Winter
1988

Resources®

NO. 90 RESOURCES FOR THE FUTURE ISSN 0048-7376

Contents

Resources *is published four times a year. To receive copies at no charge, write to Publications and Communication, Resources for the Future, Inc., 1616 P Street, N.W., Washington, D.C. 20036.*

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Highlights 1987

TURNING THIRTY-FIVE WAS the highlight for Resources for the Future in 1987. V. Kerry Smith presented the keynote lecture at our anniversary celebration, and a summary of his remarks leads off this issue of *Resources*. In it he recalls the foundations of resource economics and points toward its future.

Professor Smith asserts that the purpose of resource economics—to clarify the debate about natural resources—remains as important as ever. But he also notes that the substance of the issues has changed. Thirty-five years ago, the debate centered on individual resource development projects having circumscribed impacts and tangible benefits and costs. Today's issues involve policies with more pervasive consequences and more subtle values. Smith argues that the continuing success of resource economics requires new methods of resource evaluation that respond to these changes.

In another article related to our anniversary, Hans Landsberg looks back on the report of the President's Commission on Materials Policy, *Resources for Freedom*, itself being thirty-five years old and one of the principal forces behind the founding of RFF. He concludes that, despite the changes that have taken place since 1952, the report has enduring value because of its approach to resource problems. The commission's stress on economic analysis, its embrace of both growth and conservation, and its essential optimism about the future are legacies that continue to influence policy debates.

Continuity of purpose in the face of changing circumstances is a theme shared by the other contributors to this issue. Lawrence Scheinman finds that the world of the International Atomic Energy Agency is profoundly different from that at its creation thirty years ago. Yet the agency's central purpose remains so critical that, in his view, if the organization did not exist today, it would have to be invented.

Paul Portney and Michael Dodman speak to the need for change in two other established settings, environmental protection and the electric utility industry. Portney addresses the need for more reliable environmental statistics, long a weak link in environmental policymaking and analysis. Dodman reviews the trend toward competition in the traditionally monopolistic utility industry.

This "Highlights" issue thus fairly reflects RFF at thirty-five. We remain committed to our continuing surveillance of issues in natural resources and the environment. And we understand that our research will continue to elevate debates about these issues only if it anticipates how the world is changing around us.

Robert W. Fri
President and Senior Fellow
Resources for the Future

Resource evaluation at the crossroads

V. Kerry Smith

Resources for the Future was founded in 1952. The decade of its beginning was also the decade during which benefit–cost analysis began to receive professional acceptance as a legitimate enterprise for economists seeking to inform public decision making. (That development stemmed from the early work of a small group of economists that demonstrated the linkage between the principles of welfare economics and a practical set of procedures for computing the net benefits arising from public investment projects—primarily water resource projects at that time.) During the three intervening decades, RFF has been a key player not only in the initiation but in the development of benefit–cost analysis as an instrument now used increasingly in the evaluation of many types of public policy issues.

Originally, benefit–cost analysis was applied to traditional public investment projects. Today its applications extend to a diverse array of problems—regulatory decisions, analyses of resource management policies, and natural resource damage assessment being a few examples—the scope of which could not have been envisioned thirty years ago.

This expansion of applications has far-reaching implications for the techniques used and for the treatment of measures of the benefits and costs. Consequently, it has led me to argue for the use of a broader term, *resource evaluation,* to describe more adequately the amendments and expansions to benefit–cost methods in evaluating today's environmental and natural resource issues. Recognition of the implications of this expansion is especially important today, because the practice of resource evaluation has reached a critical juncture for reasons arising from both political and methodological sources.

Benefit–cost analysis in the evaluation of most national regulatory policies was mandated in 1981 by President Reagan's Executive Order 12291. This mandate also created strong incentives to use benefit–cost analysis in other areas of federal policymaking and in decisions at the state level. And recent environmental legislation has increasingly recognized a need to balance the benefits of new initiatives with their costs. Yet, despite the growing interest in benefit–cost methods for policy analysis, it is reasonable to expect that a new administration will choose to evaluate the achievements of benefit–cost methods and to consider new directions for analyzing regulatory policies.

