



RESOURCES

RESOURCES FOR THE FUTURE

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Research to Go

As the 104th Congress gets down to business, people inside and outside Washington are curious to see what the Republican-controlled House and Senate will—and won't—do. Some observers predict sweeping changes throughout the federal government, while others forecast two years of legislative gridlock. One thing is certain, though. When the debate swings to issues concerning energy, natural resources, or environmental quality and standards, RFF will be ready to serve up a full course of impartial research and analysis.

The articles in this *Resources* address topics likely to appear on the new congressional agenda. Linda Stuntz, a member of RFF's board and former deputy secretary at the U.S. Department of Energy, discusses a California proposal to restructure the electric utility industry; she analyzes the effect that enhanced competition may have on that industry and its customers. Looking ahead, RFF is launching a multiyear project to study the environmental impacts of restructuring the electricity industry. Restructuring will also be the subject of the next RFF Council meeting, to be held in Carmel, California, in April.

Terry Davies looks back at the 103d Congress, "the Congress that discovered risk assessment." Risk assessment has been hailed as an effective tool for setting environmental priorities, and the new Republican Congress may be more, rather than less, willing than previous Congresses to use it to undertake regulatory reform. But, as Davies notes, selecting the appropriate version of risk assessment for a given application is extremely important. He has long propounded the effective use of risk assessment and has learned

to appreciate both the strengths and weaknesses of this analytic tool.

The U.S. space program will also be scrutinized by the budget-minded 104th Congress, as legislators and policymakers consider how much to spend on space research and what to expect from that research. Molly Macauley, a pioneer in the field of space economics, reviews the tangible and intangible benefits the nation has historically expected from its space program. In her article, she asks tough questions about whether some articulated goals of the space program—jobs, international status, technology transfer—are best met through space research.

In the next year or so, the United States will attempt to implement a pledge, made at a United Nations convention in 1992, to reduce its greenhouse gas emissions to 1990 levels by the year 2000. Although the Clinton administration has proposed a plan to meet these targets, achieving them will be a difficult task for the United States and other industrial nations. Joel Darmstadter, who has studied climate issues for many years, outlines the Clinton administration plan. He identifies immediate challenges and pinpoints a missed opportunity or two.

When it comes to environmental legislation and policymaking, RFF won't be found on either side of the aisle. We attempt to be as objective, as precise, and as dispassionate as possible, and we try to anticipate issues before they fully emerge. We are grateful for the generous support of our contributors, who enable us to have research and analysis ready when it is needed.

Robert W. Fri, President

Current Shock: Competition in Electricity Service

Linda G. Stuntz

Consumers may not have given much thought to who supplies their electricity, or how, but they should know that a tremendous battle is being waged behind their electrical sockets. Just as several long-distance telecommunication carriers (AT&T, Sprint, MCI) now compete to serve each household, so too firms with currently unfamiliar names may one day—in the not-so-distant future—be competing to supply household electricity. Whether, when, and how this happens are questions at the center of a vigorous debate occurring in Washington, in state capitols, and in courtrooms around the United States.

California proposal to open the electricity market

Traditionally, households and businesses have had little choice when it comes to buying electricity. Utility companies providing electricity were granted exclusive service areas (or monopoly franchises) by the states in which they operated. In return, electric companies were obligated to provide service to all customers within that territory who wanted it. And the rates electric companies could charge for the electricity they sold were regulated by state public service or public utilities commissions.

Earlier this year in California, however, the public utilities commission floated a proposal that sent tremors throughout the electricity industry, not only in California but everywhere else as well. Under this proposal, by 1997 large industrial customers in California—a factory, for example—could buy power from any supplier, including electricity

brokers or nonutility generators. Individual homeowners would have a similar option by 2002; in other words, they could shop around for electricity “bargains” in the same way they shop for other commodities. The local utilities, for whom these customers used to be captive, would be required to *wheel* the power—that is, the local utility would have to use its power lines to bring to each factory or home the bargain electricity that customer had purchased elsewhere. In return for this service, the local utility would be paid a fee.

Thus, under the California proposal, if a power producer in Nevada could generate more electricity than it could sell to its customers there, it could sell the surplus power to customers in California if its price were attractive compared to the price charged by California electric utility companies. To say the least, such an arrangement would represent a fundamental shift in the way electricity service is provided. Michigan,

Under the California proposal, by 1997 large industrial customers in the state could buy power from any supplier, including electricity brokers or nonutility generators.

Wisconsin, Texas, and several other states are either experimenting with or contemplating similar changes, though none have gone so far as California.

The debate sparked by the California proposal—whether consumers should

have the right to purchase power from sources other than their local utilities—can be traced back to the Energy Policy Act. Little noticed when it was signed into law by then-President George Bush in October 1992, the Energy Policy Act gave the Federal Energy Regulatory Commission expanded authority to order utilities to use their transmission and distribution lines to make available electric power generated by other utilities and nonutilities. That authority applies only to wholesale transactions—that is, sales of electricity from one utility company to another. But the competitive forces unleashed by the Energy Policy Act have prompted interest in extending this competition to all levels of the industry and to all consumers of electricity.

Two sides of the restructuring debate

There are many reasons for the recent interest in enhanced competition in the electricity business. One is the wide disparity in prices paid by electricity consumers, not only in different regions of the country but even within a single state. For example, the Pennsylvania cities of Pittsburgh and Uniontown are only fifty miles apart, but homeowners in Pittsburgh pay 12.4¢ per kilowatt hour for their electricity, while Uniontown homeowners pay only about half that, 6.5¢ per kilowatt hour. Similar disparities in rates exist among states and regions of the United States and between industrial and commercial users. These disparities can create very real competitive consequences when a firm in a higher-cost area competes against one in a lower-cost area.

Proponents of the “shopping” approach to electricity argue that consumers will benefit if given the opportunity to hunt for the lowest-priced electricity. They argue that only through competition will inefficiencies associated with the current structure and regulation of the electric utility industry be elimi-

nated. As evidence, they point to the substantial reductions in long-distance telephone rates in the wake of deregulation in that industry.

Many utilities, small consumer groups, and environmentalists argue that moving to wide-open competition in electricity markets will benefit only the largest industrial customers.

Countering these arguments for "shopping," however, are many utilities, small consumer groups, and environmentalists, who argue that moving to wide-open competition in electricity markets will benefit only the largest industrial customers. Rather than producing lower rates for all consumers, these opponents argue that extending supplier choice to the retail level will only result in costs being shifted from large customers, who are most attractive to new suppliers, to smaller customers. Moreover, environmentalists and consumer advocates worry that making electricity markets more competitive could jeopardize many programs currently conducted by utilities to protect low-income households, conserve energy, and develop new, more environmentally benign electricity-generating technologies. In 1992, for example, electric utilities spent \$2.2 billion on energy conservation programs (called demand side management, or DSM), up from \$1.7 billion the previous year.

Industrial customers have long argued that DSM, low-income assistance, and other programs increase their electricity rates while the benefits of such programs have accrued mostly to other customers. If these industrial customers were free to shop around for electricity, they would seek to avoid paying for such programs. (In much the same way, after years of subsidizing local telephone

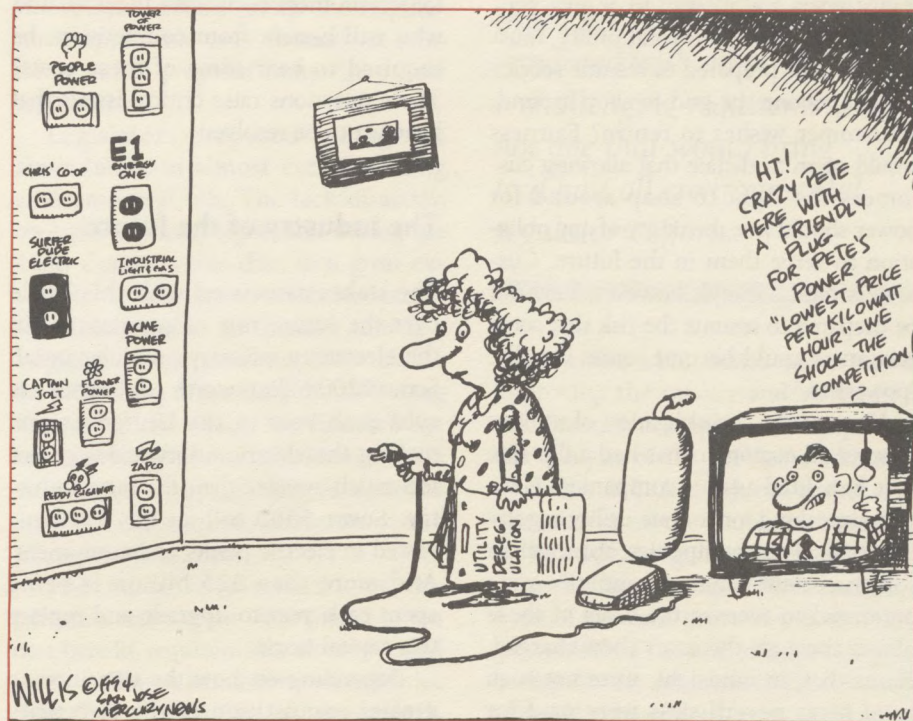
service, businesses took advantage of cheaper long-distance telephone rates when they became available). Thus, if DSM and other socially desirable programs carried out by utilities—acting essentially as agents of the government—are to continue in a more competitive electric utility industry, these programs will have to be funded through different mechanisms. Faced with competition from nonutility electricity generators who do not undertake similar programs, utilities already are reducing DSM spending and cutting back on research and development efforts.

The advent of nonutility generators and new technology

The debate over competition in the electricity industry is fueled further by the growing share of electricity that is being supplied by entities other than traditional utility companies. These nonutility generators include companies that produce electricity as a byproduct of, say, steel or chemical production (called *cogenerators*); small producers

using unconventional fuels, such as biomass or geothermal energy; and independent power producers, which produce electricity using traditional fuels but which do not own distribution or transmission facilities. Such nonutility power producers own electric-generating capacity but, unlike traditionally regulated electric utilities, they lack a designated service area.

Since 1978, when the Public Utility Regulatory Policies Act (PURPA) was passed to encourage the construction of cogeneration and small power plants using unconventional fuels, these non-utility producers have supplied an increasing amount of U.S. electricity. Although still responsible for less than 10 percent of the electricity generated nationwide, each year since 1991 they have brought more new generation capacity into service than have utilities. Moreover, in certain states (such as California, Virginia, and New Jersey), nonutility generation has grown to account for more than 20 percent of the state's installed generation capacity. Using new technologies, such as highly efficient, combined-cycle, natural gas



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turbines, and taking advantage of historically low natural gas prices, nonutility producers frequently generate electricity at a cost below average utility system costs.

This is not the first time in the history of the electric industry that new technology has offered cost advantages. What is new, however, is the argument that the benefits of new technology should be available directly to certain customers, rather than to *all* customers through the utility as their supplier. The key issue, then, is whether new, advantageously priced electric supplies should continue to be sold to utilities as "portfolio managers" for all customers or whether some or all individual customers should be able to purchase power directly from the supplier of their choice, thereby obtaining for themselves the benefit of new technology.

