of the Federal Reserve Bank of Dallas, the economies of eight states—Alaska, Louisiana, New Mexico, North Dakota, Oklahoma, Texas, Wyoming, and West Virginia—will be hurt by lower oil prices. These eight states have economies that depend on energy production for export to other states. The extent of the effects depends on the prominence of oil in the state's energy mix and the lack of diversity in the state's economy.

We also found that the economies of 42 states and the District of Columbia are helped by lower oil prices. The extent of the help in each state owes primarily to the lack of energy extraction industries and, to lesser extent, the size of the state's multiplier effects. Oil and gas extraction, oil field machinery, and coal mining are well below the national average in the states most helped by lower oil prices. Consequently, there is less of a negative offsetting effect from these energy-extraction industries, and these states see a greater benefit from falling energy prices than the average US state.

If we look back to the 1980s, the states that benefited the most from falling energy prices were Delaware, South Carolina, and New Jersey. Those three states had energy-intensive refining and petrochemicals industries but relatively little energy extraction. Because they diversified away from energy-intensive refining and petrochemicals, the sensitivity of refining and petrochemicals to energy price shocks has diminished since the 1980s. Consequently, these states are much less sensitive to oil price movements, and states with a well-

below-average presence of energy-extraction industries and strong multipliers now stand out as the most sensitive to oil price movements.

Conclusions

Recent changes to world oil prices will help consumers by giving them more disposable income. In contrast, lower oil prices will hurt US energy producers and the states that rely heavily on the energy industry. Although the effects of the oil price declines are uneven across the United States, the increase in disposable income will be a mild stimulus to US economic activity. A potential shift away from US oil production may slightly lessen the nation's energy security, and more plentiful oil could lead to increased environmental degradation. ●

US consumers have already responded to lower gasoline prices by increasing their purchases of larger, less fuel-efficient vehicles, which will raise US fuel consumption and emissions for the life of the vehicles.

Effects on US Oil Security

The reduction in oil prices will have a disproportionate effect in temporarily discouraging oil production in the higher-cost oil-producing regions of the world—which many analysts consider to include some US shale oil plays, Canadian tar sands, and new Brazilian offshore wells. A reduction in output from these producers reduces the share of oil coming from politically stable countries and may serve to reduce the security of global supply. The Council on Foreign Relations predicts that, at the same time, Russia, Iran, and Venezuela will see reduced oil income, which could weaken their ability to oppose US interests.

Effects on the Environment

The environmental effects of lower oil prices depend on oil consumption. Technological change and new resource finds have led to a rebalancing of the world oil market with greater supply and a lower oil price trajectory—one consistent with higher world oil consumption and a concomitant increase in local pollution and carbon dioxide emissions. The news media reports that US consumers have already responded to lower gasoline prices by increasing their purchases of larger, less fuel-efficient vehicles, which will raise US fuel consumption and emissions for the life of the vehicles.

This article is an updated version of Brown, Stephen P.A. 2014. Falling Oil Prices and US Economic Activity: Implications for the Future. Issue brief 14-06. Washington, DC: RFF.

FURTHER READING

Brown, Stephen P.A., and Hillard G. Huntington. 2013. Assessing the US Oil Security Premium. *Energy Economics* 38: 118–127.

Brown, Stephen P.A., and Mine K. Yücel. 1995. Energy Prices and State Economic Performance. *Economic Review.* Dallas, TX: Federal Reserve Bank of Dallas.

Brown, Stephen P.A., and Mine K. Yücel. 2013. *The Shale Gas and Tight Oil Boom: US States' Economic Gains and Vulnerabilities*. Washington, DC: Council on Foreign Relations.

Council on Foreign Relations. 2006. *National Security Consequences of US Oil Dependency.* Independent Task Force Report No. 58. Washington, DC: Council on Foreign Relations Press.

Krupnick, Alan J. 2014. Where Falling Oil Prices May Take Us Next. Common Resources, December 3. http://commonresources.org/2014/where-falling-oil-prices-may-take-us-next/.

Morris, Adele, and Aparna Mathur. 2014. *A Carbon Tax in the Context of Broader Fiscal Reform: Design and Distributional Issues*. Arlington, VA: Center for Climate and Energy Solutions.

A Look at What's Happening

Inside RFF

Research Director and Senior Fellow **Karen Palmer** was selected as the recipient of the 2015 Distinguished Service Award, given by the Public Utility Research Center (PURC) within the University of Florida's Washington College of Business Administration. She received the award at the 42nd Annual PURC Conference in Gainesville, Florida, in February.