On the methodological side, much has been learned about the procedures used for measuring benefits and costs of policy actions in carrying out evaluations. Nonetheless, the established practices have been slow to be changed, and they continue to be used despite the fact that many current environmental problems are fundamentally different from the problems that gave rise to existing methods of evaluating public actions. A new codification of theory—and especially of practice—is needed if resource evaluation techniques are to inform decisions that must be made in the future.

Then and now

To provide some perspective on the research issues that face resource economists today, consider the typical public investment decision of the 1950s. It concerned a water resource project. The bulk of the project's outputs were reasonably tangible—water for municipal, industrial, or irrigation purposes; hydroelectric power; improved navigation; or flood control—usually with available market prices or close proxies as valuation measures.

Consequently, project benefits could be monetized using market prices or alternative costs. Project outputs that could not be evaluated in market terms—the so-called intangible items such as the recreation opportunities created by the lakes formed by dams constructed for flood control—were assumed to be unimportant factors in any project. The actions under review, then, were uniformly regarded as improvements; by definition, the development of water resources was in the national interest. The only issue was one of establishing priorities among projects and recognizing the trade-offs between local and national interests in selecting the mix of public works.

In addition, the effects of any one of these projects were principally local. The scale might be large for any specific region but was small in comparison with the national economy. And the time frame was usually limited to one generation of consumers.

Today, the subject of a "typical" resource evaluation is *not* a project. It is a policy, often a regulation imposing constraints on how private economic activities can be undertaken. For example, we must evaluate the potential levels for national standards for inorganic arsenic emissions or judge the merits of on-board controls for automobiles versus a two-hose system for gasoline refueling to control volatile organic compounds. Of course, water resource projects remain subjects of resource evaluation, but even here the focus of the analysis has changed.

Because today's issues are so diverse, it is difficult to identify a set of attributes common to all of them. Nonetheless, in general, they tend to include several of the following features.

First, public or quasi-public goods, the intangibles of the fifties, now dominate the outputs to be valued. Second, the scale of a policy is acknowledged to be large in relation to the whole economy. Third, the time frame for the effects of a decision can extend over many generations—perhaps even, as in the case of the nuclear waste problem, longer than our records of civilized activities.

A fourth feature of today's issues is

that they often involve new dimensions such as technologically sophisticated services (e.g., allocating the use of space for communication satellites), reductions in risk, or complex matters such as the disposal of hazardous materials. Because of the complexities of these issues, the direct experience of households responding to policy analysts' surveys and these respondents' ability to understand and organize the information relevant to a choice may be subject to question.

A fifth characteristic is that, in measuring consumers' values with regard to a particular policy, analysts must provide some means of connecting the expected physical changes in the affected environmental resource to the quality features of the resource that consumers would recognize and value. For example, a reduction in the concentration of polychlorinated biphenyls (PCBs) in the sediment at the bottom of a river, lake, or estuary reduces the prospects for contamination in aquatic life and the potential for bioconcentration, but its direct observability by individuals may be impossible.

Finally, the distribution of effects related to current environmental issues involves not only monetary gains and losses but also physical hazards, with the result that decisions raise important conceptual and ethical issues.

A set of practical guidelines akin to those available for evaluating the water projects of the fifties is clearly needed. While it is recognized that many existing methods for organizing the information inherent in a resource evaluation are inappropriate for dealing with current issues, credible alternatives to "muddling thru" have been difficult to come by. Four major changes seem to offer a start for adapting the methods now in use to fit today's issues.

Assets

Conventional economic practice has dichotomized the analysis of natural and environmental resources. The former, whether renewable (forests, water, and so on) or nonrenewable (e.g., minerals), have been treated as natural assets, thereby recognizing the implications of allocation decisions for future resource availability.

USDA—SOIL CONSERVATION SERVICE

Sailing on the Chester River in Maryland. Public or quasi-public goods such as recreational opportunities, the "intangibles" of the 1950s, now dominate the outputs to be valued in the "typical" resource evaluation of today.