An obligation to serve

A serious complication in the debate about enhanced competition in the electricity industry has to do with the electric utilities' historic obligation to serve. If customers are allowed to choose suppliers other than their local utility, must the utility be prepared to resume service if, after leaving the grid to shop around, a customer wishes to return? Fairness would seem to dictate that allowing customers the right to shop around for power should free the utility of any obligation to serve them in the future. Customers (and society), however, may not be prepared to assume the risk that some customers could become, quite literally, "powerless."

Historically, the obligation of utilities to serve all customers has had a flip side that benefited utility companies. Generally speaking, once state utility regulators had given companies approval to construct new plants, the utilities were permitted to recover the costs of those plants through the rates they charged. Plants that, in hindsight, were not such good ideas nevertheless were paid for

by consumers, along with the plants that turned out to be bargains and were worth more in the market than regulated rates reflected.

What will happen in a more competitive environment if utilities cannot pass along to electricity consumers the costs associated with high-cost plants and other commitments undertaken voluntarily or by direction from regulators to

With enhanced competition, what becomes of the electric utilities' historic obligation to serve? Customers and society may not be prepared to assume the risk that some customers could become, quite literally, "powerless."

meet customer needs? Will stockholders be forced to "eat" the costs associated with these stranded assets? Should the low-cost generators, or the customers for whom these costs were incurred and who will benefit from competition, be required to bear some of these costs? These questions raise critical issues that have yet to be resolved.

The industry of the future

The stakes associated with this battle over the future role of competition in the electricity industry are substantial. Some \$200 billion worth of electricity is sold each year in the United States, making the electric utility industry not too much smaller than the auto industry. Some \$500 billion has been invested in electric plants and equipment. And more than \$25 billion is being spent each year to upgrade and replace this capital stock.

Depending on how the transition to greater competition in the electricity

industry is structured, electricity consumers, generators, shareholders, and the financial community all fear the possibility of large losses. Utilities with high rates relative to the marginal cost for production for the region within which they operate (for example, those utilities required to purchase large amounts of high-cost power under PURPA, and some with recently completed nuclear power plants) are especially at risk of financial loss.

The rough outlines of the electric utility industry of the future are beginning to emerge. Almost certainly, there will be disaggregation of the vertically integrated utilities we have known in the past. Generation, transmission, and distribution are likely to be separate functions, if not separate companies. Some experts and participants in the debate favor a system in which atomistic buyers and sellers negotiate bilateral contracts. Others favor a system in which all electricity transfers are coordinated by a central controller. This controller would run an organized spot market for electricity and dispatch power based on the bids of buyers and sellers. Some argue that there is a role for both a central spot market and bilateral contracts.

Regardless of the system that results, the electricity industry of the future will differ as much, or more, from the industry of fifteen years ago as modern financial institutions or telecommunications companies differ from their seemingly prehistoric ancestors. As our economy becomes increasingly electrified—demand for electricity continues to grow faster than that for other energy sources and faster than growth in gross domestic product—the change is one we would all do well to watch closely.

Linda G. Stuntz is a partner in Van Ness Feldman, P.C., a law firm located in Washington, DC, and a member of RFF's board of directors. She thanks Cheryl Feck of Van Ness Feldman for helping to develop this article.

Congress Discovers Risk Analysis

Terry Davies

The 103d Congress, which concluded in November 1994 in a blaze of partisan bickering, will be forgotten for many reasons by those interested in environmental policy. With the exception of creating a new national park in the California desert, Congress failed to take action on a long list of environmental issues. However, the 103d Congress will be memorable on at least one environmental count: it was the Congress that discovered risk analysis.

Congress has regulated risk for decades. For example, the national ambient air quality standards called for in the Clean Air Act of 1970 are required to protect against health risks to sensitive populations. The Toxic Substances Control Act, enacted in 1976, was probably the first law to explicitly use "unreasonable risk" as the criterion for government to take regulatory action. But Congress has never concerned itself with *how* risks were calculated or with comparing different risks. Risk as a general concept was of concern but, with a few notable exceptions, risk analysis was not. In 1993–1994, this situation changed dramatically.

Below I review some of the efforts in the 103d Congress to deal with risk analysis; I then identify the major factors underlying lawmakers' interest in such analysis. I also outline what risk legislation can (and cannot) accomplish and distinguish among the uses of risk assessment, two issues about which Congress seems to be confused.

Legislative risk proposals

More than a dozen bills dealing with risk analysis were introduced in the 103d

Congress. Notable among these were bills introduced by Senator Daniel Patrick Moynihan (D–New York) and Representative Herbert C. Klein (D–New Jersey). Even more notable was an amendment to S.R. 171, a bill proposed by Senator John Glenn (D–Ohio) to make the U.S. Environmental Protection Agency (EPA) a cabinet department.

Senator Bennett Johnston (D–Louisiana) introduced the amendment, which would have required that EPA conduct a risk analysis for each of its regulations and compare the risk reduction to be achieved by the regulation with the cost of the legislation and with other types of risks. The Senate overwhelmingly passed it by a 95–3 vote, but later the content of the Johnston amendment was modified several times. (The original version required risk analysis of *all final* regulations; later versions made the requirement applicable only to *major* regulations and to *proposed* rather than final regulations.)

Legislators proposed adding this amendment to almost every pending environmental bill. The lack of action on environmental legislation during the 103d Congress was due, to a great extent, to an inability to reach an acceptable compromise on the amendment's language. Junior members of the House surprised the leadership by defeating the rule under which the EPA cabinet bill would go to the House floor for a vote, in part because the rule would have precluded consideration of the Johnston amendment.

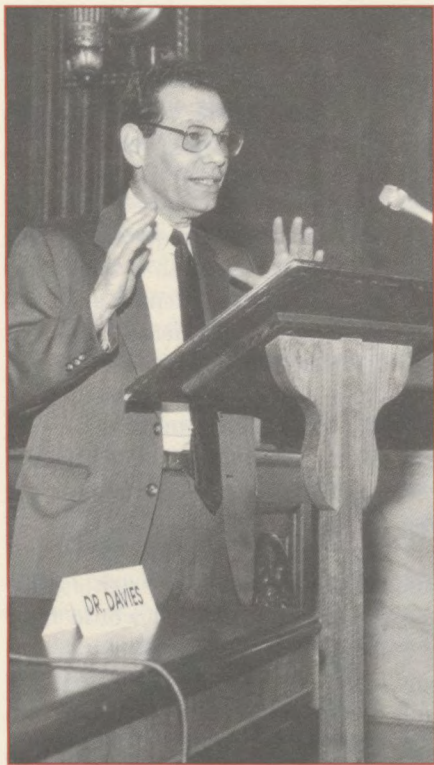
The basic requirements of the Johnston amendment were similar to the cost-benefit requirements already called for by a Clinton administration executive order (E.O. 12866). The Johnston amend-

ment's one novel requirement was that the risks to be regulated be compared with other risks—a challenging requirement but not one that would bring to a halt all environmental regulatory efforts.

Senator Moynihan's bill (S.R. 110), the "Environmental Risk Reduction Act of 1993," would have required the EPA administrator to establish a Committee on Relative Risks to "identify and rank the greatest environmental risks to human health, welfare, and ecological resources," as well as a Committee on Environmental Benefits to provide expert advice on estimating the quantitative benefits of reducing risks. In addition, the bill would have required EPA to develop "guidelines to ensure consistency and technical quality in risk assessments." Finally, the bill would have required EPA to establish a research program on environmental risk assessment and to create an Interagency Panel on Risk Assessment and Reduction to coordinate federal efforts.

The Johnston amendment's one novel requirement was that EPA compare risks to be regulated with other risks—a challenging requirement but not one that would bring to a halt all environmental regulatory efforts.

Moynihan's bill, which was aimed at improving the quality and visibility of risk assessment, emphasized comparative risk analysis of the problems addressed by different EPA programs, rather than risk analysis of the problems addressed by individual regulations. A bill introduced by Representative Klein contained some of the same provisions as the Moynihan bill but focused on improving the quality of risk assessments done to support individual regulations. Klein's bill



Terry Davies chaired a forum on risk assessment organized by the Center for Risk Management. Six high-level policymakers—including EPA Administrator Carol Browner, Senator Max Baucus, and Representative John Mica—attended the March 1994 event. Their discussion centered on legislation sponsored by Mica that would require EPA to conduct a risk analysis for all regulations it proposed.

(H.R. 4306) would have established a Risk Assessment Program within EPA to develop, review, and update risk assessment guidelines. Other elements of the Klein bill included research and training in risk assessment and a pilot project on comparative risk analysis.

The Klein bill originally was supported by the Clinton administration. Environmentalists, who have generally opposed any efforts to promote risk analysis, stated that they would not oppose the bill. However, the House Committee on Science, Space, and Technology made a series of changes in the bill that caused both the administration and the environmentalists to oppose its passage.

The offending changes were put forward by congressional members and staff who believe that EPA risk assessments are generally biased in favor of regulation and exaggerate the degree of risk. The changes would have done two things. First, they would have made both risk assessment guidelines and EPA's risk assessments potentially subject to judicial review. In withdrawing support for the bill, EPA stated that the changes could make risk assessment "more a construct of the courts than of sound science." Second, the changes would have directed EPA to use "the most plausible" and "unbiased" assumptions to calculate "central estimates of risk" and to employ the "best information." Although these changes sound innocuous, they could have changed EPA's risk assessment methodology in fundamental ways, especially when combined with the threat of litigation.

In the closing days of the session, Congress enacted a U.S. Department of Agriculture reorganization bill with a version of the Johnston amendment attached to it. However, the amendment applies only to environmental and health regulations promulgated by the Department of Agriculture. No other risk legislation passed, but the issues raised in the debate over the Klein bill will be high on the agenda of the 104th Congress, many of whose Republican members have promised reform of federal regulation as part of their "Contract with America." The reasons for interest in risk have become, if anything, more pressing, and the Republicans have generally been more supportive of risk legislation than the Democrats.

Factors underlying Congress's interest in risk

Why the sudden passion for risk analysis and comparative risk assessment? Several interrelated factors account for Congress's newfound interest.

The first factor is a shift in the public's view of environmental problems.

Whether because of the increasing costs of environmental remedies, the rightward shift of the nation's politics, growing cynicism toward all groups and institutions, or other reasons, many people no longer believe that all environmental problems are urgently pressing. The notion of priorities—of some problems being more important than others—has entered the environmental debate.

State and local governments have seized upon comparative risk assessment as a potent weapon for fighting expensive and often unwanted federal environmental requirements.

The second factor is the squeeze being put on some state and local governments by unfunded environmental mandates. These governments have seized upon comparative risk assessment as a potent weapon for fighting expensive and often unwanted federal requirements. In many cases, states and localities believe they can show that they are being required to expend funds on problems that either pose smaller risks than those arising from other problems on which the money could be spent or that pose trivial or nonexistent risks. This "grass roots" dimension of the push for comparative risk analysis is politically of great significance.