RFF Center for Energy and Climate Economics scholars **Brian Flannery**, **Raymond Kopp**, and **Clayton Munnings** participated in the United Nations 2014 Climate Change Conference in Lima, Peru. Kopp presented research with RFF University Fellow **William Pizer** and Visiting Fellow **Joseph Aldy**, and Kaito Akimoto from Japan's Research Institute of Innovative Technology for the Earth.

Vice President for Research and Senior Fellow **Molly Macauley** will serve as the liaison to the National Oceanic and Atmospheric Administration (NOAA) Climate Working Group for the NOAA Science Advisory Board. Macauley also participated in the annual meeting of NASA's Applied Sciences Advisory Committee in San Francisco, as one of eight members.

Alan Krupnick, RFF senior fellow and co-director of the RFF Center for Energy and Climate Economics, and **Zhongmin Wang**, an RFF fellow, served as lead editors for a special issue of *Energy Policy* (Volume 75, 2014) that focuses on energy and climate issues in China.

RFF Names New Head of Finance and Administration

Terri O'Brien has been named RFF's new vice president for finance and administration. She succeeds Ted Hand, who has retired after having been with RFF since 1980.

O'Brien was previously the chief operating officer at Independent Sector, a coalition of nonprofits, foundations, and corporate giving programs, where part of her duties included working with a core leadership team on a new 25-year strategic vision.

Before that, she held positions that included chief financial officer for BoardSource and director of financial operations for World Wildlife Fund, Inc.

Said RFF President Phil Sharp, "One of the most critical jobs at an organization like RFF is vice president for finance and administration. That person must provide essential guidance on how a research institution of RFF's caliber can best engage the most pressing environmental and energy issues of the day while strictly adhering to principles that assure objectivity and integrity. Terri O'Brien understands this and has a proven track record.

"But she also has the biggest possible shoes to fill," said Sharp. "Ted Hand has, as much as any one person, guided RFF unfailingly for the last 35 years as head of finance and administration. It is an understatement to say we shall miss him. And we are fortunate that even in retirement he has agreed to make himself available for advice."

O'Brien began her new position at RFF on March 16.

RFF Remembers Kenneth Frederick and Robert Young

The RFF family was saddened to learn of the deaths last year of two of its members, former RFF Senior Fellow **Kenneth D. Frederick** and RFF collaborator **Robert A. Young** of Colorado State University.

Kenneth Frederick passed away on October 19, 2014. He began his career as an economic advisor in Brazil for the US Agency for International Development in 1965. Two years later, he accepted an assistant professor position in the department of economics at the California Institute of Technology. Passionate about policy, Frederick moved his family across the country to join RFF as a senior fellow in 1971 as a member of the then Latin American Program. He went on to serve as director of the former Renewable Resources Division and remained with RFF until his retirement. His contribution to the field includes authoring and coauthoring 9 books and more than 60 peer-reviewed articles on the economic and environmental aspects of water and natural resources planning. In addition to his written work, he has left behind a generous contribution as a member of the RFF Legacy Society.

Robert Young passed away on July 17, 2014. Well regarded in the research community for his work on water economics and policy, Young began his teaching career at the University of Arizona in 1963 and in 1968 was recruited as an RFF research associate. He worked with RFF Senior Fellows Charles Howe, William Vaughan, and Clifford Russell, and together with John Bredehoeft, who was visiting RFF from the US Geological Survey at that time, he conducted cutting-edge and foundational modeling work on the optimal pattern of water use over time as groundwater characteristics change. In 1970, he accepted a professorship at Colorado State University, where he stayed until retirement in 1992. His research in water policy includes the 2005 book *Determining the Economic Value of Water: Concepts and Methods.* RFF Press released Young's second volume earlier this year, co-authored with Colorado State University Professor John Loomis.

Meet RFF's Newest Fellows

Two of RFF's newest research fellows—Kailin Kroetz and Benjamin Leard—describe their past, present, and future research interests.

Kailin Kroetz

Examining species management and conservation

I have two undergraduate professors to thank for my interest in environmental economics. At Dartmouth, I had the opportunity to work as a research assistant and write a thesis with Karen Fisher-Vanden and Andy Friedland. The projects I worked on during that time helped me understand the role of economics in the policymaking process and motivated me to pursue a career related to environmental and natural resource policymaking.

For my dissertation, I examined the potential to design tradable permit programs to meet multiple objectives. I used data from the Alaska Halibut and Sablefish Individual Fishing Quota program to provide some of the first empirical evidence of the potential for tradable permit programs to sustain fishing jobs and communities, as well as increase economic efficiency.

I am currently interested in a range of topics related to the design of policies to

manage and conserve marine and terrestrial species. In addition to extensions of my dissertation work, some of my upcoming projects involve exploring how to improve management of coupled biological and economic systems through a better understanding of their underlying systems and linkages.

