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RESOURCES

RESOURCES FOR THE FUTURE RESEARCH THAT MAKES A DIFFERENCE

Paul R. Portney

To our readers:

Despite several years of writing these short messages to you, it is still difficult for me to distill in a few paragraphs all that what we have been doing over the past three months at RFF. That editorial challenge, however, pales in comparison to the greater one all wordsmiths confront today: finding something meaningful to say in the wake of September 11th.

Our "family" here at RFF has reacted in much the same way I imagine you have. We watched first in horror at what was happening in New York, then, three short miles away, at the Pentagon in Arlington, and finally, in Pennsylvania. We recoiled in horror, and many of us were enraged, at this first foreign attack at the civic core of our country since the War of 1812, when the British burned the Capitol. And now we hope that those responsible for this atrocity are tracked down and brought to swift justice without the killing of more innocent people. Like you, this horrible (and ongoing) series of events then reminded us—as perhaps nothing else in our lives has—it is our families, friends, communities, and country that are really important to us, not the many little things that seemed so before September 11th. Finally, we were left wondering what we might do in our jobs and in our lives to make the world a safer and better place for all of our children.

Here at RFF, we are doing work that is relevant to the new challenges we face as a nation. As close readers of *Resources* will recall, Michael Taylor and his colleagues in RFF's Risk, Resource, and Environmental Management division (formerly the Center for Risk Management) have mounted a very ambitious program on world food safety and security. In many of the poorest parts of the world, abject hunger fans the flames that fanatics spark, while in the developed world, food safety has become a dramatically more important concern. Similarly, RFF senior fellow Mike Toman has long been an expert on energy security in the United States, a subject on which much ink—including some of our own—will soon be spilt. You can expect to see more from RFF on this subject, both here in *Resources* and elsewhere, in the months ahead. RFF fellow Ramanan Laxminarayan is doing pioneering research on an issue that is now more relevant than ever: antibiotic resistance. While antibiotics have transformed modern medicine in many ways, five decades of use and misuse have fueled drug-resistant bacteria that defy even the most powerful antibiotics. RFF research efforts relating to drinking water quality; energy conservation and renewable energy; and the robustness of the nation's electricity, natural gas, and petroleum infrastructure is also directly germane to the tasks that lie ahead.

These examples notwithstanding, most of what we do bears no direct connection to the events of the last two months. My guess is that this is the case, too, with most of you. That does not mean, however, that our work is unimportant. First, we have no choice but to go on with our lives. As we all know, to become paralyzed by sadness, fear, or outrage is to give in to those who hate the freedoms that we have and would take them from us. Second, we are all parts of a wonderful mosaic, whether we fight fires, drive trucks, teach students, trade bonds, grow wheat, wash dishes, or make music or art.

We at RFF believe that this mosaic—part private sector, part public sector, and part in between—is what is making life better and better for more and more people on the face of this earth with each passing year. To be sure, the pace of progress is much too slow, and its fruits much too unevenly divided. As September 11th reminds us, moreover, the steps backward are much too painful. But living standards are rising, life expectancies are increasing, and more and more people each year get to choose who governs them.

Just as each of you will continue to do what you can to make the world a better place, we'll do the same here at RFF.

RESOURCES

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GOINGS ON

RFF Researchers Exploring the Complex Relationship Between Land Use and Transportation Needs

The symbiotic relationship between land use and transportation is complex, to say the least—transportation funding depends on attainment of air pollution goals, but air pollution is affected by land use and development, which affect transportation needs. That's why a series of studies spearheaded by RFF researchers Winston Harrington, Virginia McConnell, Elena Safirova, Pete Nelson, Dave Mason, and Ian Parry is called Urban Complexities. Harrington, McConnell, and their colleagues hope to untangle those relationships, one strand at a time, through the investigation of independent factors that affect the whole. Among the facets being studied are land development, urban transportation systems, and the commuter phenomenon known as slug lines.

Transportation Development and Land Use

One study will investigate the correlation between transportation development and land use. "Right now, there is a tendency to develop commercially and industrially out in the suburbs; in part, that's because getting into town is so difficult," says Harrington. "People respond to that development in part by moving still further out . . . and moving jobs further out. Suburbanization, in turn, is a solution to the congestion problem, but it produces a land-use problem, at least in the minds of a great many people."

That land-use problem is low-density development, the epitome of which is the single-family home. Low-density residential and commercial development, one of many definitions of sprawl, is believed by some to contribute to congestion, a problem it's supposed to help solve.

Supporters of low-density development say the market supports their model, that people want their secluded homes and their cars. Harrington's research intends to determine the veracity of this claim. "If you have a case where the prices are wrong," he says, "there are effects of the transaction that fall on other people besides the buyer and seller. For example, you decide to use your car for a trip, but you're not really paying for the air pollution and congestion that result from heavy automotive traffic in general. What we're focusing on is where there's likely to be market failures in urban transportation and land development."

Along these lines, McConnell and Harrington are looking into hidden costs of rural land use. "One of the interesting things we've found has to do with tax policies," says McConnell. "Farms pay incredibly low taxes," she points out, "but farming is fairly intensive land use." To compound the economic inefficiency of that model, farms require social services that, while expensive, serve only a few.

For example, residents in rural areas are often too far out to take advantage of the sewer systems used by their urban neighbors. The solution—septic tanks—carries additional costs. "It's much cheaper for residents to put a septic tank in," says McConnell, "and when septic systems do go bad they can count on the public health department and the government to step in and take care of it." But the cost of such a scenario, both to the environment and to taxpayers, is disproportionate to the convenience of the tank.

DC's Transportation System

An investigation of transportation systems will be conducted in the metropolitan Washington, DC, area. As Harrington points out, Washington has a citywide transportation system that also services the surrounding Maryland and Virginia suburbs. The city is one of the fastest-growing metropolitan areas in the country and consistently ranks in the top three or four most congested areas nationwide.

Compounding the complications of growth are money problems. "The revenue available from the traditional sources is not sufficient to build new transportation facilities that traffic projections tell us are needed, including both transit and highways, and also maintain the existing system," says Harrington.

The researchers plan to build a transportation model of Washington, DC, that eventually will be an integrated transportation-land use model. "What we're going to look at is a variety of pricing policies," says Harrington, "because we think that's one of the major problems with transportation - the reason we're running out of money is that we're not charging the right prices for transportation, either for public transit or for highways."

While the model will be similar to the one the Metropolitan Washington Council of Governments uses, Harrington says it has much less geographic detail. "On the demand side, we have a lot more detail on households and policies." Given these characteristics, it may not be useful for transportation facilities planning, but it is perhaps better suited for policy analysis.

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Harrington and his colleagues will be able to plot the intersection of travel and development in the metropolitan area. "Once we get that," says Harrington, "we'll be able to look at one of the major issues facing government officials in the area, which is how can strict limitations be placed on land use without affecting the price of transportation."

McConnell adds, "We're looking at the costs of different land uses in terms of provision of infrastructure like schools and roads." McConnell says she will be asking, "Is the infrastructure being priced correctly?"

Slug Lines

Tangentially related to the DC study is a separate study of what have come to be known as slug lines, which can be found only in the Washington, DC, area and Oakland, Calif. Slug lines are the grass-roots phenomenon that brings commuters in need of a ride together with complete strangers—drivers who need passengers in order to use high-occupancy-vehicle lanes. With car pool use down 36% in the Washington area between 1980 and 1990, and another 24% in the last 10 years, Harrington and Safirova think there's something to be learned from this flourishing trend, including how to expand the concept to other areas.

Disagreeing with the Climate Agreement

U.S. Waits as Ratification Process Begins

The world climate negotiations over the past five months have been hailed as a significant achievement in international diplomacy and politics. But, while some 160 nations have compromised on language for the Kyoto Protocol and set the stage for individual country ratification of the treaty, the United States withdrew last March. Ironically, many of the deals struck since then basically reflect policies the United States has long favored. Virtually all the important compromises addressed the economic cost of meeting a country's Kyoto target. But none involved enforceable actions, leaving one to wonder what has actually been achieved.

After the negotiations broke down at the conference in The Hague in November 2000, they resumed last July in Bonn. There the environmental diplomats reached agreement in principle on most of the outstanding disputes, but many contentious details were left to a further conference in Marrakech, Morocco, in November. As defined by the agreements reached there, the Kyoto treaty will now go to the governments of most of the world's countries—but not the United States—for ratification.

Changes made in this process that coincide with U.S. interests include these:

- The long and contentious debate between the European Union and the United States over "supplementarity," that is, what limits should be placed on permit trading as a means of meeting Kyoto commitments, was resolved. Participants agreed no quantitative limits should be placed on trading; this mirrors the United States' position.
- The use of forest and cropland management to increase the amount of carbon sequestered in biological sinks during the first commitment period was agreed to, subject to some upper bounds. Clashes between the United States and the European Union over these very same sinks was blamed, in part, for the breakdown of the talks in The Hague.
- All the forms of greenhouse gas credits (or permits) can be used to meet a country's commitment. These credits include the purchase of assigned amounts through Annex 1 trading, certified emission reductions obtained through the use of the Clean Development Mechanism (CDM), and emission reduction units obtained through joint implementation within Annex 1 countries.
- Afforestation and reforestation projects, which are assumed to be very cost-effective ways to sequester carbon in developing countries, were deemed eligible for the CDM.
- A limit on the share of the proceeds (a portion of the revenue raised by a CDM project) derived from CDM projects that would go to developing countries to meet the costs of adaptation to climate change was set at 2% of the certified emission reductions generated from a CDM project.