In Congress, risk analysis also has been linked with the issue of *takings*, uncompensated restrictions on private land use. Environmentalists have dubbed risk analysis, unfunded mandates, and *takings* as "the unholy trinity," although risk and *takings* do not have the direct, substantive connection that risk and unfunded mandates often do. The three have become linked because each potentially could slow or halt federal environmental regulation.

A third factor contributing to the interest in comparative risk is the shortage of public funds at all governmental levels. The shortage emphasizes the need to set priorities and to make hard choices. Not coincidentally, the congressional committees responsible for appropriating money to EPA have been strong supporters of applying comparative risk analysis to different EPA programs (as opposed to different proposed regulations). For these committees, risk analysis holds the promise of providing a rationale and a defense for difficult budgetary choices. At the same time, the results of risk analysis are sufficiently broad and uncertain that the committees do not have to worry about losing control over budgetary decisions.

What risk legislation can accomplish

No other congressional issue is marked more by confusion and misinformation than the current debate over risk assessment. One reason is that legislators seem confused (perhaps in some cases deliberately) about what risk assessment legislation can accomplish.

Members of Congress have an understandable tendency to blame EPA for problems that local constituents have with pollution-control requirements. Since risk assessment supposedly guides EPA decisions, they believe that changing the way risk assessment is done can alleviate the problem of unwanted or unreasonable requirements imposed on local governments and corporations. However, for Congress, in many cases both Shakespeare and the comic strip character Pogo are apt. The fault is not in the stars—Congress has met the enemy and it is them.

The unfunded mandates that have caused the most problems for local governments are those related to drinking water. Communities complain that EPA is requiring them to monitor for chemicals that pose no risk and that the agency is demanding expensive capital invest-

ments to deal with nonexistent threats. But most of these difficulties arise from the 1986 amendments to the Safe Drinking Water Act—amendments that required EPA to set standards for forty water contaminants within two years of the act's passage and to keep issuing standards for additional contaminants at an equally rapid pace. Congress directed that the standards be set "as close to the maximum contaminant level goal as is feasible." In turn, the maximum contaminant goal is to be set "at the level at which no known or anticipated adverse effects on the health of persons occur and which allows an adequate margin of safety."

To put it bluntly, Congress should not pass laws that require absolute protection for the public and then complain when EPA promulgates standards that provide such protection. It should not pass laws that require EPA to move rapidly to promulgate numerous regulations and then complain when the agency moves rapidly to promulgate numerous regulations. Implementing the law should not be considered a political crime.

Congress should not pass laws that require absolute protection for the public and then complain when EPA sets standards that provide such protection. Implementing the law should not be considered a political crime.

Another "confusion" in Congress is that risk drives all environmental decisions. In fact, many environmental regulatory requirements are statutorily determined by technology and thus relatively unaffected by risk findings. For example, the initial standards for controlling hazardous air pollutants under

the Clean Air Act Amendments of 1990 are to be based on the best technologies employed by each type of polluting facility, not on risk. Similarly, many of the regulatory requirements under the Clean Water Act are based on "best available technology," a determination of which is unrelated to risk. EPA actions under these provisions will not be influenced by any changes in risk assessment methods.

Uses of risk assessment

A more general source of confusion in the current debate over risk assessment arises from a failure to distinguish among different uses of risk assessment. At least four different policy uses of risk assessment exist. Each involves different methodologies and raises different problems.

The most common use of risk assessment in policymaking is in regulatory decisionmaking. For all significant regulations, E.O. 12866 requires the agency proposing the regulation to conduct a cost-benefit analysis. From the perspective of EPA and the other health and safety regulatory agencies, the benefit side of the cost-benefit equation generally is the amount of risk reduced by the regulation as calculated by some type of risk assessment. Within EPA, risk assessment is often used to gauge where to set a standard (although, as noted above, statutory requirements frequently preclude risk considerations), because it is the only way to determine how much (if any) danger a given substance, product, or activity poses.

A second use of risk assessment occurs in Congress's statutory definition of "acceptable risk." Probably the best example of this use is the Clean Air Act, which requires the EPA administrator to promulgate more stringent standards for emissions of hazardous pollutants when the technology-based standards for the emissions "do not reduce lifetime excess cancer risks to the individual most exposed... to less than one in one million."

These "bright line" provisions have been based on quantitative assessment of cancer risk, but cancer may not be the risk that is of most concern. Ecological threats, birth defects, liver damage, hormonal or immune deficiencies, or any of a thousand other problems may be the reason for regulating risk. Because the cancer risk may be irrelevant, gearing the risk standard to cancer may set the standard too high or too low. Risk assessment takes many different forms. Quantitative cancer risk assessment is only one of them and often not the most appropriate one to use.

The crudeness of risk estimates may make it impossible to establish clearly that one risk is greater than another. Moreover, such comparisons do not take into account the many dimensions of risk other than the amount of damage to health and the environment.

Another problem is that the bright line, acceptable risk approach assumes a precision that most risk assessments cannot achieve. Risk assessment is still a relatively crude science, and, depending on which methodological assumptions are used, its results may vary a hundredfold or more. Thus, placing great legal weight on one point estimate of risk is an open invitation to shade the assumptions in a certain direction in order to achieve the desired outcome.

A third use of risk assessment is priority setting for individual risks or regulations, which involves comparing one specific risk to another. Such comparisons can be useful in putting any particular risk into perspective; but two caveats, neither of which has received much attention in Congress, are important to note. The first concerns the

crudeness of risk estimates. If the uncertainty range around any point estimate of risk is several orders of magnitude, it frequently will be impossible to establish clearly that one risk is greater than another. The second caveat relates to the many dimensions of risk other than the amount of damage to health and the environment. These dimensions include whether the risk is undertaken voluntarily, whether the victims can be identified, and whether the nature of the risk is catastrophic—that is, whether great damage occurs at one time, as in a plane crash, or whether less damage occurs and is spread over time, as in car accidents. These dimensions of risk are important politically, psychologically, and even ethically. They need to be taken into account when comparing risks.

The fourth use of risk assessment is priority setting for government programs and budgets. This use was pioneered by EPA in 1987 when it published its report *Unfinished Business*. Senator Moynihan has introduced legislation requiring this type of priority setting to be instituted within EPA. Both the House and Senate appropriations committees for EPA have expressed interest in this approach in the belief that it might provide a "scientific" way of making (or justifying) difficult budget choices.

Comparisons of risks regulated by different programs are a useful way to consider priorities, and they hold long-term promise of bringing greater rationality to government budgeting and goal setting. However, we do not have (and may never have) good methods for comparing different types of risks. Comparing health risks with ecological risks, for example, is clearly a value-laden process. Moreover, acting on the results of broad risk comparisons is almost always impeded by individual statutory mandates. Each environmental program has its statutory support, which is designed (in part) to give each program high priority and prevent its being compared to other programs.

The road ahead

Risk assessment can be a powerful tool for improving environmental policy and decisionmaking. Like all powerful tools, however, it can be abused and employed for nefarious purposes.

Most of the risk legislation that has been proposed would have little short-term effect on environmental policy. However, I believe some of the proposals could do major harm to the quality of the science behind regulatory initiatives by making risk guidelines judicially enforceable. Doing so would transform risk analysis from a scientific undertaking to a legal one, would preclude the exercise of scientific judgment on how to conduct risk assessments of individual chemicals, and would be a major obstacle to incorporating scientific advances into risk assessment. In addition, some proposals would make risk assessment information useless to decisionmakers by dictating which risk assessment methodologies are used. Some of these proposals can be interpreted to mean that risk assessments should determine risk to the average person rather than to the most vulnerable people.

However, the discovery of risk analysis by the 103d Congress means that the new Republican Congress has an opportunity to forge legislation that will improve the long-term quality of regulatory decisions and environmental policy. If the varied interests with a stake in environmental policy can reduce the ideological and partisan coloration that has characterized the risk debate so far, and if they can accept both the uses and limitations of risk assessment, the risk debate could lead to a new era of more effective, efficient, and equitable environmental programs.

Terry Davies is director of RFF's Center for Risk Management. Portions of this article appeared previously in Inside EPA's Risk Policy Report (vol. 1, no. 2, October 14, 1994).

INSIDE RFF NEWS AND PUBLICATIONS

RFF cosponsors population and environment workshop

On November 16, 1994, RFF and the World Bank held a workshop to explore what is known about relationships between population and the environment and to assess the implications of that knowledge for investment and policy decisions. The workshop focused on three basic questions: Are population pressures frequently a prime cause or exacerbating factor in environmental damage? Are there significant feedback effects from the environment to the population? What policy conclusions can be drawn from answers to these questions?

Two presenters considered these questions in the context of broad issues that are ultimately related to land use. Hans Binswanger, a senior advisor in the World Bank's Agriculture and Natural Resources Department, examined agricultural capacity and environmental side effects. Richard E. Bilsborrow, a fellow of the Carolina Population Center at the University of North Carolina—Chapel Hill, explored forest management and land conversion.

Other presenters focused on the workshop's three questions in the context of issues affecting the urban landscape. Ellen M. Brennan, chief of the Population Policy Section of the United Nations Population Division, discussed urban population densities and their effects on

the availability and cost of delivering water, sanitation, and other urban environmental amenities. Maureen Cropper, a senior fellow in RFF's Center for Risk Management who is currently serving as principal economist in the Policy Research Department of the World Bank, was one of three presenters who examined feedbacks from the environment to the population. M. Gordon Wolman, who is the B. Howell Griswold Jr. Professor of Geography and International Affairs at the Johns Hopkins University, summarized knowledge gaps emerging from the presentations.

Organizers of the workshop noted the importance of learning more about relationships between population and the state of environmental resources. If population pressures were found to be a prime cause of environmental degradation, a potentially strong case could be made for intensifying efforts to manage population. If, on the other hand, population were not a prime cause of that degradation, emphasis could shift to other remedies, including standard prescriptions of environmental economics for better resource management. Indeed, even if population were an important contributor to environmental stress, these other remedies might be more effective than population control policies.

Journalists attend seminar on environmental issues

RFF Vice President and Senior Fellow Paul R. Portney and Terry Davies, director of the RFF's Center for Risk Management, were speakers at a recent seminar to help journalists become better reporters on environmental issues and policy alternatives. RFF and the National Press Foundation, a nonprofit group that fosters excellence in reporting on public affairs, sponsored the second annual seminar for journalists on November 13–16, 1994, in Washington, D.C. Twelve reporters from newspapers, magazines, and public radio were selected on a competitive basis to attend the seminar, which featured talks on a variety of environmental issues by representatives of government, environmental groups, the academic community, and industry.

One of the most pressing of these issues is cleanups of hazardous waste sites. Paul Portney discussed these cleanups under the Resource Conservation and Recovery Act and under Superfund, which is up for reauthorization in the current session of Congress. Terry Davies discussed another issue of increasing concern—how to set priorities for dealing with environmental risks.