By contrast, environmental resources (e.g., clean air, clean water, scenic values) have generally not been considered assets. In these cases, attention has been diverted from the resources themselves to the activities involved in using them and to the ways in which the actions of some users affect the well-being of others—for instance, how emissions by manufacturers impose externalities (costs generated but not borne by the producer) in the form of pollution on households. Consequently, the analysis has focused on the harm and associated costs experienced by the households involved. (In principle, these households would be willing to pay at least the equivalent of these costs, and perhaps more, to avoid the damages if a mechanism could be developed for making the payments.)

A needed adaptation of existing methods of resource evaluation, then, is to model both natural *and* environmental resources as assets, with appropriate recognition of the short- and long-term impacts of allocation decisions. This is important not simply as a reflection of the capacity of the environment to absorb various types of pollutants, but also in attempts to understand and to measure the values that people may place on resources which they themselves do not use.

At a conceptual level, the strategy of treating environmental resources as assets implies that the evaluation of proposed allocation decisions (e.g., public investments) or past allocation decisions (e.g., natural resource damage assessments) involving an environmental resource should be based on how the decision will (or did) affect the value of that resource as an asset and on how much the changes required by the allocation choice will (or did) cost.

Evaluation from this perspective would incorporate a number of consid-

erations: the uncertainty that influences individuals' behavior and their valuing of a resource; use and nonuse motivations that affect individuals' values of environmental resources; and more intangible characteristics of the resource that might be associated with its quality. Such analysis must also consider the time pattern of effects (or outputs) that would follow from decisions so that these effects can be used in gauging how the value of each asset changes with each decision.

Uncertainty

Uncertainty is an integral part of the decisions of economic agents, policymakers, and economic analysts. While there are different types of uncertainty facing each, in sum they have a cascading set of effects on the form and the content of resource evaluations. The constituent sources of these uncertainties have been recognized in past work; nonetheless, there is still no consistent treatment of all of them. Moreover, except in rather special cases, there appear to be no practical guidelines for policymakers on how to effectively incorporate the implications of these uncertainties into policy decisions.

With regard to economic agents: since uncertainty exists in all decisions made by firms and households, from the perspective of the analyst describing the behavior of these agents, what is relevant is whether the uncertainty is "important enough" to affect what they do. There has been long-standing recognition of this point in economics, but slow replacement of the conventional practices with methods that adequately incorporate the implications of uncertainty for economic behavior and the corresponding measures of the resulting benefits and costs.

Uncertainty in policymaking takes several forms. Policies are fashioned in an uncertain environment. They may well deliver uncertain results. And, most recently, with an important class of environmental initiatives—the Environmental Protection Agency's risk management policies—they have been focused on actions that are intended to reduce some of the uncertainty that faces individuals.

The theory and most especially the practice underlying resource evaluations have not adjusted to the fact that in some cases economic agents' behavior is in response to the uncertainties they face. Consequently, in measuring the changes in individuals' welfare that would accompany resource allocation decisions, people may not be guaranteed a level of well-being. Instead, policy may simply reduce the chances of undesirable outcomes, not guaranteeing safety but merely improving the odds for a safer environment.

The uncertainties facing the economic analyst are also varied. The majority of economic analysis, as it is currently applied to the testing of hypotheses or estimating models, relies on outcomes *after* choices have been made. Observed choices are supplemented with assumptions about what was known by the individual (or firm) prior to the observed outcome and with postulated constraints that are treated as relevant for the decision, as well as with a set of assumptions describing how both were used in the choice process.

These models provide the basis for the indirect methods of estimating households' values for environmental purposes. There is, however, no objective indicator for uncertainty about any of the elements facing the household *prior to* the choice. There are no mechanisms allowing individuals' perceptions to be "signaled" to the analyst.