> Biological sinks are generally forests, although they can include various types of agricultural products, that capture (sequester) carbon from the atmosphere.

While some might argue that these deals undermine the environmental integrity of the protocol, the damage seems

small. The uncertainty around the proper accounting for biological sinks engenders the greatest concern, but the use of sinks in Article 3 is strictly limited and the eligibility of forest projects in the CDM can be properly managed through the CDM certification process and should not raise too many concerns. However, all is not well with the protocol.

The targets and timetables of the Kyoto Protocol have at times been called legally binding commitments. Such language suggests that the force of law underlies these commitments. Nothing could be further from the truth. The protocol specifies no legally binding consequences to enforce compliance with these commitments, such as financial penalties. If a party to the protocol fails to meet its commitment by, say, *X* tons, 1.3 times *X* tons is deducted from the second commitment-period allocation.

However, since the second commitment-period allocation has yet to be negotiated, a noncomplying country has ample opportunity to factor its first period overages and the 30% "surcharge" into its second commitment period negotiating position. These provisions of the protocol provide no legal or economic incentives for compliance, except that a country is not eligible to trade if it is out of compliance.

If there are no strong legal or economic incentives for compliance, then surely some parties to the protocol will choose not to comply if the cost of compliance becomes too great. A noncomplying party has no incentive to purchase permits on the international market, thereby reducing permit demand and prices.

If permit prices depend on compliance and there are no strong incentives for compliance, how well would one expect an international permit market to function? The answer seems to be not well at all. The value of assigned amounts or CDM credits traded on the international market depends on the demand for these assets, and demand exists only if compliance is ensured. Uncertainty over compliance translates into uncertainty over the value of permits, relegating permits in the market to nothing more than highly speculative investments—not the sort of assets upon which a multibillion-dollar global trading system would rest.

If a robust international market in greenhouse gases is one of the best ways to ensure cost-effective greenhouse gas control for decades to come, then the current approach to compliance in the protocol seems to lay a very poor foundation upon which to build a robust market.

RFF Board Member Joseph E. Stiglitz Shares Economics Nobel Prize

RFF Board Member Joseph E. Stiglitz recently was honored with the 2001 Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel for his innovative analysis of markets with asymmetrical information.

"Our scholars look to our board for inspiration, guidance, and validation of their research. Imagine the thrill of having not just one, but now two Nobel laureates on our governing body," says Paul Portney, RFF's president. "Stiglitz's research back in the 1970s has informed much of our own work on improving regulatory policy."

A market with asymmetrical information refers to a situation where agents on one side of a market have much more information than those on the other side. While textbook examples include insurance and credit markets, in many policy situations, parties subject to governmental regulations have more information regarding their activities than the regulator seeking to alter their behavior.

For example, a program that aims to retire an old (and dirtier) type of technology might be disproportionately comprised of plants where the technology has already been mothballed or plants that were already going to make a switch based on their cost characteristics, which are unknown to the regulator. Applying the insights of Joseph Stiglitz and this year's other Nobel laureates in economics, environmental economists are designing superior regulatory approaches in settings as diverse as water pollution control, greenhouse gas emissions, oil exploration, and fisheries exploitation.

Stiglitz, who joined the RFF board in April 1997, is professor of economics, business, and international affairs at Columbia University. He shared this year's economics prize with A. Michael Spence of Stanford and George A. Akerlof of the University of California, Berkeley, who separately also made significant contributions to the literature on markets with asymmetric information.

RFF Board Member Robert M. Solow of the Massachusetts Institute of Technology won the Nobel in 1987.

The Environment and the Information Age

The Costs of Coping With Used Computer Monitors

Molly Macauley, Karen Palmer, Jhih-Shyang Shih, Sarah Cline, and Heather Holsinger

The "information economy" has brought about a surge in demand for electronic equipment. At the same time, the useful life of computers and monitors grows shorter and shorter with each successive generation, due to the rapid pace of advances in computing technology.

The "information economy" has brought about a surge in demand for electronic equipment. According to recent estimates, shipments of personal computers in the United States grew from about 10 million units in 1992 to just over 30 million units in 1997. At the same time, the useful life of electronic equipment grows shorter and shorter with each successive generation, due to the rapid pace of advances in computing technology. For example, in 1997, the average life span of a computer was four to six years; by 2005, it is expected to be just two years. As a result, much electronic equipment becomes obsolete each year.

The growing quantity of old equipment poses real challenges for waste management officials. One of the primary concerns is that the equipment often contains hazardous materials, which could be released into the environment during incineration or concentrated and then dispersed in the form of incineration ash. For example, most computer monitors and color televisions use cathode ray tubes (CRTs), which contain lead to shield users from radiation. This lead poses a potential environmental hazard when CRTs are incinerated. Some experts say that, in the United States alone, approximately 1 billion pounds of lead from computers and other electronic equipment will enter the waste stream within the next decade.

Dealing with used electronic equipment also is a challenge for the businesses and households that generate the waste. Under Subtitle C of the Resource Conservation and Recovery Act, domestic commercial and industrial users of large numbers of CRTs must treat the used equipment as hazardous waste, using special carriers licensed to transport hazardous waste and disposing of the equipment at a hazardous waste facility—a procedure that costs much more than conventional landfilling. In recent years, a growing number of large companies are finding it economical to send their used equipment to recycling facilities, but this practice is not widespread.

Current Disposal Practices

With the exception of some jurisdictions that now restrict all landfilling and incineration of CRTs, smaller com-

mercial users and households can dispose of CRTs with the rest of their ordinary trash. In practice, however, surveys repeatedly indicate that both large and small businesses and households appear to be storing their obsolete CRTs and postponing their ultimate disposal.

In light of concerns about the eventual disposal of CRTs, some states and localities have initiated restrictions on disposing of the equipment as ordinary trash and have set up programs specifically to increase recycling. Since April 2000, Massachusetts has banned disposal of CRTs at all municipal solid waste (MSW) landfills and incinerators. This ban is being coupled with the establishment of several CRT drop-off sites throughout the state, as well as other efforts on behalf of the state to promote use of these facilities and other means of CRT recycling. Communities in New York, Minnesota, New Jersey, Virginia, and Illinois have experimented with various types of collection programs, including one-day drop-off opportunities for consumers to bring in old equipment, the siting of permanent depots for disposal of equipment, curbside collection, and point-of-purchase (retail) collection.

Some approaches also seek to assign manufacturers the responsibility for funding the disposal or recycling of machines they have produced. Manufacturers have opposed these approaches, noting that they already participate in and underwrite many pilot projects to reclaim old computers. These manufacturers have instituted programs under which consumers may return used equipment for a fee, either to a local retail electronics store or a local waste management facility, or by shipping directly to a recycler that has a contract with the manufacturer. The manufacturers donate usable equipment to charity and dismantle the rest.

Several countries, including the United Kingdom, Belgium, Sweden, the Netherlands, and Japan, are developing regulations that require manufacturers or distributors of electronic equipment to take the equipment back at the end of its useful life. A prominent related issue is the effect of take-back requirements on overseas companies that manufacture and export electronics.

Some of these policies could prove to be quite costly, while the associated benefits to the environment are largely unknown. We developed a model of consumers' options for discarding computer monitors based on the costs of different options and their associated effects on human health of lead releases from incineration. For the stock of monitors disposed of in the United States in 1998, our preliminary findings suggest that banning some disposal options, such as incineration and landfilling, would increase disposal costs on the order of from $1 per monitor to between $3 and $20 per monitor. Policies to promote a modest amount of recycling of monitor parts, including lead, can be less expensive. In all of the policies we studied, the costs of the policies exceed the value of the avoided health effects of CRT incineration.

Environmental Concerns

A computer monitor display is typically composed of a glass panel, a cathode ray tube, a casing, connecting wiring, and shielding. Lead in the glass of the cathode ray tube itself is the major source of lead in the display. While CRTs and other electronics are not the primary use of lead, they now comprise the largest proportion (by weight) of lead entering the solid waste stream in the United States. This differential may be partially explained by restrictions on disposal of lead-acid batteries in MSW landfills and increased battery recycling.

Our focus was limited to the environmental and health damages associated with lead that may be released into the air during incineration of CRTs in computer monitors. We chose this focus because these incineration-related damages are the largest likely source of health effects according to the epidemiological literature. Incinerated lead either is emitted into the air or remains in the ash. The ash obtained from the incinerator must then be disposed of in a landfill—or a hazardous waste landfill if the lead content is above acceptable levels.