A. W. Mellon Foundation grant supports evaluation of U.S. regulation of pollution

The Andrew W. Mellon Foundation has awarded RFF's Center for Risk Management (CRM) a grant of \$290,000 to conduct a study of the strengths and weaknesses of the current pollution-control system in the United States. The project is a result of the growing sense that the environmental regulatory system in the United States is "broken" and needs fixing in fundamental ways. With many environmental statutes up for reauthorization, reme-

diates might be proposed and implemented before the nature of the system's problems are well understood. In the RFF study, CRM Director Terry Davies and other CRM researchers will analyze the current environmental regulatory system and formulate options for changing it.

Criticisms of the current environmental regulatory regime focus on both the regime's ineffectiveness—its failure to identify and deal with major environ-

mental problems—and its inefficiency—its failure to give our money's worth for the amount being spent on pollution control. "The view that the system is broken is held most strongly by those who are regulated," says Davies. "It also is increasingly the view of those who write the laws and those who administer them. Within the organized environmental community there is more willingness to ask searching questions and try new approaches."

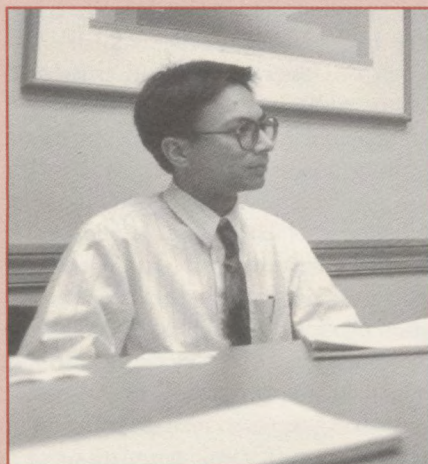
RFF hosts visiting scholar from Nepal

Sunil K. Shrestha of the Royal Nepal Academy of Science and Technology began a four-month visiting fellowship at RFF in December 1994. The fellowship was provided by the U.S. Agency for International Development through the Asia Foundation. Shrestha is collaborating with Walter O. Spofford Jr., who heads RFF's Environment and Development Program, on a study of pollution problems and issues in the Katmandu Valley.

Shrestha's visit coincides with RFF's development of several proposals to help Nepal address issues of environment and development. Currently RFF is seeking financial support for this effort, which would be modeled on its successful program to help the People's Republic of China (PRC).

According to Spofford, the success of a similar program in Nepal hinges on the ability of RFF to send researchers to Nepal and to host Nepalese economists and policy analysts. "In the PRC," said Spofford, "we are giving Chinese economists and policy analysts on-the-job

training in environmental planning and policy design using real situations in China, as well as instructing them in applied methods of environmental planning and policy design during visits to RFF. This blend of technical assistance and applied research training would help Nepal develop its capability for dealing with the environmental consequences of industrialization and urbanization."



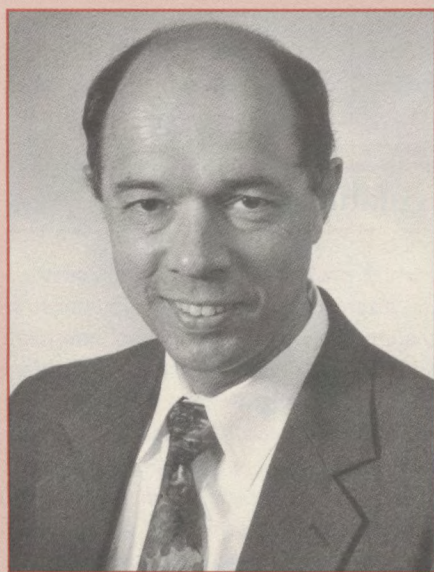
Sunil K. Shrestha

Summer interns sought

Every summer, RFF offers a limited number of paid internships to students. Interns assist RFF staff with projects ranging from technical studies to applied policy analyses. Interested students are invited to apply for RFF internships at this time. Applicants should have outstanding academic records in the undergraduate or graduate programs in which they are enrolled, and they should have undertaken course work in one or more of the following fields: microeconomics; statistical and quantitative methods; agricultural, environmental, or natural resource management; or environmental sciences.

The deadline for applications is March 15, 1995. The internships begin on or about June 1, 1995 and last from two to three months. Stipends are commensurate with experience and length of stay. For further information about applying for internships, contact the Office of the Vice President, Resources for the Future, 1616 P Street NW, Washington, DC 20036-1400. Telephone: 202-328-5067.

Resources readers help in RFF research on transportation and the environment



Winston Harrington

Resources for the Future would like to thank the more than four hundred *Resources* readers who responded to an auto insurance survey designed by RFF researchers studying motor vehicle use and air pollution. The surveys were mailed last October to nearly 2,700 *Resources* readers in an attempt to collect urgently needed data for the newest project in RFF's ongoing research on transportation and the environment.

When Senior Fellow Winston Harrington and several other RFF researchers began last summer to examine the costs and effects of different transportation policies aimed at reducing motor vehicle emissions by raising driving costs, they were unable to find detailed information about one impor-

tant cost—car insurance. To the researchers' surprise, no information about the relationship between insurance rates in different parts of the country and certain household characteristics (such as the number and age of drivers) seemed to exist.

Because such information is crucial to their study, Harrington and his colleagues decided to gather it themselves. Although RFF researchers have conducted many surveys in the past, this was the first time that they had asked *Resources* readers to help supply data. According to Harrington, response to the auto insurance survey was adequate to meet their needs. Some preliminary results of the survey will be reported in a future issue of *Resources*.

RFF helps assess effects of climate change on natural resources

In September 1988, RFF and the U.S. Department of the Interior (DOI) entered into a multiyear cooperative agreement to undertake interdisciplinary research on climate change. The agreement, which has since been extended to September 1998, has generated several major research projects. The latest of these projects is an attempt to develop an economic-based framework for evaluating the implications of climate uncertainty for water resources development and management. This research, which was commissioned by the U.S. Army Corps of Engineers, is being conducted by Kenneth D. Frederick, a senior fellow in RFF's Energy and Natural Resources Division, and David Major of the Social Science Research Council. As part of the research, Frederick is examining water management strategies and institutional arrangements for adapting to climate change.

The most recent product of the RFF/DOI agreement is the book, *Assessing the Impacts of Climate Change on Natural Resource Systems*, edited by Frederick and Norman J. Rosenberg, a former RFF senior fellow. The volume is a collection of papers delivered at a workshop organized by RFF and held in San Diego, California, in 1993. The workshop focused on methodologies to assess both the effects of climate change on terrestrial and aquatic ecosystems and the socioeconomic consequences of those effects. The workshop papers were originally published in the journal, *Climate Change*. *Assessing the Impacts of Climate Change on Natural Resource Systems* is available from Kluwer Academic Publishers.

RFF on the Internet

RFF was connected to the Internet in April 1994. We can receive electronic mail at info@rff.org.

New book

Footing the Bill for Superfund Cleanups: Who Pays and How?

Katherine N. Probst, Don Fullerton, Robert E. Litan, and Paul R. Portney

How much is actually spent cleaning up the nation's toxic waste sites? And who bears the costs associated with the federal government's Superfund program? A corporate environmental tax, along with taxes on chemical and petroleum feedstocks, generates about one billion dollars annually for the Superfund trust fund. While the broad outline of total program costs has been known for some time, researchers are only now beginning to understand how much potentially responsible parties and their insurers spend on transaction costs and on site cleanups.

The authors of *Footing the Bill for Superfund Cleanups* develop information, on a site-by-site basis, on who is likely to pay the cost of the current Superfund program. They explore the short-term financial implications of changes in liability and taxes on four key sectors affected by Superfund: chemicals, oil, mining, and commercial property-casualty insurers. They analyze the incidence of different taxing mechanisms and liability schemes and compare the financial effects on specific industries of the current Superfund program and of several alternative liability and tax-based funding mechanisms available.

The alternative liability approaches examined in the book include scenarios in which liability is eliminated for all multiparty sites created before Superfund was enacted and in which parties are released from liability at sites where municipal and industrial wastes were codisposed. The authors also assess the economic implications of a variety of taxes that could be used to finance the creation of a larger trust fund for site cleanups.

Katherine N. Probst is a senior fellow in RFF's Center for Risk Management. Don Fullerton is professor of economics and public policy at the University of Texas–Austin. Robert E. Litan, formerly a senior fellow at the Brookings Institution, is deputy assistant attorney general in the Antitrust Division of the U.S. Department of Justice. Paul R. Portney is vice president and senior fellow at RFF.

Footing the Bill for Superfund Cleanups is copublished by Resources for the Future and the Brookings Institution.

January 1995. 176 pages.

\$32.95 cloth. ISBN 0-8157-2994-4

\$12.95 paper. ISBN 0-8157-2995-2

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Discussion papers

RFF discussion papers convey the preliminary findings of research projects for the purpose of critical comment and evaluation. Unedited and unreviewed, they are available at a cost of \$6.00 each to interested members of the research and policy communities. Price includes postage and handling. Prepayment is required.

The following papers have recently been released.

- "Integrated Economic and Ecological Modeling for Public Policy Decision-making," by Hadi Dowlatabadi, Lawrence H. Goulder, and Raymond J. Kopp. (94-37)
- "Environmental Regulation and Technology Diffusion: The Effects of Alternative Policy Instruments," by Adam B. Jaffe and Robert N. Stavins. (94-38)
- "An Analysis of Alternative Approaches to Implementing Social Costing of Electricity in Maryland," by Karen L. Palmer, Alan J. Krupnick, Hadi Dowlatabadi, and Stuart Siegel. (94-39)
- "The Structure of an Environmental Transaction: The Debt-for-Nature Swap," by Robert T. Deacon and Paul Murphy. (94-40)
- "Methods for Estimating the Economic Value of Human Health Benefits from Environmental Improvement," by Winston Harrington and Michael A. Toman. (94-41)
- "Sustainable Forest Ecosystems and Management: A Review Article," by Michael A. Toman and Mark S. Ashton. (94-42)
- "Ecosystem Valuation: An Overview of Issues and Uncertainties," by Michael A. Toman. (94-43)
- "Goals and Policies for Promoting 'Sustainability': Some Thoughts on the President's Council on Sustainable Development," by Michael A. Toman. (94-44)

- "Deforestation, Investment and Political Stability," by Robert T. Deacon. (94-45)
- "Resource Evaluation at a Crossroads," by V. Kerry Smith. (94-46)
- "Social Values for Education: Environment," by V. Kerry Smith. (94-47)
- "Valuing Health Effects of Air Pollution in Developing Countries: The Case of Taiwan," by Anna Alberini, Maureen L. Cropper, Tsu-Tan Fu, Alan J. Krupnick, Jin-Tan Liu, Daigee Shaw, and Winston Harrington. (95-01)
- "Materials Use and Solid Waste Disposal: An Evaluation of Policies," by Karen L. Palmer and Margaret A. Walls. (95-02)

- "Environmental Regulation and Innovation: A Panel Data Study," by Adam B. Jaffe and Karen L. Palmer. (95-03)
- "Correlated Environmental Uncertainty and Policy Instrument Choice," by Robert N. Stavins. (95-04)
- "Extending Liability: Should the Sins of the Producer Be Visited Upon Others?" by James Boyd and Daniel E. Ingberman. (95-05)
- "Managing Carbon Via Forestry: Assessment of Some Economic Studies," by Roger A. Sedjo, Joe Wisniewski, Al Sample, and John D. Kinsman. (95-06)

Recent contributions from individuals

The following individuals made gifts of \$100 or more between September 19 and December 1, 1994, in support of research and education programs at Resources for the Future:

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 Charls E. Walker
 Marilyn and Hal Weiner
 John Fred Weston
 Nathaniel Wollman
 Kenji Yamaji
 Don W. Yu

The following individuals made gifts between September 19 and December 1, 1994 in memory of former RFF President Joseph L. Fisher, in whose name RFF has established dissertation awards to support graduate students in the final year of their dissertation research on environmental and natural resource issues.