Benjamin Leard

Assessing issues in energy and transportation

As cliché as it might sound, I knew that I wanted to have a career devoted to economics after my first college lecture on the subject. I eventually focused my studies on environmental and natural resource economics after realizing that many of the big issues facing humanity involve how humans interact with the environment and how we handle the world's resources.

Once I saw that economic analysis stands at the forefront of how countries decide to remedy problems related to climate change and resource depletion, I knew that I wanted to devote my understanding of economics to finding solutions to these problems. I focused my dissertation on issues in climate and energy policy, and I explored how heterogeneity matters for designing environmental and energy policies.

Since arriving at RFF, I have teamed up with Senior Fellow Virginia McConnell to analyze the new credit trading markets under federal fuel economy and greenhouse gas regulations for automobiles. I also am examining issues related to gasoline tax incidence, demand for vehicle automation technology, and the environmental impact of policies for promoting electric vehicles.

COMMONRESOURCES

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

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

RESOURCES FOR THE FUTURE

Highlights from Journal Articles by RFF Researchers

Evaluating US Oil Security and Import Reliance

Stephen Brown and Hillard Huntington
Energy Policy | April 2015 | Vol. 79 | 9–22
The authors examine the literature that considers the consequences of US reliance on imported oil. They take an approach that covers many ideas about the related costs, identifying the ideas that have broad support in the economics literature and those with only limited support. They also quantify the costs of US reliance on imported oil as expected US economic losses over a time horizon from 2010 through 2035, taking into account world oil market conditions, market power, probable oil supply disruptions, and the response of the oil market to those supply disruptions.

Using Taxes to Reduce Carbon Dioxide Emissions Rates of New Passenger Vehicles: Evidence from France, Germany, and Sweden

Thomas Klier and Joshua Linn
American Economic Journal: Economic Policy
February 2015 | Vol. 7, No. 1 | 212–242
France, Germany, and Sweden link taxes to passenger vehicles' carbon dioxide emissions rates. Based on new vehicle registration data from 2005 to 2010, the authors find that carbon dioxide taxes reduce registrations. The effect is larger in France than in either Germany or Sweden, and the French results are robust to alternative estimation models. Compared with those of France, the German results vary somewhat more, and the Swedish estimates are the least robust.

Is What You See What You Get? The Value of Natural Landscape Views

Margaret Walls, Carolyn Kousky, and Ziyan Chu
Land Economics | February 2015 | Vol. 91, No. 1 | 1–19
Views of natural areas and green space may have value quite apart from access to those lands. Using 25 years of home sales data from St. Louis County, Missouri, and modern geographic information system tools to measure views, the authors estimate a hedonic property fixed-effects model that captures the effects of changing land cover on house sale prices. They find that forest views negatively affect home prices, whereas farmland views have positive effects. Changes in relative scarcity of these land types over time may explain the findings.

Conservation Planning: A Review of Return on Investment Analysis

James Boyd, Rebecca Epanchin-Niell, and Juha Siikamäki
Review of Environmental Economics and Policy
Winter 2015 | Vol. 9, No. 1 | 23–42
Land and natural resource conservation programs are increasingly being evaluated on the basis of their return on investment (ROI). This article surveys the literature in this area. The authors discuss the state of the art of ROI analysis, highlight some unresolved issues, and make suggestions for improvements. The literature indicates that conservation planning that uses ROI analysis can considerably alter the locations and targets of conservation, lead to more protection and higher-quality conservation outcomes, and result in significant savings.

Make this a **SUMMER**

WELL SPENT.

Support RFF and help build smarter policies to strengthen both the economy and the environment.

Learn more at www.rff.org/support.

RESOURCES
FOR THE FUTURE

RESOURCES FOR THE FUTURE

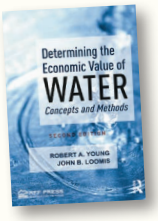
1616 P St. NW
Washington, DC 20036-1400

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

NEW TITLES from RFF PRESS

Browse the new 2015 Routledge RFF Press Catalog

View all the latest books from RFF Press in our new online catalog, available here:
http://www.routledge.com/u/rff2015/

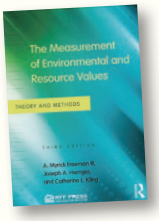


Determining the Economic Value of Water

Concepts and Methods, 2nd Edition

By Robert A. Young and John B. Loomis

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

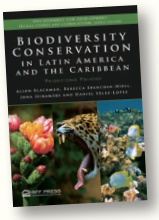


The Measurement of Environmental and Resource Values

Theories and Methods, 3rd Edition

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

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



Biodiversity Conservation in Latin America and the Caribbean

Prioritizing Policies

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

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

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