Lead uptake may result in several health problems for different segments of the population. However, it is important to note that environmental releases of lead and other hazardous substances can take place throughout the monitor's life cycle. For example, the extraction and processing of the raw materials used in CRT production—as well as the fabrication of the CRT—may lead to environmental releases of lead and, subsequently, adverse health effects. The mining and manufacture of lead used in CRTs result in emissions of lead: lead mining results in solid by-products released into the environment, while lead smelting and the production of lead oxide (the form of lead used in CRT glass) result in lead emissions into the air as well as solid by-products that contain lead, which are subsequently disposed of and thereby disseminated. Other stages depend critically on a host of parameters outside the scope of our model, such as the effectiveness and cost of enforcing occupational safety and health provisions, or even any environmental effects of the recycling

processes themselves. The extent of many of these effects are regulated by existing environmental, safety, and other laws.

Our Model

In order to analyze the private and social costs of different approaches to CRT waste management, we constructed a simulation model to track what happens to monitors in the United States once they are retired at the end of their useful lives. This model provides a snapshot of how consumers manage their used CRTs during a single year. We assumed that all consumers pick the least costly discard option among the options available to them, but that consumers do not take explicit account of the social cost of the health effects that may arise from incineration of monitors.

The discard options we examined for residential consumers were disposal in the regular trash pickup (in which case the monitors are incinerated or landfilled based on the municipality's MSW practice); and recycling by either dropping off the CRT at a designated recycling center or by placing the CRT at the curb. Nonresidential consumers that generate large quantities of CRTs for disposal must, by U.S. federal law, treat disposal as hazardous waste. Nonresidential consumers generating smaller quantities may use regular trash service. All consumers—residential as well as firms—may choose storage as a short-term discard option.

There are significant differences in the costs of these options. To capture these differences, we divided consumers into six groups. Four of these groups cover different types of residential consumers: those who live in apartments and those who live in houses, and in each case, those who face pricing of their waste collection and those whose waste fees are "buried" in other local taxes and fees (most often, in property taxes). We distinguished apartment and house dwellers because we assumed they face different storage costs. The other two groups are nonresidential consumers classified as hazardous waste generators and nonresidential consumers classified as nonhazardous waste generators.

We included both the private and social costs for each end-of-life option by sector. The private costs of these options include the costs of storing a monitor, which we based on rental rates per square foot for residential apartment dwellers and nonresidential consumers, and which we assumed to be zero for residential consumers living in detached homes. The cost of using other options includes residential household time and travel (transportation) costs; shipping costs if the monitor is shipped to a disposal or recycling facility; and recycling process costs when paid by the consumer. Under some options, some of these costs are paid by general governmental revenues and we defined these as the community costs for managing the waste. In addition to private and community costs, the full social costs of disposal also include the health effects of monitor disposal. We used a U.S. Environmental Protection Agency model that relates the health effects of lead and the economic value of these effects to approximate their monetary cost.

Our Results

We evaluated a variety of approaches that policymakers are taking or have proposed. These included banning disposal in landfills, incinerators, or in both; subsidizing recycling; making it easy for households to recycle their monitors by allowing them to simply place them at the curb; and various combinations of these approaches. It is important to note that, in all cases, someone bears the costs—for example, when using a drop-off center, consumers bear the transportation and travel time costs to take monitors to the center and the community as a whole bears the cost of operating the center. With curbside recycling, the costs to the householder may be much less but the community bears the pickup costs. We sought to compare these costs, both private and community, with the value of the health effects that would be avoided were various policies implemented.

We used the most recently available U.S. data (for 1998) to both estimate how many computer CRTs were retired during the year and then assess how many of those CRTs will be dis-

Table 1. Policy Costs and Recycling Rates

	Policy Intervention	Private and Community Costs ($ millions)	Cost of Recycling Subsidy ($ Millions)	Health Damages ($ Millions)	Recycling Rate (percent)
A	Baseline	13.54	N/A	2.67	0.2
B	Ban All Disposal (Incineration and Landfill)	292.3	N/A	0	23.4
C	Ban All Disposal and Subsidize Recycling by $10 per Monitor	333.7	96.6	0	61.1
D	Curbside Recycling with Ban on All Disposal	300.6	N/A	0	29.7
E	Ban Incineration Only	50.3	N/A	0	3.5
F	Curbside Recycling Offered	28.1	N/A	2.5	5.3
G	Subsidize Recycling to Achieve 10% Recycling Rate	51.9	22.9	2.36	10.3
H	Subsidize Recycling to Achieve 23% Recycling Rate	100.8	65.9	2.03	23.1

carded using different options. (See Table 1 for a summary of our results regarding the nearly 16 million monitors retired that year.) In our "baseline" case—in which consumers may store, dispose of, or recycle their used monitors by taking them to drop-off centers—we found that the private and community disposal and recycling costs are a little less than $1 per monitor. The health damages that would be avoided by recycling are about a nickel per monitor. The total cost of handling monitor waste is about $13.5 million and the associated total health damages are about $2.7 million (see Table 1, row A).

How do various policy interventions compare? We can evaluate them based on their consequences for a variety of possible goals: reducing or eliminating health effects, increasing recycling, or achieving a combination of these objectives.

Two options, banning disposal in both landfills and incinerators—as now practiced in Massachusetts—or coupling such a ban with various financial incentives to recycle at drop-off centers, eliminate health effects associated with disposal and also increase the rate of recycling significantly (Table 1, rows B, C, and D). However, the cost to consumers and the community's waste management budget is quite large—on the order of $300 million compared with avoided health damages ($2.7 million). If the policy objective were to avoid health effects entirely, the most economical approach is to ban incineration only, according to our model; although even in this case, the cost is $50 million to avoid damages of $2.7 million (Table 1, row E).

Another goal for CRT disposal policies is to encourage recycling, in the hope that increased recycling activity will ultimately lead to lower costs of recycling. If the policy goal is strictly to increase recycling, then providing recycling at the household's curb is the least expensive policy intervention (Table 1, row F). It produces a modest amount of recycling (5%), but it does very little to reduce health damages. We also considered subsidies to recycling to attain specific goals of recycling rates as some states and communities have proposed—a modest 10% (Table 1, row G) and a more ambitious 23% (Table 1, row H; we chose this percentage to match the level of recycling predicted in our outright ban on disposal). These approaches are expensive and, moreover, they do not greatly reduce health damages.

Conclusions

Our research offers a basis for evaluating policy alternatives for the case of a growing component of the CRT waste stream, used computer monitors. The significant differences in costs resulting from our policy scenarios indicate that identifying the most cost-effective policy depends on the goal of the policy (for example, eliminating or reducing health effects, encouraging recycling generally, encouraging recycling to meet a specified recycling goal, or some combination of these). Regardless of the type of intervention, the benefits of reducing airborne emissions of lead associated with CRT incineration appear to be small. Other end-of-life benefits or environmental benefits that may be achievable earlier in the CRT lifecycle—for example, during manufacturing—would need to be large to justify the costs associated with policy actions that induce increased storage and recycling.

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Biotechnology in Forestry

Considering the Costs and Benefits

Roger A. Sedjo

The economic benefits resulting from the introduction of forest biotechnology will be lower costs and increased availability of wood and wood products. Important environmental issues, including rehabilitation of habitats altered by disease and the overuse of natural forests for industrial wood, may also benefit from biotechnology solutions.

Forestry today is on the threshold of promising change as biotechnology is introduced into its operations. Sophisticated tissue cultures for cloned seedlings and genetically modified organisms portend many benefits as more of the world's industrial wood is being produced on planted forests. In many cases biotechnology in forestry is simply an extension of agricultural innovations, such as herbicide resistance. However, biotechnology also has applications unique to forestry, such as fiber modification, lignin reduction and extraction, and sterility, which is an important factor to prevent modified genes from "leaking" into the natural environment.

The economic benefits from the introduction of biotechnology to forestry will be lower costs and increased availability of wood and wood products. Additionally, innovations in forest biotechnology have the potential to address important environmental issues, including the rehabilitation of habitats altered by disease, like the American Chestnut blight, or invasive exotics. Moreover, the increased productivity of tree plantations may free large areas of natural, or primary, forest from pressures to supply industrial wood and thus improve their ability to preserve biodiversity. And as trees are modified to grow in previously unsuitable areas—such as arid lands or saline soils—the new forests could not only produce more wood but also enhance watershed protection and sequester carbon for climate change mitigation.

Some History

The planting of forests for timber began in earnest in the 19th century in Europe and about the middle of the 20th century in North America. Over the past 30 years, industrial plantation forests have become a major supplier of industrial wood, largely because of the higher productivity of planted forests and the higher costs of extracting timber from natural forests under more stringent environmental standards.

The traditional breeding techniques practiced in forestry have followed the model of other agricultural crops. Early improvements in trees involved identification of superior trees with desired traits and attempts to capture offspring having those traits. The planting of genetically improved stock began about 1970. In the 1990s, modern biotechnology, including tissue culture and genetic modification, began to be undertaken in forestry in earnest. As more of the world's industrial wood is being produced on planted forests, the potential benefits from introducing desired genetic alterations into the seedling utilized in planting have become obvious.