Margaret W. Fisher
 Shirley F. Weiss

Recent contributions from corporations and foundations

RFF received contributions from the following corporations and foundations between Sept. 19 and Dec. 1, 1994:

- Alcoa Foundation
- Center for Global Partnership
- Multinational Business Services, Inc.
- Pennsylvania Power and Light Co.

For more information about the RFF Gift Fund, gift annuities, gifts of appreciated securities, bequests, or other types of planned gifts, please contact RFF Vice President—Finance and Administration Ted Hand at 202-328-5029 or check the appropriate box on the enclosed reply envelope for individual contributions.

For information about contributions from corporations or private foundations, please contact RFF Development Manager Patrick Hagan at 202-328-5154.

Especially for RFF donors: Tax law changes make RFF Gift Fund attractive as a philanthropy option

Changes in the tax law that became effective on January 1, 1995 will affect the tax considerations for individuals interested in setting up private foundations. The RFF Gift Fund may be an excellent alternative for these individuals.

In the past, many people have used appreciated stock to set up private foundations, since they have been able to claim the full market value, not just the original cost basis, of the stock as a federal tax deduction. Because of changes in the tax law, donors are no longer able to claim the full market value of appreciated stock when setting up a private foundation. Thus they incur a 28 percent capital gains tax on the increase in value between the purchase of the stock and its sale to create the foundation.

The Resources for the Future Gift Fund is a very attractive alternative for individuals considering establishing a private foundation. Unlike donors setting up private foundations, donors to the RFF Gift Fund can still deduct the

full market value of appreciated stock in the year the contribution is made. They can then recommend future distributions from the RFF Gift Fund, so they can see the benefits of their RFF Gift Fund contributions during their lifetimes. These distributions may be made to the RFF general fund or to other qualified tax-exempt organizations, such as hospitals, churches, or universities.

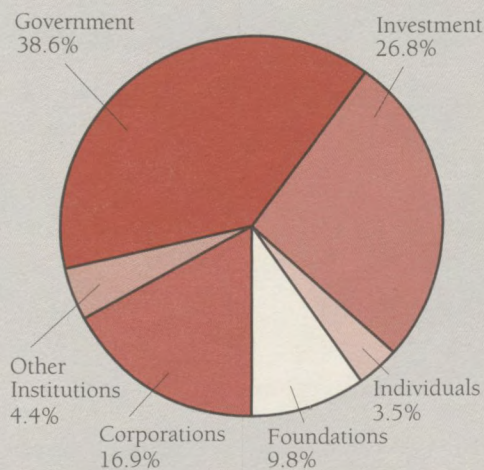
Gifts to the RFF Gift Fund are unconditional, with RFF retaining control over the use of the funds. The donor is encouraged, however, to advise RFF about the distribution of fund assets. Contributions to the RFF Gift Fund are placed under professional investment management and compound until distributions are made.

Even if the Resources for the Future Gift Fund is not the most appropriate way for you to plan your charitable giving this year, keep in mind the benefits of making gifts of appreciated securities, which are deductible up to full market value.

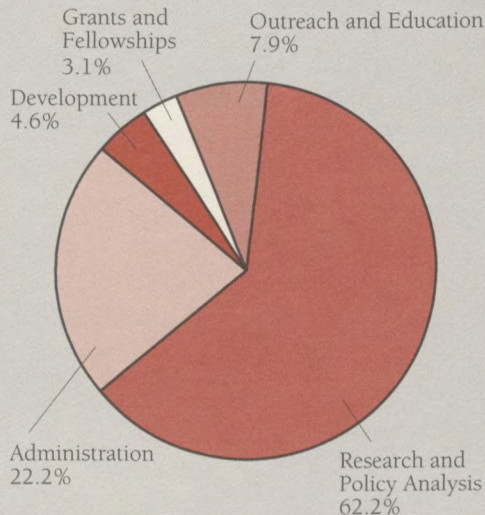
Resources for the Future 1994 Revenues and Expenses

Friends and supporters of RFF frequently ask where the institution's support comes from and how the money is spent. These charts provide a graphic breakdown of revenues and expenses. (For more detailed information, consult RFF's annual report.)

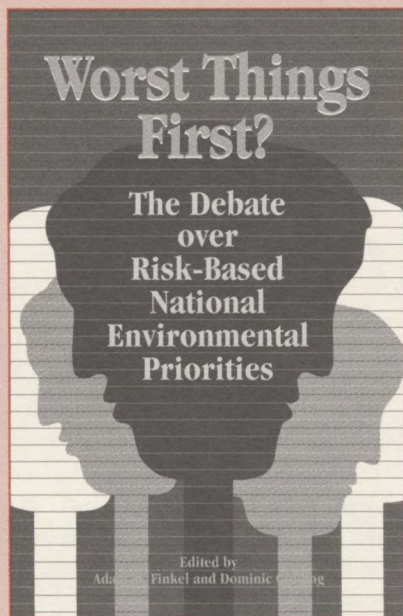
Revenues



Expenses



Books from Resources for the Future



Worst Things First? The Debate over Risk-Based National Environmental Priorities

*Adam M. Finkel and
Dominic Golding,
editors*

EPA representatives describe the agency's use of risk-based planning to set the nation's environmental priorities, while analysts suggest ways to improve its methods, process, and implementation. Leading advocates of alternative paradigms also present their best cases in this collection of conference papers.

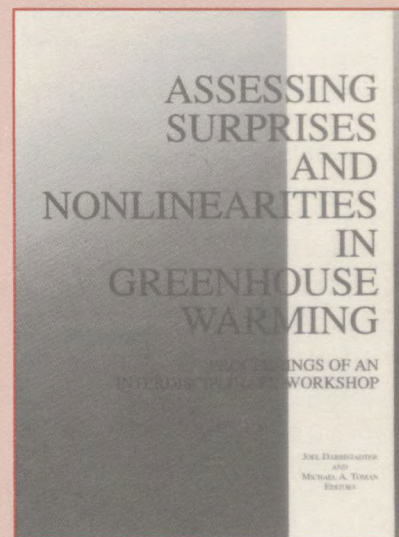
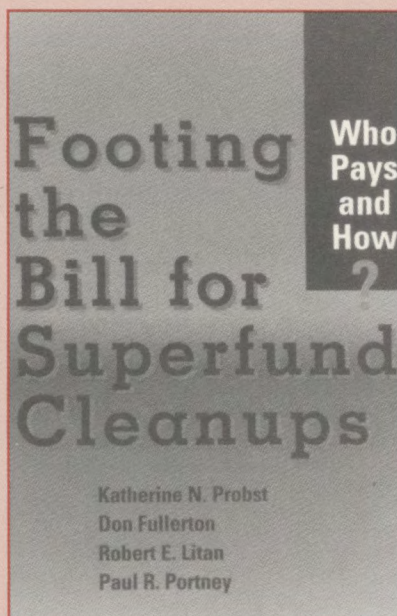
1994 / 346 pages
ISBN 0-915707-74-8 (cloth)
\$45.00

Footing the Bill for Superfund Cleanups: Who Pays and How?

*Katherine N. Probst, Don Fullerton,
Robert E. Litan, and
Paul R. Portney*

The authors explore the financial implications of changing two components of Superfund's current financing scheme—liability for cleanup costs and a series of taxes to raise revenues for the Superfund trust fund—on key sectors of the economy. They analyze who pays under the current approach, as well as under four alternative liability schemes that were hotly debated in the 1994 reauthorization debate. (Copublished with the Brookings Institution)

1995 / 176 pages
ISBN 0-8157-2994-4 (cloth)
\$32.95
ISBN 0-8157-2995-2 (paper)
\$12.95



Assessing Surprises and Nonlinearities in Greenhouse Warming

*Joel Darmstadter and
Michael A. Toman,
editors*

Researchers examine the existing state of knowledge regarding surprises (effects that are not natural extensions of existing trends) and nonlinearities (responses disproportionate to changes in stimuli that may threaten adaptive capacities) in natural and socioeconomic systems confronted with human-induced climatic change.

1993 / 158 pages
ISBN 0-915707-71-3 (paper)
\$25.00

The Economic Value of Space Exploration

Molly K. Macauley

The value of U.S. space activities ranges from the tangible to the intangible, from making scientific discoveries and developing and finding applications for myriad technologies to instilling a sense of national pride. To many people, only some of these values have relevance. Thus federal spending on space projects generates heated debate. To this point, the National Aeronautics and Space Act has emphasized the tangible economic benefits of space activities, even though studies suggest that federal spending for these activities produces no long-term productivity gains for the economy. Given this situation, policymakers might find a better rationale for allocating a space budget by examining the intangible values associated with space activities.

There has long been lively debate in the United States about the attractiveness of space exploration. For example, one of the most controversial issues is the construction of a space station to be built and run by the United States and other space-faring nations. Opponents have called it "Project Vampire" and "Space Station Zero," while proponents have envisioned it as a step toward fulfilling humankind's manifest destiny. Such polar views on the value of space activities have been reflected in Congress, which generally appears divided on the question of funding for these activities. In 1993, for example, a single vote saved the proposed space station.

The difficulty of measuring the intrinsic value of space activities lies at the heart of these funding debates. Like beauty, the value of space exploration is

in the eye of the beholder. To some, the value is scientific merit; to others, it is technical accomplishment. To some, space exploration fosters a sense of pride, stirs the spirit, and offers an opportunity for vicarious wandering or wondering. To still others, the value of space exploration is manifested as some tangible economic gain in the quality of life, a means of encouraging young people to study science or engineering, or a source of employment. To others, the value lies in wielding geopolitical influence. To many, it is some combination of these ends. And for many others, exploring space has little or no value.

In this article I briefly examine the legislation establishing the U.S. space program (the National Aeronautics and Space Act and its amendments) as one guide to the program's expected benefits or values. I also draw from public discussion about the space program in order to illustrate some comparatively intangible benefits that seem to have become expected ends of space activities. Then I summarize the economic evidence about the size of these benefits, point out some gaps in space economics research, and conclude with back-of-the-envelope calculations designed to illustrate an approach to thinking about the size of these benefits.

Values implied in NASA legislation and public debate

Values alleged to arise from space activities have expanded throughout the history of the U.S. space program. Amendments to the National Aeronautics and Space Act reflect changing national concerns and interests but have consistently

emphasized tangible values. However, the full range of values attributed to publicly funded space projects is obscured by the legislative record. Intangible values have been just as consistently emphasized in public discussion about space activities.

According to the legislation that established the National Aeronautics and Space Administration (NASA) in 1958, the U.S. space program is to expand knowledge about Earth's atmosphere and about outer space, develop and operate space vehicles, preserve the leadership of the United States in inventing and applying aeronautics and space technology, and cooperate with other nations in space projects. These statutorily mandated goals imply a mixture of tangible and intangible values associated with civil space activities.

Amendments to the National Aeronautics and Space Act manifest economic relevance and pragmatism; they have not directly reflected many intangible values that have become expected ends of space activities.

Tangible values predominated in subsequent amendments to the National Aeronautics and Space Act. These amendments read like a time line of the American social agenda. During the 1970s, when energy and environmental concerns dominated that agenda, the amendments broadened the legislated goals of the space program to include research on and demonstration of many new technologies. These included solar heating and cooling technologies, energy-efficient and environmentally benign ground propulsion systems, bio-engineering technologies that minimize the effects of human physical disability,

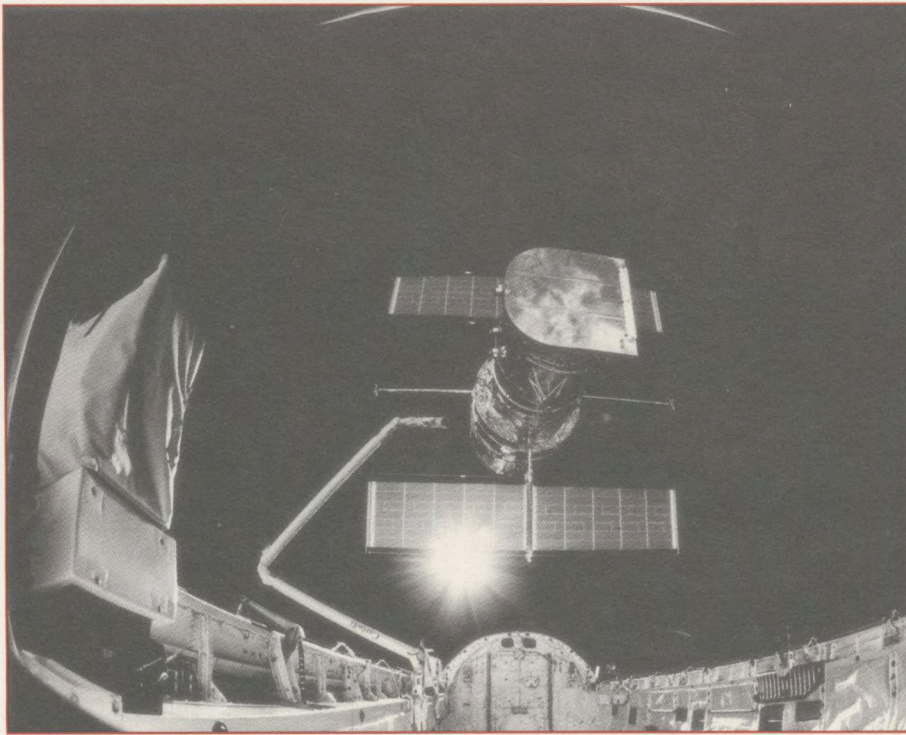


Photo courtesy of the National Aeronautics and Space Administration

The Hubble Space Telescope, shown here being deployed by the space shuttle, has scientific objectives, but it also represents intangible value in the form of national prestige.

advanced automobile technology, and electric and hybrid vehicle technologies.

During the 1980s, when the respective roles of government and business were being debated, new amendments encouraged commercial use of space and use by the federal government of commercially provided space services and hardware. Moreover, these new amendments directed those involved in civil space activities to pursue knowledge of the Earth itself (to monitor climate change, for example) and to ensure the preeminence of the United States in industrial manufacturing processes. Like earlier amendments, those of the 1980s manifest economic relevance and pragmatism, as well as concern with social welfare, the environment, and commercial opportunity.

Thus far, Congressional legislation has not directly reflected many of the more intangible values of space activities. Yet values such as inspiring young people to study science, enlarging the human spirit, or instilling a sense of

pride have been so emphasized in reports by advisory committees to NASA and by other groups as well that it is *as if they are expected ends of space activities*. A 1992 report by the National Research Council contends that success in space research could motivate young Americans to choose careers in science, engineering, and technology and that a vigorous space science program could produce information that would interest and enlighten a national audience. *Pioneering the Space Frontier*, a 1986 report by the presidentially appointed National Commission on Space, asserts that space exploration will remove "terrestrial limits to human aspirations [and] prove of incalculable value to planet Earth and to the future of our species."

The value of intangibles

How "valuable" are the intangible benefits said to be associated with space activities? To date, economics research has

been more or less limited to measuring the effect of space expenditures on the economy, using either large econometric models or case studies. The models seek to explain overall macroeconomic growth on the basis of several variables, including federal expenditure on space activities. The case studies generally compare the costs of space program development with the financial return on commercially successful technologies, such as communications satellites.

A recent Congressional Budget Office (CBO) report, *Reinventing NASA*, summarizes the conclusions of these case studies. One conclusion the CBO reaches is that the short-term economic effects of expenditures on space activities—one possible measure of economic benefit—are no different from those of other federal spending. This determination is not surprising, since it is hard to see why federal spending on space activities should spur the economy more than, say, federally funded highway repairs.

Nor do the case studies find any evidence of long-term productivity gains to the economy from space activities. There may well be productivity gains in some industries (such as in telecommunications as a result of communications satellites), but these positive effects have been due, in large part, to significant industry investment rather than to federal spending. As in the case of short-term effects, the long-term effect of federal spending on space is similar to that of federal spending on other activities. Evidence of long-term economic impact, particularly from federally funded research and development activities associated with space projects, has been negligible.

But what about contributions the space program has made in the way of new products? As the Congressional Budget Office observes, these so-called spin-offs or spillovers have become part of the mythology of space projects. For example, TANG, Velcro, and Teflon—all frequently cited as spin-offs from the Apollo program—were actually developed *before* the Apollo program began. While some spin-offs have no doubt

resulted, it is unclear at best whether they should determine the level of investment to make in space activities. However, the program might have refined these products or brought them to broader attention and hence expanded their commercial markets. Whatever the case, singling out the effect of government influence on the products' markets is difficult. To date, analysts have been unable to answer two questions concerning spin-offs: What should be the expected probability that space activities will produce a spin-off? By how much should the space budget be augmented to include this likelihood?

Case studies show that the economic-stimulus effects of spending on space activities are no larger than those of spending on other federal projects, and they offer no evidence of long-term productivity gains to the economy from space activities.

More important than answering these questions is ensuring that public policies include incentives to generate spin-offs when so doing seems appropriate. (Examples of such incentives include cooperative research and development agreements between industry and the federal government; commercialization programs, such as NASA's Earth Observations Commercialization and Applications Program; and other technology transfer activities by which the private sector picks the government technologies upon which to capitalize.) And, because economists think pursuit of spin-off products and services is cheaper and faster if *directly* funded rather than indirectly funded by way of space projects, the space budget should probably not be increased in the expectation of spillovers.

Future research

A gap in space economics research to date is that no studies have sought to measure the national prestige, geopolitical influence, and vicarious thrill that many associate with space exploration. To ignore these intangible values may be to underestimate significantly the benefits of space activities.

Contingent valuation (CV) methodology offers one possible approach to estimating intangible benefits. It involves the development, administration, and analysis of sophisticated surveys designed to elicit individuals' valuations of difficult-to-measure goods and services for which no market prices exist. CV surveys typically supply information to respondents about the good or service they are being asked to value, but in a way that does not bias the respondents in reporting their valuations.

One way contingent valuation could be applied to space activities is by asking respondents how much extra federal income tax they would be willing to pay each year in order to finance additional space activities. The survey would describe these activities and the scientific knowledge or other benefits expected to be gained from them.

CV methodology is at the frontier of economics research—and, like any frontier research, it is controversial, and not all of the kinks have been worked out yet. If CV surveys are to provide useful information, they must meet many conditions. But the CV approach offers promise for helping to clarify our understanding of the intangible values associated with space activities. It might even shed light on the magnitude of these values as well.

A dilemma and some informal arithmetic

National surveys—informal public opinion polls rather than CV surveys—suggest that the majority of U.S. taxpayers favor reducing spending on space, al-

though not to zero. Americans like having a space program, even though they are not necessarily well informed about the program or what it has already revealed about space. Information collected by the National Science Foundation (NSF) from 1979 until the present indicates that a majority of U.S. citizens do not understand the nature of the solar system or the origins of stars or galaxies. In *Science and Engineering Indicators* (1993), the NSF concludes, "The American understanding of science is, indeed, rather earthbound." These survey results pose a dilemma to policymakers. How can they determine an appropriate space budget when they cannot reconcile this apparent lack of understanding with the values implicitly attributed to space projects in NASA legislation and public discussion?

Given this gap, space activities often end up being judged by default on their job-creating potential. Indeed, observers claim that the federal space program has become another public works project. To win support for the international space station, NASA periodically generates a map indicating the number of jobs in each congressional district that are associated with the station. Of course, space-related jobs are a *cost*, not a benefit, to the 179,500,000 taxpayers who are not employed in the federal space program. For this reason, jobs should not be the basis of—the value to pursue in—a space program. But even if they were, a more effective prescription might be to allocate the \$14 billion NASA budget by giving \$30,000 a year to each of the 433,333 persons believed to be employed in the "space industry" ($30,000 \times 433,333 = 14$ billion).

If job creation is a poor rationale for the U.S. space program, and economic-stimulus effects are no larger for space projects than for other federal programs, policymakers might find guidance for funding NASA in the intangible values that are alluded to in public debate about space activities. The CV approach to measuring these values has not yet been explored. But the following back-of-the-

envelope arithmetic illustrates the possible implications of CV-like results.

Approximately \$1–\$2 billion has been at stake each year in recent congressional deliberations on the space budget, which has ranged between \$14 billion and \$16 billion (in inflation-adjusted dollars) since 1990. Suppose people were asked if \$1 billion would better promote the intangible values associated

Intangible values attributed to space activities—for example, promoting education—could be measured by asking people if \$1 billion would go farther to realize these values if the money were instead allocated to nonspace activities.

with space activities if the money were instead allocated to nonspace activities. For instance, suppose that \$1 billion is to be allocated to a space project under-

taken with Russia and other countries of the former Soviet Union and that, like current plans for the international space station, the project is to be used in part as a means of international aid. The effectiveness of this approach to international aid could be tested by asking people if allocating \$1 billion to the space project is just as likely to help the countries of the former Soviet Union as an outright doubling of the U.S. budget (currently \$1 billion) for direct aid to these countries.

A comparison of alternative projects might help to clarify debate about heretofore nebulously described intangible benefits of space activities, such as promoting education. For example, \$1 billion would double current federal capital spending for college-level science and engineering programs or double the federal contribution to higher education. Or it would fully fund the college education of some 20,000 students. Would such programs be more effective stimuli to education than space-related activities?