Benefits will be found, first, in lower costs of wood production, which in turn will result in lower costs to consumers of wood and wood products. And second, biotechnology in forestry has the potential to address important environmental issues. On the cost side, how-

ever, concerns relate to potential genetic transfers between transgenic and wild trees, and the potential implications for the natural environment.

Biotechnology in Forestry

Biotechnological innovation in forestry falls into three main areas: the use of vegetative reproduction methods; the use of genetic markers; and the production of genetically modified organisms (GMOs), or transgenic trees. Most of the biotechnologies used in forestry today involve vegetative reproduction through tissue culture and molecular marker applications. However, GMOs are also likely to play a major role in forestry. Using techniques adapted from agriculture, selected foreign genes are introduced into the plant genome. In one such approach, specific genes are identified and modified to affect biochemical pathways and the resulting phenotypes. For example, the promise of controlling the lignin—cells that impart strength to the tree's structure but that must be removed in papermaking—depends on the ability to identify and modify lignin genes, thereby altering the amount, type, and form of lignin that is produced in the tree. The ease of gene transformation varies with different species, generally being more difficult in conifers than in hardwoods.

Benefits of Biotechnology

Economic benefits. A distinguishing feature of the introduction of technology is increased productivity—that is, output per unit of input. Alternatively stated, technology can be either cost reducing or yield (output) enhancing. For society, more output for the expenditure of inputs means a societal increase in efficiency. For the consumer, technology typically means that relative prices of the desired good fall compared with what they would have been in the absence of the innovation. Plantation forestry has enjoyed success in recent decades in part because its associated cost-reducing technology has given wood from planted forests a competitive advantage over that harvested from natural old-growth forests. Furthermore, the opportunities for the application of cost-reducing biotechnology to forestry appear substantial.

Tree improvements can take many forms. These include increased growth rates (wood volume yields), improved tree form (straight trunks with minimal branching), and disease resistance. Efforts to improve resistance to disease and pests may target problems common in the growth of particular species or extend the climatic range of certain species.

Besides ensuring establishment, survival, and rapid growth of raw wood material, tree improvement programs can also focus on wood quality. Some characteristics are valued not for their utility in the final product but for how they affect the production process. In pulpmaking, for example, desirable traits would be the easy breakdown of wood fibers and the removal of lignin during chemical processing. Desired traits also vary by end product. Wood quality may involve one set of fiber characteristics for pulping and paper production and another set of characteristics for milling and carpentry. Paper production, for instance, requires fiber with adequate strength to allow sheets to be produced on high-speed machines, an attribute determined by the wood fiber characteristics. To the extent that the raw material can be customized to meet the requirements of producers, wood values increase.

Environmental benefits. In addition to the direct market benefits, forestry biotechnology could also be used to generate a number of desired environmental outputs and objectives, summarized in Table 1.

One nonmonetary benefit of biotechnology in forestry has been the substitution of plantation wood for that of primary forests, which has reduced commercial logging pressure on natural forests that have value for biodiversity and wildlife habitat. Biotechnology also offers the potential to assist in ecosystem restoration and repair by, for example, saving species that have been essentially destroyed by disease, such as the American chestnut. Similarly, biotechnology may help deal with invasive exotics, which have in many places threatened indigenous species. Modified tree species also prove useful in providing environmental services in areas where trees now have difficulty surviving, such as arid or drought-prone areas and areas with saline soil or frost zones.

Another application of biotechnology involves biological sinks—a potential tool to mitigate the buildup of greenhouse gases associated with global warming. Regions not currently forested could grow carbon-sequestering plantations of transgenic trees.

Costs of Biotechnology

Transgenic biotechnology has become controversial when applied to agriculture and some of the controversy appears to be spilling over to forestry. The controversy centers on a number of issues.

Table 1. Environmental Benefits

Biotechnological innovation	Environmental output
Plantation wood substitutes for wood from natural forests at lower costs.	Pressure to log primary forests can be reduced.
Trees are genetically modified to grow in arid or saline conditions.	Protection forests can be established on degraded lands.
Trees are genetically modified to adapt to traditionally unsuitable sites.	Carbon-sequestrating forests can be established on sites previously not suitable for forestry.
Cold-tolerant species of a desired genus are developed.	The range of desirable trees can be extended.

One involves the effects of biotechnology—particularly the introduction of transgenic plants—on human health. The food-safety issue is not generally raised for plants such as trees or cotton, which are not usually a food source. However, cellulose is increasingly being used as a filler in food products, and the food-safety issue could become a concern.

A second issue is the effect of transgenic plants on the natural ecosystem, should there be genetic exchange between domestic and wild populations. In cases where plantation tree species are an exotic, genetic "outcrossing" to the natural environment would not be a factor. Where genetic exchange could be a problem, planting sterile trees or varieties with reduced or delayed flowering would lessen the likelihood of their "escape."

If modified genes do escape, how serious are the expected consequences and the worst-case consequences? In the case of the herbicide-tolerant gene, the consequences of release into the wild are probably small. Herbicides are unlikely to be applied to most of the natural environment, and where necessary, other types could be used to which the escaped genes do not confer tolerance. In the intermediate and longer term, the herbicide in question will almost surely be replaced periodically in the normal course of product change and development. Thus the presence of that modified gene in the natural environment appears unlikely to constitute any serious environmental problem, either short- or long-term. For genes that affect tree form or fiber characteristics, release into the natural environment is similarly unlikely to provide a competitive advantage in survival and therefore unlikely to have significant or adverse consequences.

However, the consequences could be different if a survival gene is involved. For example, the release into the wild of a gene for *Bacillus thuringiensis* (Bt), which makes a plant toxic to certain pests, could constitute a more serious problem if it altered the comparative competitive position of wild vegetation in dealing with pests. Ultimately, the seriousness of this problem depends on the probability of the transfer of a survival gene into the wild, the scale of the transfer, and the comparative change in the competitive balance within the natural habitat. To the extent that pests adapt via natural selection to modified genes, however, the long-term impact of the release of the modified gene into the natural environment will be mitigated.

That effect of biotechnology on the pest population brings up another concern. Pests would adapt to genetic pest controls through natural selection, and wild populations would gradually become resistant to the Bt gene, thereby undermining its longer-term effectiveness. The long period of tree growth would likely exacerbate that problem because it would allow insect populations many generations to develop resistance mechanisms. An approach to extend the life of transgenic pest control would be to establish "refugia," places planted in trees without the Bt gene, thereby diluting the ability of pests to develop resistance through natural selection.

Conclusions

The benefits of biotechnology in forestry go beyond economic advantages—including increased production, lower costs to consumers, and trees modified for easy processing or specific production values—to such environmental benefits as helping to preserve biodiversity and mitigate global warming. But biotechnological innovations also raise concerns about biosafety and the effects of transgenic plants on the resistance of pathogens and on the natural ecosystem, particularly the question of genetic exchange between domestic and wild populations.

Roger Sedjo is a senior fellow in RFF's Energy and Natural Resources Division and director of RFF's Forest Economics and Policy Program.

Carbon Emission Trading Costs and Allowance Allocations: Evaluating the Options

Dallas Burtraw

The lessons learned from examining three approaches to allocating carbon dioxide (CO_2) allowances in the electricity sector are likely to be highly relevant for an economywide program.

Although the Bush administration declined to participate in the Bonn agreement that addressed international reductions in carbon dioxide (CO_2) emissions, the president has repeatedly acknowledged the severity of the climate change problem. The preponderance of scientific evidence suggests that greenhouse gas emissions are warming the planet's atmosphere. Carbon dioxide emissions are primary contributors to the buildup of greenhouse gases, and the United States accounts for 24% of global carbon dioxide emissions.

President Bush has ordered a cabinet-level review of U.S. climate change policy and spoken about the need for market-based approaches to reducing emissions. It is possible the president's carbon policy will be similar to one of his father's significant environmental initiatives, which included a sulfur dioxide (SO_2) emission trading program as part of the 1990 Clean Air Act Amendments. If Bush proposes a similar trading program for CO_2, one of the biggest issues will be how to initially allocate the emission allowances.

The approach to allocating emission allowances for CO_2, which we measure in equivalent units of carbon, is important for two reasons. The first is that the potential transfer of wealth within the economy under a carbon trading program is tremendous and is likely to far outstrip the magnitude of any previous trading program. The market value of emission allowances that are allocated, bought and sold, and potentially reflected in electricity prices can be as much as 10 times greater than the actual cost of compliance with an emission reduction target. This is because every ton of carbon emission would require an allowance. For example, if the United States were to reduce its emissions by 5%, the marginal cost per ton of those reductions would be expected to determine the price of an emission allowance, and this would be the value per ton for each of the remaining 95% of emissions.

The second reason the allocation of carbon emission allowances is important is its effect on the economic cost of achieving emission reductions. This may come as a big surprise to many advocates of emissions trading. For the most part, the economics literature has either ignored

allowance allocation entirely or primarily treated it as a distributional issue. Most courses in economics, public policy, or law teach that emission trading programs can be efficient and do so without considering how emission allowances are allocated in the design of the program. However, this idea is based on an idealized characterization of markets that often is not realized. In practice, how one allocates allowances affects the efficiency of a trading policy.

In new research at RFF, we have investigated the cost-effectiveness and distributional effects of three approaches to distributing carbon emission allowances under an emission-trading program in the electricity sector. The focus on the electricity sector is not meant to detract from the view of most economists that an economywide approach to trading carbon emissions would be preferable, a view we share. Nonetheless, the focus here on the electricity sector is deliberate. Although it is responsible for a little more than one-third of carbon emissions in the United States, the electricity sector would be expected to contribute two-thirds to three-quarters of the emission reductions under a policy that encompasses the entire economy in a cost-effective, or least-cost, way. The lessons we learn by examining the electricity sector in detail are likely to be those most relevant for an economywide program.

One way to allocate the emission allowances is through a revenue-raising "auction." The auction could be coupled with a cap—or safety valve—on the maximum price for allowances. (This approach has become known as the Sky Trust proposal, after a group by that name formed to advance this approach.) A second approach is grandfathering, patterned after the SO_2 trading program, in which allowances would be distributed on the basis of historic generation. A third approach is a generation performance standard (GPS), embodied in current legislative proposals and nitrogen oxide (NO_x) policy in Sweden. Under such a standard, allowances would be allocated based on shares of current electricity generation. We solve a detailed national electricity-market model and measure the economic cost, as well as the distributional effects felt by consumers and producers of each of these three allocation schemes.

Findings

Our main finding, and a surprising one at that, is that an auction is dramatically more cost-effective than the other approaches—roughly 50% cheaper than grandfathering or the GPS. This finding is illustrated in Figure 1 in a snapshot for the year 2012. In the absence of a policy, baseline emissions are estimated to be 626 million metric tons of carbon (mtC) in 2012. The horizontal axis indicates the size of emission reductions from this baseline. The vertical dotted line anchors a point equivalent to 1990 emissions in the electricity sector, which were about 150 million mtC less than in the baseline projected for 2012. The vertical axis reports the average social cost in 1997 dollars per mtC of emission reduction.

Average social cost is calculated as the ratio of the total additional economic cost divided by tons of emission reduction, and economic cost is measured as the sum of the changes in consumer and producer surplus in the electricity sector. Consumer surplus is the difference between consumers' willingness to pay for electricity and the price consumers actually pay. We measure this as the area under the demand curve and above electricity price. Producer surplus is the difference between revenues and costs, or equivalent producer profits. A critical issue, as we discuss below, is how revenues collected under the auction are used. In the results illustrated in Figure 1, we assume revenues are redistributed to households.

For more moderate emission-reduction targets, the ratio of cost under the auction approach is closer to one-third the cost of grandfathering and GPS, and it is somewhat greater than one-half of the cost of grandfathering and GPS for more ambitious reduction targets. However, auctioning looks better and better as the emissions reductions we consider become more ambitious because the overall level of costs incurred and the absolute value of the cost savings under the auction approach grow substantially.

The cost-effectiveness of the auction approach holds—in general terms—under a variety of assumptions about the future state of economic regulation and competition in the electricity sector. Accounting for changes outside the electricity sector that result from changes in relative fuel costs reinforces the differences among the three approaches.

The differences in the societal costs of the three approaches flow from the effect of each approach on electricity price. Allocating permits on the amount of electricity a utility generates (GPS allocation) creates an incentive for each utility to increase electricity generation. In effect, the GPS subsidizes electricity which, in turn, mitigates electricity price increases; however, it also raises social cost of reducing CO_2 emissions. The way electricity prices are determined in practice departs from economic efficiency, and the output subsidy amplifies the distortion away

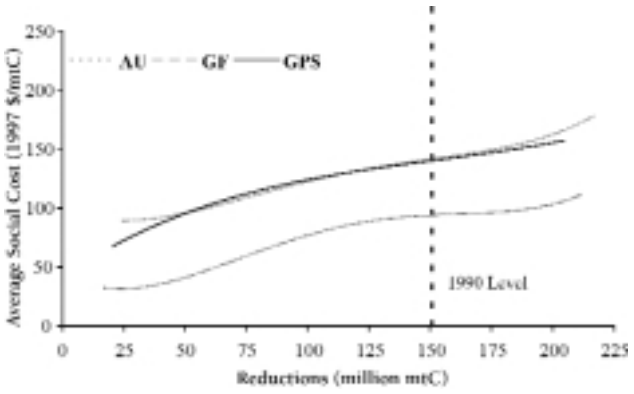


Figure 1. Social cost of allocation approaches over a range of emission targets.

from efficiency in most electricity markets and time blocks. In contrast, the auction approach increases electricity prices the most, but the efficiency costs of the price changes are less than the costs under the other approaches.

Significant distributional differences also exist among the approaches to allocating emission allowances. Electricity consumers face the highest electricity prices but the lowest natural gas prices under the auction approach. Grandfathering falls midway between the other two approaches with respect to both electricity and natural gas price changes. The GPS leads to the lowest electricity prices and consumers are best served by the GPS if we only consider electricity price changes. However, this approach also results in the highest natural gas price.

The auction approach is unique because it raises substantial revenues. In our study, we assume that these revenues are returned to households. Some observers have suggested that electricity companies or state public utility commissions could be responsible for recycling the revenue to households. Several other recent studies find that the method by which revenues are distributed can matter. Many studies argue that an auction or emissions tax can be substantially less costly than other approaches to allocating allowances because auction revenues can be used to reduce the consumer's marginal income tax or other taxes. The approach we model, direct redistribution to households, is the least efficient way that revenues can be recycled if one considers effects in the general economy.[1] If auction revenues are used in a more efficient way, such as to reduce preexisting taxes, the cost-effectiveness of the auction would further increase.

Just as important to the political dialogue is the effect of allowance allocations on firms. In order to estimate the effect on electric power companies, we calculate changes in the net present value of generation assets over a 20-year horizon, which directly indicates how the value of a firm would be affected under each approach. Figure 2 reports the change in asset value for each major type and vintage of generation capacity on a national aggregate basis. Value is indicated as dollars per megawatt (MW) of capacity. The figure illustrates a specific example of a 35 million mtC (6%) reduction in emissions from baseline levels, phased in and taking full effect in 2008. The designation of existing capacity applies to generation capacity in 1997.

Even though grandfathering appeared to be an intermediate approach when measured by its effect on electricity and natural gas prices, electricity companies have the most to gain from grandfathering (as shown by the middle bar for each type of asset) because it represents a substantial transfer of wealth from consumers to them. In fact, producer profits and asset values increase substantially compared to the baseline (absent a carbon policy)—surprisingly, making electricity generators better off with carbon reduction than without, but leaving consumers substantially worse off. The auction and GPS approaches have much more moderate distributional effects and, therefore, we focus more attention on a comparison of these two alternatives.

The relative performances of the auction and GPS approaches are surprising. Overall, owners of existing and new generation assets in the aggregate enjoy an increase in asset values under both the auction and GPS, and can expect to do at least as well under an auction as they would under a GPS.

Another surprise is that owners of existing assets can expect to do substantially better under an auction than under a GPS.

The value of existing generation assets is indicated by a group of bars in the center of the figure, and it shows that the value of assets falls the most under the GPS. At the regional level, values vary according to the mix of generation assets and by the way prices are set (regulation or competition) in each region. In fact, in several regions we find the values of existing assets actually increase under auction.

The relative performance of the auction approach raises an interesting paradox: producers do better paying for emission allowances (through the auction) than receiving them for free (under GPS). The reason for this is that the GPS yields the lowest electricity price, which erodes the value of existing assets.

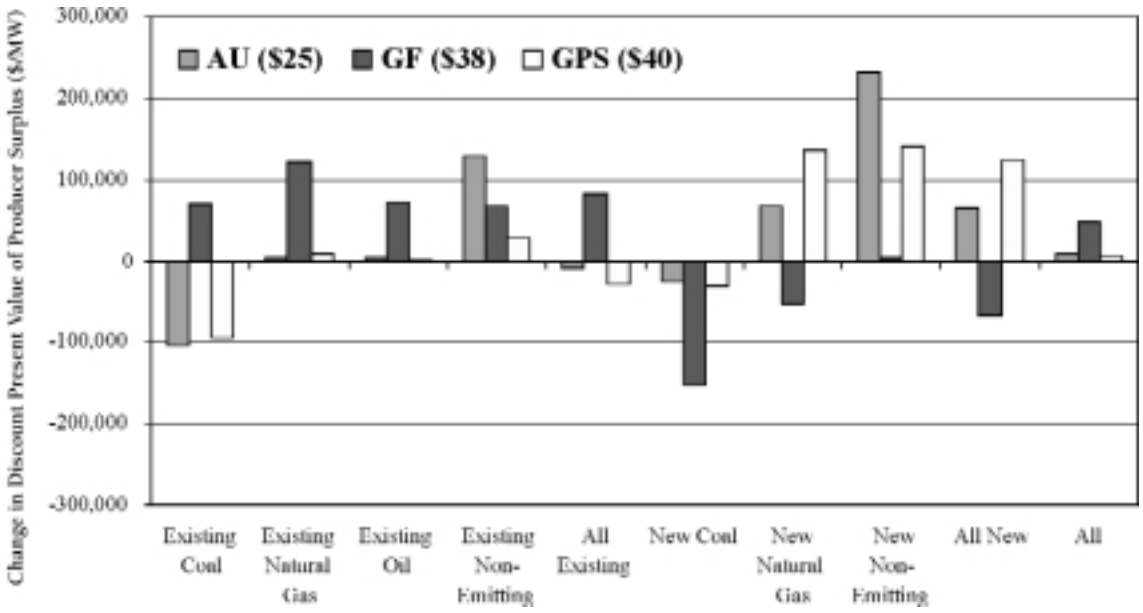


Figure 2. National aggregate changes in asset values by technology and vintage (1997 $/MW in 2001; 35 million mtC reduction).