As in the case of space projects, each of these alternative projects could claim its own intangible benefits, spin-offs, or spillovers, such as contributing to national economic health and international compe-

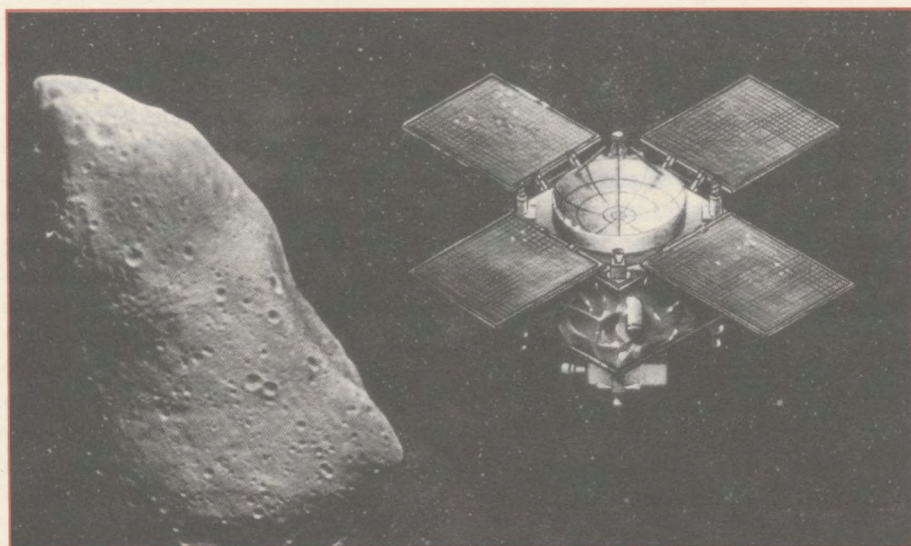
tion. What must be articulated in public debate, then, is when and to what extent space activities better meet the same goals.

Making allocation decisions

Probably no other federal program is expected to meet as many disparate objectives as the civil space program. Together, NASA legislation and the publicly articulated values that have become expected ends of space activities require the program to contribute to space science, understanding of the environment, space vehicle development, and industrial manufacturing, to name but a few enterprises. Nor has any other program been directed to engage in so many activities while at the same time pursuing as many possibly conflicting objectives—science research versus commercial gain, technological innovation versus routine operation, international cooperation versus international preeminence. Americans expect a lot from their space program.

Given high and diverse expectations on the one hand and scarce resources on the other, Americans must decide which of the values associated with space activities they prize most highly and whether space projects or nonspace projects are best suited to realize these values. Such decisions should inform resource allocation both within the space program and between the space program and other public programs. Intangible values might be a key factor in this allocation, but such values have yet to be measured. Doing so might ease the growing tension between demands for accountability in the use of public money and the freedoms granted the space program in the interests of science, technology, and other public gain.

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The NEAR spacecraft, shown in this artist's conception, will collect data about the near-Earth asteroid Eros. Given the space program's scarce resources and possibly conflicting goals, such as science research versus commercial gain, Americans must decide which values associated with space activities they prize most and whether space projects are better suited to realize these values than nonspace projects.

Photo courtesy of Johns Hopkins University Applied Physics Laboratory

The U.S. Climate Change Action Plan: Challenges and Prospects

Joel Darmstadter

In 1992, the United States and 154 other countries signed the United Nations Framework Convention on Climate Change, an international accord outlining measures for dealing with the threat of global warming. The following year, the Clinton administration released its Climate Change Action Plan for meeting the convention's goal of stabilizing emissions of carbon dioxide and other greenhouse gases at 1990 levels by the year 2000. Evaluation of the plan's prospects for success must necessarily be speculative at this point, but already several of the assumptions on which the plan is predicated appear questionable. Moreover, even if the emissions stabilization goal is met, the problem of global warming will persist. Therefore, the greatest contribution of the plan might be to raise consciousness about the need for sustained measures to address climate change and its attendant socioeconomic consequences.

As steadily growing scientific consensus suggests that unabated growth of greenhouse gas emissions might increase global mean temperature by 2–5 degrees centigrade, raise sea levels by 30–100 centimeters, and significantly alter weather patterns before the end of the next century. Coastal flooding, impaired agricultural productivity, and other consequences of global warming could threaten economic and social well-being throughout the world. In light of these possibilities, 155 countries signed the United Nations Framework Convention on Climate Change (FCCC) at the United Nations

Conference on Environment and Development in 1992. The FCCC maps out a strategy intended to diminish the prospects of serious climatic change and to lessen the severity of the economic and social disruption that might accompany such change (see "Evolution and Key Provisions of the FCCC," p.20).

The near-term challenge for the United States is to do its part to meet the FCCC goal of stabilizing developed countries' greenhouse gas emissions at 1990 levels by the year 2000. While this goal does not represent a binding obligation, the United States's resolve in attempting to achieve it is evident in the Clinton administration's Climate Change Action Plan (CCAP), released in October 1993. The plan outlines the means for reducing this country's emissions of carbon dioxide (CO₂) and other greenhouse gases within the framework of the FCCC. It lays out a set of nearly fifty public and voluntary private-sector initiatives designed to reduce total greenhouse gas emissions in the year 2000 to the level recorded in 1990—1.46 billion carbon-equivalent metric tons.

Below I review the major challenge and one missed opportunity of the plan and evaluate the plan's prospects for success. I also comment briefly on the long-term global perspective within which the plan must be viewed.

The key challenge and a missed opportunity

If successful, CCAP initiatives would eliminate 7 percent (around 110 million tons) of greenhouse gas emissions otherwise projected by decade's end. The plan ranges over a wide menu of energy-

saving and other measures for bringing about these emissions reductions. No sector of the economy is overlooked in reckoning potential contributions toward meeting the overall goal. For this reason, the means proposed to reach the goal vary widely. They include private/public partnership and incentive programs, exercise of statutory authority, and institutional reforms.

As outlined, the plan confronts many challenges. It also misses opportunities for some basic reforms that would increase energy savings and increase economic efficiency. Undoubtedly, the key challenge is bridging the persistent gap between actual and economically optimal energy use. A missed opportunity appears in the plan's proposal to deal with subsidized parking, a practice that discourages carpooling and use of public transportation. I deal with each in turn.

The gap between actual and economically optimal energy use represents the potential for a major payoff in energy savings; but it also poses a significant challenge in terms of overcoming past inertia in bridging the gap.

The administration predicts that implementing the CCAP will contribute to lowering the federal budget deficit and (using somewhat optimistic assumptions) yield the private sector an attractive return on investments that are designed to lower emissions of CO₂ and other greenhouse gases. (CO₂ is the dominant greenhouse gas; its release is associated primarily with fossil fuel combustion and secondarily with deforestation.)

This outcome presupposes significant changes in energy use by the private sector, almost entirely undertaken

Evolution and Key Provisions of the FCCC

The process leading to adoption of the Framework Convention on Climate Change (FCCC) began in the late 1980s. It was reinforced by a 1990 report of the Intergovernmental Panel on Climate Change (IPCC) that underscored the legitimacy of concern over greenhouse warming. The report prompted the United Nations General Assembly to constitute an Intergovernmental Negotiating Committee charged with the task of drawing up a framework convention on climate change. The committee's text of the FCCC was adopted—somewhat reluctantly in the case of the Bush administration—by 155 signatories at the United Nations Conference on Environment and Development at Rio de Janeiro in June 1992. The convention was transformed into an international treaty in March 1993.

Key provisions of the FCCC include:

- periodic preparation of national inventories of greenhouse gas emissions and sinks
- formulation by member countries of strategies for mitigating and adapting to climate change

- cooperation in promoting development and diffusion of technologies for reducing human-made emissions of greenhouse gases
- commitment by a party to the convention of developed countries to stabilize net emissions of greenhouse gases at 1990 levels by the year 2000
- assistance from developed countries to developing countries—financial assistance to meet inventorying responsibilities, technology transfers, and (in some cases) assistance in meeting the costs of adapting to the adverse effects of climate change

A ratifying "Conference of the Parties," which is scheduled to convene in Berlin in March 1995, will assume responsibility for overseeing implementation of the FCCC treaty. An updated IPCC report assessing prospective climate change will no doubt help inform the implementation process. The report, which is slated to appear later in the year, will describe the state of climate science, the possible physical and economic effects of global warming, and the feasibility of mitigation and adaptation strategies.

by voluntary rather than prescriptive actions. For example, the plan ascribes well over 15 percent of the overall greenhouse gas savings in the year 2000 to residential energy users. These savings are to be achieved, among other measures, through development of energy-conscious building codes and mortgage-lending practices, as well as incentive programs that would lead to the introduction of new energy-efficient appliances. An expanded "Green Lights" program is designed by the U.S. Envi-

ronmental Protection Agency to acquaint the commercial lighting market with opportunities for profitable investments in energy-efficient lighting systems. The "Motor Challenge" initiative of the U.S. Department of Energy seeks to increase the market share of efficient electrical motors in industry. (See table on p. 21 for a breakdown of how these and other CCAP initiatives are expected to change greenhouse gas emissions levels.)

Successful implementation of the proposed initiatives is predicated on the

willingness of individuals and firms to narrow substantially the gap between economically optimal and habitually less-than-optimal energy use. While this gap represents the potential for the major payoff in energy savings foreseen by the administration, it also poses a significant challenge in terms of overcoming the inertia that seems to inhibit greater energy conservation. In the past, heightened consciousness of energy costs has narrowed the gap between optimal and suboptimal energy use, but significantly bridging the gap has remained an elusive goal.

One CCAP initiative that might have been advanced more boldly is a proposal designed to discourage use of employer-subsidized parking and thereby encourage commuters to use public transportation or to carpool. If implemented, this proposal, together with several other energy-saving transportation proposals, would bring about some seven million tons of greenhouse gas savings.

Employer-subsidized parking has long been criticized by tax-reform advocates, who argue that this form of untaxed, in-kind income (up to \$155 per month) limits expansion of the tax base and unfairly penalizes commuters whose employers do not offer it. It has also been attacked by conservationists, who view the practice as the squandering of a rich opportunity for energy savings. The Clinton administration entered the parking pork fray—but only gingerly—when it proposed, as part of the CCAP, that employers offer employees the cash equivalent of the employees' currently subsidized parking. The administration argued that this (henceforth taxable) income would induce many recipients to use public transportation or to carpool and would enable them to pocket part of their after-tax receipts. But political caution has not been thrown to the wind: nonparticipating employees would continue to receive free, untaxed, parking benefits. Implementation of this rather timid proposal is far from certain, since it requires new legislative authority.

The CCAP's prospects for success

For three reasons, an interim evaluation of the prospects for achieving the hoped-for stabilization in greenhouse gas emissions by decade's end, though speculative, is somewhat pessimistic.

First, some proposed actions will require considerable shifting of federal agency funds. Such shifting seems far from assured. If, in the eyes of some, the Clinton administration has failed to press environmental policy with the fervor once expected of it, the change in party control in the 104th Congress may not improve prospects for doing so in the future.

It may be premature to declare the CCAP emissions savings target unreachable, but both increased economic growth and lower-than-expected energy prices make it difficult to check growth in energy use to the extent implicit in the plan.