The auction results in the highest electricity price, which preserves or enhances the value of many generating assets.

Although consumer expenditures increase under the auction approach, substantial revenues also are raised and they serve as compensation to consumers through redistribution to households. In addition, a portion of revenues could be diverted to compensate producers as well, perhaps through a hybrid program that combined an auction with a GPS or grandfathering during a transition period. This hybrid approach could be phased out, ultimately culminating in an auction of all allowances in future years. A portion of revenues under an auction, or allocation of some allowances, could be directed to support energy conservation and other benefit programs.

Admittedly, this is pretty complicated stuff. The bottom line is that the auction approach would result in significantly lower overall costs to society than either of the two gratis approaches to allocating allowances. The auction approach also provides policymakers with flexibility through the collection of revenues that can be used to meet distributional goals or enhance the efficiency of the process even further by reducing pre-existing taxes. Finally, an auction initially targeting only the electricity sector could easily be expanded to an economywide policy, something that would be much more difficult under a grandfathering or GPS approach. Because an auction approach would be cost-effective, reducing CO_2 emissions that way would have less effect on economic growth than under the other two approaches. This attribute provides perhaps the most significant form of distributional benefit.

Dallas Burtraw is a senior fellow in RFF's Quality of the Environment Division. This article is based on an RFF discussion paper, "The Effect of Allowance Allocation on the Cost of Carbon Emission Trading," by Dallas Burtraw, Karen Palmer, Ranjit Bharvirkar and Anthony Paul (www.rff.org/disc_papers/PDF_files/0130.pdf).

1. For a more detailed description, see "The Cost-Effectiveness of Alternative Instruments For Environmental Protection in a Second-Best Setting," 1999, (Lawrence H. Goulder, Ian W. H. Parry, Roberton C. Williams III, and Dallas Burtraw), *Journal of Public Economics*, vol. 72, no. 3 (June), 329–360.)

IN APPRECIATION

In Appreciation – Dr. Hans Landsberg

Hans Landsberg, one of RFF's intellectual founders and a pioneer in energy and mineral economics, died peacefully October 14, from complications of Parkinson's disease. He was 88.

Landsberg joined RFF in 1960, where he was among the first scholars to specialize in the role of energy in a modern economy. He gained national recognition for his groundbreaking 1963 RFF study, *Resources in America's Future*, an economic and technological blueprint for projecting long-term requirements and availability of energy, nonfuel minerals, land, water, crops, and numerous other industrial materials, which he co-authored with Leonard Fischman and Joseph Fisher.

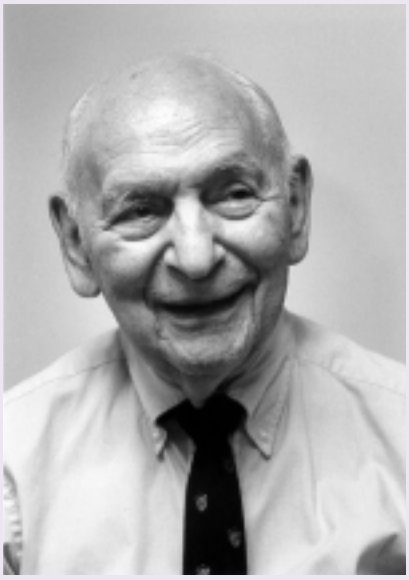
The work of Landsberg and his collaborators—including the landmark 1979 study, *Energy: The Next Twenty Years*—provided the impetus for what is now the routine and systematic collection and analysis of energy data by the federal government and private industry.

"Those of us here who knew Hans and worked with him over the years mourn the loss not only of a friend, but also someone who helped give RFF the reputation it enjoys today as the place to turn for factual data on trends in energy and mineral availability," says RFF President Paul Portney.

"When others said we were running out of these key natural resources, Hans helped to prove otherwise. He was scrupulously careful in his work, and as independent as the day is long. Until the end of his long life, he was someone to whom reporters could turn for expert—and always understandable and entertaining—explanations of current events and policies."

Landsberg built his career during turbulent times. Born in 1913 in East Prussia, he spent much of his youth in Berlin, fleeing in 1933 to escape the Nazi threat. After earning a degree at the London School of Economics, Landsberg came to the United States in 1936, where he earned a master's degree in economics from Columbia University. During World War II, he served as

SYLVIA JOHNSON PHOTOGRAPHY



an intelligence officer in Italy with the Office of Strategic Services. In Rome at the war's end, he married Gianna Giannetti, who passed away in 1993. In the 1950s, he worked as a consulting economist and served on the staff of the Office of the Economic Adviser to the Israeli government.

Throughout his professional career, Landsberg served on a number of distinguished advisory panels for the National Academy of Sciences and the congressional Office of Technology Assessment, among others. In 1972, he served as an adviser to Maurice Strong in his capacity as the secretary general of the United Nations Conference on the Human Environment. In 1974, Landsberg was named a Fellow of the American Academy of Arts and Sciences and in 1982, he became a Fellow of the American Association for the Advancement of Science. The International Association of Energy Economists honored Landsberg in 1983 for his outstanding contributions to the field.

Joel Darmstadter, an RFF colleague with whom Landsberg frequently collaborated, says he will, "cherish the memory of one who was both a close personal friend and an intellectual mentor. Hans had the ability to convey difficult ideas with an unforced, unhackneyed ease of expression, which deserves the envy of many writers."

Michael Toman, RFF Senior Fellow, said Landsberg's work was both grounded in pragmatism and audacious in the scope of the questions raised. "In his perceptiveness and breadth of vision about problems to be addressed and solutions to be found, as well as in the quality of his scholarship, he set a lofty example for all those who followed him in the field."

Adds Senior Fellow Molly Macauley: "There was always a twinkle in his eye, and his door was always open, even to the rookies. He had more economic intuition than most, and a gracefulness with prose one can never learn in grad school. He helped weave the very fabric of RFF—it's hard even to quantify just how very much we learned from him."

Landsberg is survived by his daughter Ann S. Landsberg, his sister Dr. Eva Landsberg-Lewin, and his two grandsons, James Truslow and Max Baehr.

INSIDE RFF

RFF Welcomes Three New Board Members

RFF is pleased to welcome three new members to its board of directors: Julia Carabias Lillo, president of Centro Interdisciplinario de Biodiversidad y Ambiente (CEIBA); Frank Loy, former undersecretary of state for global affairs, U.S. Department of State; and Lawrence Linden, co-chairman and chief operating officer for Goldman Sachs & Co.

Julia Carabias Lillo

Apart from her role as president of CEIBA, **Carabias Lillo** is a member of the science faculty and a thesis adviser at the National Autonomous University of Mexico (UNAM). Her research areas include tropical forest regeneration, environmental restoration, natural resource management, productive systems and ecology, urban ecology, calculating the value of environmental heritage, global change, poverty and the environment, and environmental policymaking.

Carabias Lillo has held several positions in the Mexican government, including minister of the environment, natural resources, and fisheries, from1995 to 2000, and secretary of fisheries, from 1994 to 1995. She was also president of the National Ecology Institute in 1994.

Carabias Lillo has represented Mexico in global environmental forums, such as the U.N. Environmental Programme, the Commission for Sustainable Development of the U.N. General Assembly, and the Organisation for Economic Co-operation and Development Committee on Environmental Policy. She also was a member of the Commission for Developing Countries and Global Change, which published the report, *For Earth's Sake*, during the 1992 U.N.-sponsored Conference on the Environment and Development in Brazil.

She currently serves on the World Wildlife Fund (WWF) board of directors and until recently was a member of the board of Leadership for Environment and Development (LEAD INTERNATIONAL).

She was awarded the 2001 J. Paul Getty Wildlife Conservation Prize offered by WWF. She received a B.S. in biology and an M.S. from UNAM.

Frank Loy

Over the past several decades, **Loy** has had several careers. Most recently, from 1988 to 2001, he served as undersecretary of state for global affairs. This marked his third appointment in the U.S. State Department and the fourth time he has served in the federal government. From 1980 to 1981, he was the director of the Bureau of Refugee Programs, with the personal rank of ambassador.

In the corporate sector, Loy was president of Penn Central Transportation Co. and helped lead the company out of bankruptcy (1974–79). Before that, he was senior vice president for international and regulatory affairs for Pan American World Airways.