Second, the case for improved energy efficiency that is critical to the success of the CCAP has been predicated on the economic benefits that would accrue to energy users even without the spur of higher prices, provided that numerous market barriers, institutional impediments, and informational gaps are overcome. It may well be that past attempts to get people to capitalize on energy-saving opportunities were not as skillfully designed and disseminated as the CCAP initiatives and thus inhibited a greater degree of energy conservation. Still, some analysts argue that prevailing energy-use behavior comes close to representing consumers' conscious preferences and that only through higher energy prices or taxes—neither of which are proposed in

Changes in greenhouse gas emissions levels under the U.S. Climate Change Action Plan (CCAP) (carbon-equivalent million metric tons)

	Actual emissions of greenhouse gases in 1990	Projected emissions of greenhouse gases in the year 2000	
		without CCAP	with CCAP
Carbon dioxide emissions by sector:			
Residential ^a	253	272	253
Commercial ^b	206	202	187
Industrial ^c	446	468	443
Transportation ^d	433	503	496
Total	1,338	1,445	1,379
Plus: carbon sequestered through use of nonfossil fuel energy	29	29	29
Equals: gross carbon dioxide emissions	1,367	1,474	1,408
Less: carbon dioxide sinks ^e	130	137	147
Equals: net carbon dioxide emissions	1,237	1,337	1,261
Plus: methane emissions ^f	166	150	134
Plus: nitrogen oxide and hydrofluorocarbon emissions ^g	59	81	64
Equals: total greenhouse gas emissions	1,462	1,568	1,459

Note: Footnotes below refer to some of the means by which the CCAP proposes to reduce greenhouse gas emissions.

^aMeasures such as enhancing energy-efficiency standards for appliances and upgrading energy-efficiency building codes.

^bInitiatives such as an expanded EPA energy-efficient lighting program, as well as energy-efficiency information, demonstration, and training programs.

^cMeasures such as accelerating energy-efficient process technologies.

^dKey proposal: reform of federal tax subsidy for employer-provided parking.

^eIncreased uptake of carbon dioxide by forests planted for the purpose of carbon sequestration.

^fInitiatives such as more stringent landfill management to reduce methane emissions, as well as public/private partnerships to reduce emissions and leakages during the production, transmission, and distribution of natural gas.

^gKey measures: public/private partnership and regulatory efforts (under existing EPA authority) to limit emissions of chlorofluorocarbon-replacing substances, such as hydrofluorocarbons, as well as a U.S. Department of Agriculture program to promote more efficient (less nitrous oxide-producing) fertilizer use.

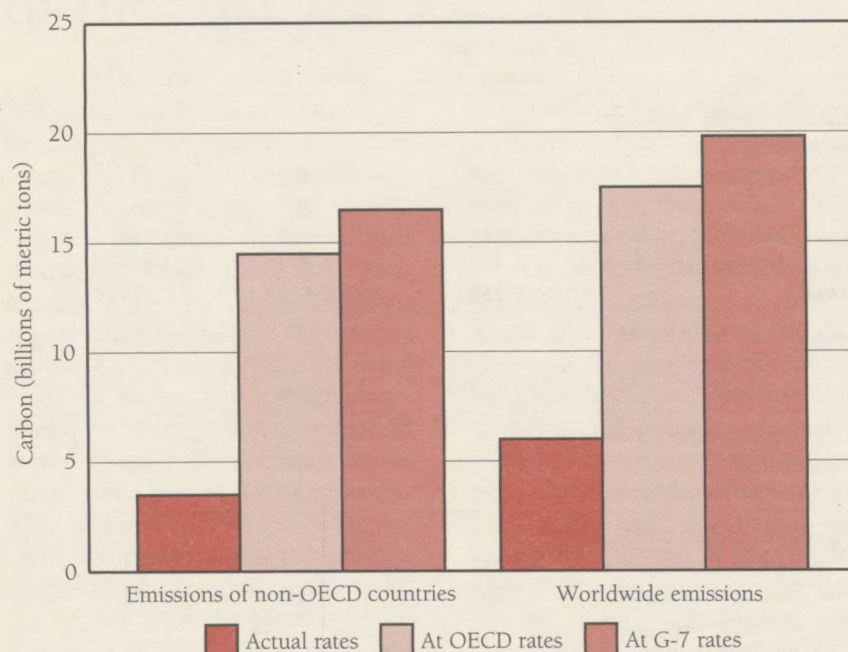
Sources: The White House, *The Global Climate Change Action Plan*, October 1993; and U.S. Department of Energy, *The Climate Change Action Plan: Technical Supplement*, Document DOE/PO-011, March 1994.

the CCAP—could energy-use behavior change significantly. I do not share that viewpoint but grant that the issue is far from resolved.

The third and perhaps most important factor undermining the emissions

stabilization goal is the unexpectedly strong upward trend in U.S. as well as foreign economic growth. Since 1990, real growth in U.S. gross domestic product has been markedly outpacing the average annual 2.3 percentage rate

Projected 1990 carbon dioxide emissions for non-OECD countries and for the world, based on the per capita emissions rates of OECD countries and of G-7 countries



Note: The Organisation for Economic Co-operation and Development (OECD) is made up of twenty-four industrialized countries. The G-7 countries are the United States, the United Kingdom, Canada, Italy, France, Germany, and Japan.

Source: U.S. Department of Energy, Energy Information Administration, *Energy Use and Carbon Emissions: Some International Comparisons*, DOE/EIA-0579, March 1994.

upon which the CCAP's estimated emissions savings are based. While this is surely good news to many households, it does signify more greenhouse gas emissions than were anticipated. Along with this economic growth comes increased demand for energy. This demand is further stimulated by relatively low energy prices worldwide—a circumstance not foreseen by the CCAP, which implicitly projects a substantial annual rise in the real world oil price for the remainder of the decade. This is a prospect that seems increasingly in doubt. Nor does the plan allow for the fact that the U.S. electricity industry is becoming increasingly competitive, potentially leading to lower electricity prices—thereby stimulating electricity demand which, again, could translate into greater emissions than foreseen.

While it may be premature to declare the CCAP emissions savings target unreachable, both increased economic growth and lower-than-expected energy prices make it difficult to check growth in energy use to the extent implicit in the plan. The plan's projection of a nearly 1.5 percent annual reduction in nationwide energy intensity thus seems open to doubt. (In recent decades, a reduction of such magnitude was strongly helped by prolonged stretches of rising and high energy prices.)

The economic recovery now evident elsewhere in the world raises doubts about the ability of other countries to meet the emissions stabilization objective. Germany and Japan, among others, have acknowledged the near-impossibility of achieving that objective by the year 2000.

Climate control policies from a broader perspective

Over the long term, whether the CCAP falls short of or surpasses its emissions stabilization goal by a few percent is of minor consequence, since its horizon is limited to the present decade. Even if the year 2000 goal is met, additional measures would be needed to avoid a substantial increase in emissions during the ensuing decade and beyond. (An important 1994 government report, *Climate Action Report*, emphatically acknowledges this point.) Moreover, even constant emissions levels after the year 2000 will still contribute to the atmospheric buildup of greenhouse gas concentrations, which many scientists argue must be avoided.

From this longer-term and global perspective, dealing with prospective climate change raises scientific, economic, and equity questions. For example, what level of emissions will prevent breaching

Even if the CCAP meets its year 2000 goal, additional measures would be needed to avoid a substantial increase in emissions and in atmospheric greenhouse gas concentrations in future decades.

some threshold level of atmospheric greenhouse gas concentrations? How much is society willing to pay to ensure a long-term climate that is not radically different from today's? Will a system of "joint implementation"—that is, a system for exchanging greenhouse gas emission "allowances" within and among countries—prove tractable in the face of monitoring and enforcement problems? (The limited U.S. experience with sulfur dioxide emissions-permit trading is promising in this regard, but that experience is too recent to demonstrate the feasibility

of such trading on a global scale.) And to what extent and by what means should developing countries be excused from the economic burden of reducing greenhouse gases? This question is ever-present in international climate talks. While developing countries will bear much of the burden associated with climate change, they are understandably reluctant to forgo the energy use necessary for economic growth in order to forestall climate change.

The possible ramifications of this development are daunting. Consider the hypothetical consequences when developing economies, which make up the bulk of the countries outside the Organisation for Economic Co-operation and Development (OECD), emit greenhouse gases at the level of the twenty-four OECD countries. If, in 1990, energy use by the non-OECD countries had led to CO₂ emissions at the per capita level of the OECD countries, their total emissions would have more than quadrupled and worldwide emissions would have nearly tripled. If their CO₂ emissions had equaled the per capita level of the G-7 countries—the United States, the United Kingdom, Canada, Italy, France, Germany, and Japan—the effect would have been even more striking (see figure, p. 22). No one predicts an inevitable future outcome along these lines: conservation, fuel-switching, and technological advances can all mute the climatic and other environmental impacts of economic growth. Nonetheless, the figure dramatizes the seriousness of the task that must be faced to bring about a more acceptable state of affairs.

Confronting global climate change

Scientific evidence on the prospective magnitude, regional incidence, and effects of greenhouse warming contains substantial uncertainty, and progress in understanding global climate change is frustratingly slow. Still, few people would

argue that we can afford to sit back, watching things unfold.

The risks of completely uncontrolled emissions were underscored from both natural science and socioeconomic perspectives in a 1993 RFF book, *Assessing Surprises and Nonlinearities in Greenhouse Warming*. In that volume, Norman Rosenberg, then an RFF senior fellow, now at Pacific Northwest Laboratory, wrote: "Driven by a variety of natural causes, climate is continually changing.

The CCAP contains some flawed elements and lacks a certain degree of reality; but as the first White House-led effort to address global warming, it deserves considerable respect and the kind of constructive critique around which ensuing policy can be built.

Now, however, human activities, particularly land use change and the emissions of greenhouse gases into the atmosphere, appear likely to induce other changes in climate, and at an unprecedented rate.... The burden of greenhouse-effect avoidance remains squarely on those industries and activities that emit CO₂ into the atmosphere through consumption of fossil fuel and through tropical deforestation."

In the same volume, Anthony Fisher and Michael Hanemann, natural resource economists at the University of California-Berkeley, call particular attention to what they call the climatic "damage function," which could spell physical, biological, and socioeconomic discontinuities of major proportions. *Could* does not mean *will*: we remain woefully ignorant about such possibilities—a fact prompting Fisher and Hanemann to "urge that more...economic research be focused on the potentially very large

costs of adjustment affecting stocks of physical, human, and natural capital."

Clearly, we cannot dismiss global warming as a trivial climatological phenomenon or blind ourselves to the possibly severely unsettling consequences of climate change. The Climate Change Action Plan contains some flawed elements and lacks a certain degree of reality; but as the first White House-led effort to move this country toward a responsible posture for managing the global warming problem, it deserves considerable respect and the kind of constructive critique around which ensuing policy can be built. The CCAP and other efforts to curb emissions of greenhouse gases can help chart policy options, as well as keep the importance of the climate change problem firmly rooted in our consciousness.

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