Loy has also been active in the nonprofit community. He was the president of the German Marshall Fund of the United States from 1981 to 1995. He is either chair or former chair of Environmental Defense, Foundation for a Civil Society, League of Conservation Voters, and Washington Ballet. He also is a board member of the Regional Environment Center for Central and Eastern Europe, Institute for International Economics, and Population Services, International.

Loy received his LL.B. from Harvard Law School and his B.A. from the University of California, Los Angeles.

Lawrence Linden

Linden became co-chairman and chief operating officer of Goldman Sachs & Co. in 2000. Before that, he was a member of the firm's Global Compliance and Control Committee, from 1992 to 2000. Linden headed Goldman Sachs's global operations from 1994 to 2000, and was co-head of the information technology department from 1992to 1994.

Before joining Goldman Sachs, Linden was at McKinsey & Co. from 1983 to 1994, rising to the rank of partner in 1988. From 1981 to 1983, Linden worked at the Cabot Corporation, as a senior business analyst. From 1978 to 1981, he was a senior staff member in the White House Office of Science and Technology Policy. Linden was a lecturer at the Sloan School of Management at the Massachusetts Institute of Technology (MIT) and a research scientist in the university's energy laboratory.

Linden is chairman of the Private Sector Advisory Task Force of the World Wildlife Fund. He also is a member of the Engineering System Division Visiting Committee at MIT. Linden holds a B.S.E. from Princeton and a S.M. and Ph.D. from MIT.

INSIDE RFF

RFF Fellowship and Internship Programs

The RFF Fellowships in Environmental Regulatory Implementation

RFF will award two fellowships for 2002–2003 for the pursuit of scholarly research that documents the implementation and outcomes of environmental regulations. The objective of our new fellowship program is to develop a base of scholarship that systematically examines environmental regulations in practice and that can be used to inform regulators, industry, and others on the underlying assumptions behind environmental laws and policies.

Consideration will only be given to proposals for research that is documentary in nature—that is, research that attempts to describe objectively how a regulation and/or regulations were promulgated and implemented, reactions to the regulation(s), and the actual outcomes—without arguing in favor of any particular policy or result. Case studies of any environmental regulation implemented within the past 50 years in the United States will be considered. The research is expected to result in substantial publishable output, such as a monograph or book.

Scholars from universities and research organizations—who have a doctorate or equivalent degree, or equivalent professional research experience—are eligible to apply. Fellows will receive: an annual stipend commensurate with experience; research support; office facilities and limited support for relocation, if the recipient chooses to conduct the project at RFF; and funding for travel and conferences. These fellowships are made possible through a generous grant from the Andrew W. Mellon Foundation.

Gilbert F. White Postdoctoral Fellowship Program

RFF offers two resident fellowships for the 2002–2003 academic year in honor of Gilbert F. White, retired chairman of the RFF board of directors, distinguished geographer, and statesman of science. The fellowships are intended for researchers who have a doctorate and wish to devote a year to scholarly work in areas related to natural resources, energy, or the environment. Social scientists as well as natural scientists interested in policy-relevant interdisciplinary research are encouraged to apply

The award is open to individuals in any discipline who have completed their doctoral requirements by the beginning of the 2002–2003 academic year.

Joseph Fisher Fellowships

In honor of the late Joseph L. Fisher, president of RFF from 1959 to 1974, RFF will award fellowships for the 2002–2003 academic year in support of doctoral dissertation research on issues related to the environment, natural resources, or energy.

This fellowship is intended to be the principal source of support for graduate students in the final year of their dissertation research.

Walter O. Spofford Memorial Internship

The Walter O. Spofford Jr. Memorial Internship was established to honor the important contributions of the late RFF researcher. He worked with Chinese officials to establish environmental standards compatible with sustainable economic growth; assisted in the development of environmental master plans for Beijing, Chungjing, and Shandong; and helped to establish the Beijing Environment and Development Institute (BEDI). To build on his legacy, RFF is offering a paid internship for graduate students with a special interest in Chinese environmental issues to spend time at RFF. If necessary, support for travel expenses and visa assistance can be provided.

Summer Internships

RFF has several paid summer internships for graduate and outstanding undergraduate students, beginning in June and ending in late August. Some flexibility in the beginning and ending dates is possible to meet particular student needs. Students will earn a stipend. The program is open to both U.S. and non-U.S. citizens, provided the latter have proper work and residency documentation.

Contact Information

For more information about all of these programs as well as the application process and requirements, please visit www.rff.org/about_rff/fellowships_internships.htm.

INSIDE RFF

A Press Update...

RFF Press published five new books during the spring and summer:

Climate Change Economics and Policy: An RFF Anthology, is edited by Michael A. Toman, a senior fellow in RFF's Energy and Natural Resources Division.

Regulating from the Inside: Can Environmental Management Systems Achieve Policy Goals? is edited by Cary Coglianese and Jennifer Nash, two scholars with Harvard's Kennedy School of Government.

People Managing Forests: The Links Between Human Well-Being and Sustainability, edited by Carol J. Pierce Colfer and Yvonne Byron, is one of several planned copublications between RFF and the Center for International Forestry Research (CIFOR), a research organization focused on sustainable management and human welfare in tropical forests.

Superfund's Future: What Will It Cost? by Katherine N. Probst (RFF) and David M. Konisky (RFF), with Robert Hersh (RFF), Michael B. Batz (RFF), and Katherine D. Walker.

Improving Regulation: Cases in Environment, Health, and Safety, is edited by Paul S. Fischbeck and R. Scott Farrow (both of Carnegie Mellon University).

The Press has signed agreements for a Chinese-language version of *The Measurement of Environmental and Resource Values,* by A. Myrick Freeman III, and an Indonesian-language version of its forthcoming *Which Way Forward? People, Forests, and Policymaking in Indonesia,* edited by Carol J. Pierce Colfer and Ida Aju Pradnja Resosudarmo (CIFOR).

In June, the Press cosponsored a workshop on "Private Initiatives in Environmental Management." Other sponsors included the Environmental Law Institute, the Regulatory Policy Center at Harvard University's John F. Kennedy School of Government, and the National Academy of Public Administration. The agenda was organized around themes from RFF's recently published book, *Regulating from the Inside.* There were approximately 150 attendees from the U.S. Environmental Protection Agency (EPA), private industry, and local environmental organizations. Participants included James Boyd (RFF), Cary Coglianese (Harvard), Jennifer Nash (Harvard), James W. Conrad, Jr. (American Chemistry Council), Daniel J. Fiorino (EPA), Al Iannuzzi (Johnson & Johnson), and Suellen Terrill Keiner (National Academy of Public Administration).

RFF PRESS
RESOURCES FOR THE FUTURE

Press Director Don Reisman attended a conference on China's forest policy in Sichuan, China. The Press will be working on a book and possibly a book series with CIFOR and several China-based researchers. The initial book will provide an independent, detailed assessment of the current state of China's forests. It will then examine various market-oriented policy options to increase forest cover, protect biodiversity, and aid efforts in sustainable economic development.

The above books include the first outside acquisitions of RFF's revised publishing program. During the next six months, RFF Press plans to publish 8 to 10 new books, including works by RFF staff, university faculty, and researchers at other nongovernmental organizations. To order books or request a copy of our Fall 2001 catalog, call RFF Customer Service, at 1-410-516-6955.

Center for Risk Management Gets New Name, Broader Scope

Fifteen years after its creation, RFF's Center for Risk Management is changing its name to the Risk, Resource, and Environmental Management Division. "The problems we created the Center to address are still receiving great attention at RFF," says RFF President Paul Portney. "At the same time, researchers in the Center have broadened their reach to examine the management of government programs ranging from Superfund to food regulation, and from water markets to public participation. Accordingly, it is appropriate that we change the name of the Center to reflect this evolution." Portney hopes to soon announce the creation of an endowed chair and fellowship program to help advance the discipline of risk analysis in regulatory policymaking.

INSIDE RFF

RFF Council Explores Balancing U.S. Energy Needs and Environmental Protection

President Bush came to office calling for a new energy policy, one that would address this country's reliance on imported oil. The tragic events of September 11 have dramatically heightened the public's awareness of this imbalance and added a new perspective to the ongoing debates over possible solutions. At the recent RFF Council meeting, held here in Washington, RFF scholars and policy experts from industry and the environmental advocacy community debated the right role for the federal government to play in establishing domestic energy security as well as the potential costs to the environment.

The panelists focused on three issues that are at the heart of the comprehensive energy bill passed by the House late this summer (H.R. 4): opening the Arctic National Wildlife Reserve (ANWR) to exploration, adjusting the Corporate Average Fuel Economy (CAFE) standards, and supporting research and development into cleaner energy technologies. The first two issues were the subject of rancorous debate, with an amendment to block exploration in ANWR being narrowly defeated.

Howard Gruenspecht, RFF, Roger Herrera, Arctic Power, and Patricio Silva, Natural Resources Defense Council

Roger Herrera—a consultant with Arctic Power, a grassroots organization supporting responsible oilfield development—challenged federal government estimates about the total amount of recoverable oil, calling them extraordinarily conservative and dated. "Today, with new technologies, we can recover between 65–70% of oil in an average field," compared to the government's figure of 37%, he said.

The coastal plain area of ANWR could yield over 10 billion gallons of oil, making it the largest new field to be found in 25 years, with the exception of the Caspian Sea, Herrera said. It also is located within 25 miles of an existing oil pipeline, which means that oil could come on line within 18–24 months following the first lease sale, he said.

Patricio Silva, a national activities coordinator in the Natural Resources Defense Council's air and energy program, said he concurred with Herrera's assessment of the volume of oil in the coastal plain field but sharply disagreed with his estimate of when and just how quickly oil could be available. It could take two to three years just to thoroughly evaluate the area and between seven to ten years before oil could flow, he said.

The administration's position on ANWR focuses on two erroneous assumptions, Silva said: first, the coastal plain is worth developing because the United States needs the oil and second, there's no other place to get it. The United States is not going to become energy independent just by opening ANWR, he said. Besides, there are other, less environmentally sensitive oil fields in the western United States and the Gulf of Mexico that should be considered, he said.

The CAFE debate

In the second panel, Josephine Cooper, president of the Alliance of Automobile Manufacturers, and Daniel Becker, global warming and energy director for the Sierra Club, debated the merits of adjusting the corporate average fuel economy (CAFE) standards.

According to Cooper, consumers consistently rank performance and safety criteria well above fuel efficiency in the factors they consider when they are buying cars, Cooper said. Automakers closely monitor consumer preferences not only to improve their market share but also to measure their rate of compliance with the CAFE standards, which is determined by the number of cars sold, she said. And what Americans clearly want are sport utility vehicles, minivans, and pickup trucks, which account for roughly 50% of all vehicles sold in the United States today, she said. Improving their fuel efficiency will take time and must be balanced against competing interests, such as safety.

Becker said that while consumers may place a low priority on improving fuel effi-

Gruenspecht, Josephine Cooper, Alliance of Automobile Manufacturers, and Daniel Becker, Sierra Club

ciency, it is one of the cheapest, most effective ways to curb greenhouse gas production in the short term. Asking people to cut the miles they travel or retrofitting close to 180,000 gas stations to handle cleaner fuels would be challenging to say the least, while getting close to a dozen car companies to retool would be easy, he said. The technology to do so exists, in the form of more efficient engines, improved transmission systems, and more aerodynamic designs. Raising the CAFE standards would be a powerful tool for spurring change, he said.

Energy Technology R&D

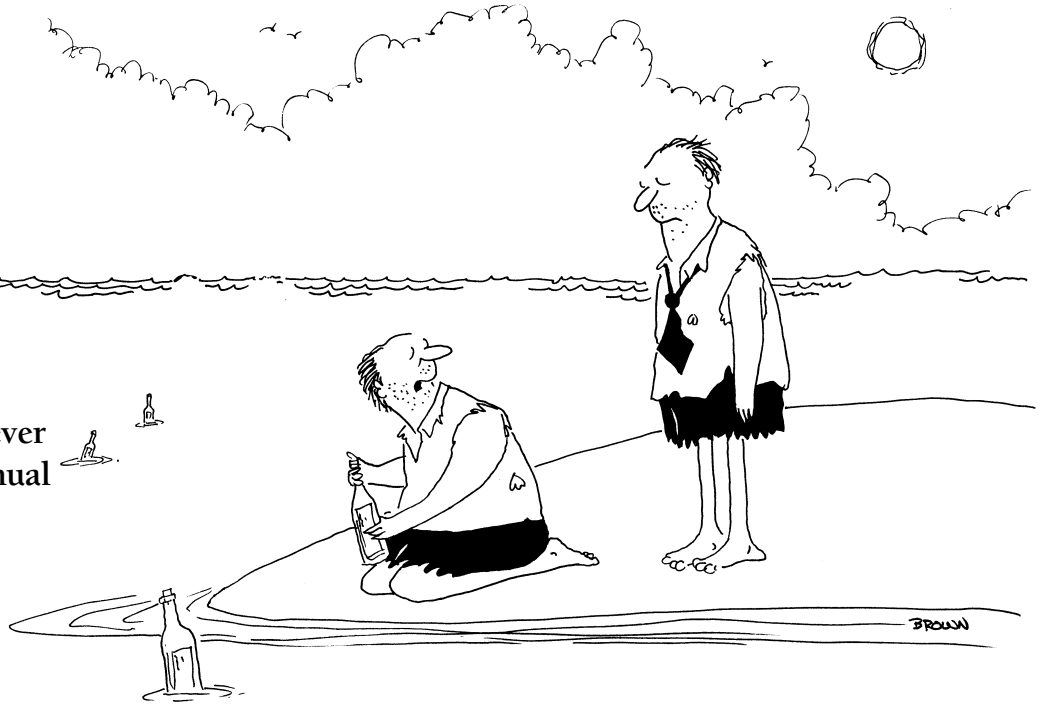
In the third panel, John Wise, vice president for research (retired) of Mobil Research and Development Corporation, and Jerry Taylor, director of natural resource studies at the Cato Institute, fundamentally agreed that the government's role in funding research into new energy technologies was of limited value in terms of enhancing commercial productivity.

Citing a recent National Research Council study on the effectiveness of U.S. Department of Energy-funded research into energy technologies, Wise said there was evidence that government support was key in the development of several research efforts with important energy efficiency and environmental benefits. However, he said, the question of whether these projects were simply "low-hanging fruit that was easy to harvest" must be considered.

Overall, Wise said, government serves the public best when it supports research into technologies that support environmental remediation; development of domestic energy sources; fragmented, low-tech industries such as homebuilding; and technologies that generate high risks for the developer but high potential rewards to society.

Taylor said that while there have been a handful of success stories, the government's overall track record on supporting energy R&D has been terrible. There are two fundamental reasons for this, he said: incompetent programming, in the form of narrowly focused research initiatives, and political, rather than economic, motives influencing the funding process.

Members of the RFF Council include corporations, private foundations, and individuals who combine an active interest in environmental and natural resource policy with a concern for RFF's financial well-being.



Shipwrecked or not, I never miss sending out my annual contributions!

Courtesy of the *Chronicle of Philanthropy*, by Joseph Brown

DEVELOPMENT

Recent Grants

RFF is deeply grateful for the support of the following corporations that have made special annual gifts in honor of the upcoming 50th anniversary of our founding. If you would like to find out more about how you can play a part, please contact Russell Ray at 202-328-5154 or ray@rff.org.

S.C. Johnson & Son and **American Chemistry Council** - $150,000 each, over three years

AT&T - $100,000

Pfizer - $70,000

BP p.l.c. - $50,000

Enron - $45,000

RFF is also pleased to announce that **Novartis** is a new corporate donor, with a gift of $10,000.

Other RFF Board News

Director of Development Lesli A. Creedon has taken on an important additional role, that of secretary to the RFF board of directors. She will be an officer of the corporation.

Ted Hand, RFF's vice president–finance & administration, said, "We made this move to formally recognize Lesli's important contributions in support of our board. She has been a source of creativity and drive and has helped RFF continue to grow in so many ways."

Dear *Resources* Reader,

Spectacular foliage and shorter days are sure signs of autumn's arrival. While temperatures may be cooling in Washington, the policy debates on Capitol Hill are only beginning to heat up. On the legislative agenda are such controversial issues as defining the U.S. role in a global climate change policy, raising fuel economy standards, and oil drilling in the Artic National Wildlife Refuge.

Resources for the Future is known for its independent research and analysis on energy, environmental, and natural resource issues. Because of our reputation for both research excellence and objectivity, we are uniquely positioned to weigh in on these timely debates. RFF scholars are busy briefing policymakers on the Hill, in federal agencies, and in the executive branch on which policy proposals make the most sense, injecting sound research into what are often polarized debates.

Time and again, we hear from decisionmakers at all levels how much they value RFF's participation in such discussions—and how our balanced, nonpartisan analyses greatly inform their policy decisions. We hope you will help us accept this challenge.

Before long, we will have torn another page from our calendars and come to December—a month of traditional tax-saving activities, such as charitable giving. As you think about your year-end philanthropy, we hope you will keep RFF in mind. Your generous contribution will help to ensure the continued success of our ambitious research activities and our significant communications and public education efforts.

I would also like to take this opportunity to make you aware of a little-known, yet incredibly powerful, service offered by RFF. The RFF Gift Fund is a tool designed to provide individuals with the opportunity to make charitable contributions (to the Gift Fund), that qualify for current income tax deductions. A donor can, at any point in the future, recommend distributions from the Gift Fund to RFF or to any nonprofit organization. This program is much like the Fidelity Charitable Gift Fund and the Vanguard Charitable Endowment Program, yet more attractive because RFF charges you nothing to establish this fund!

Think of it as your own personal foundation—brought to you free of charge by RFF. And as one who makes great personal use of the RFF Gift Fund, I'd highly recommend taking the time to learn more about it.

For more information on the Gift Fund and other ways of giving a year-end gift to RFF, please contact Lesli Creedon, director of development, at 202-328-5016 or creedon@rff.org. Thanks for your continued support of RFF. Best wishes for the holiday season!

Sincerely,

Darius W. Gaskins, Jr.
Chair, Resources for the Future Board of Directors

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