In response to these limitations, resource economists have begun to use survey techniques to learn about how individuals respond to hypothetical

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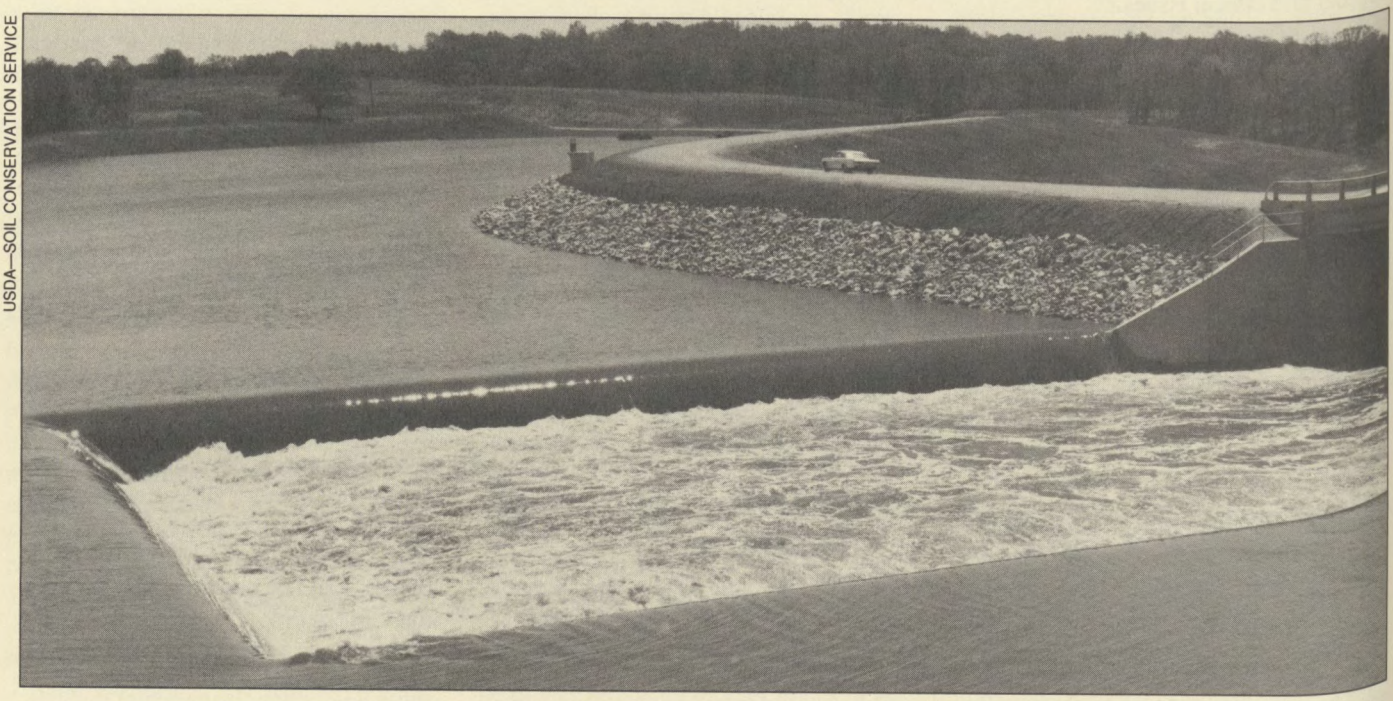

Construction at Shoal Creek Watershed, Litchfield, Illinois, built in 1966 to provide a water supply for the city of Litchfield. Several decades ago, a public investment decision to build a dam was based primarily on the dam's "tangible" outputs—e.g., municipal drinking water supply. Such outputs usually could be valued on the basis of market prices.

choices. The direct, or contingent valuation, method for estimating the values that individuals place on improvements in specific aspects of environmental resources (or on risk reductions) is one example of these efforts. A full understanding of the strengths and limitations of these methods will require a model of how individuals perceive and verbally respond to the ways in which analysts describe choice situations to them.

Clearly, such an effort extends beyond the confines of economics to psychology and the other social sciences. A new model incorporating a full range of social science insights for decision making that involves new or uncertain choices is warranted here. Economics can provide a basic structure to begin the process, but to complete the framework will require incorporating the insights of psychology and sociology.

Complementary use of direct and indirect valuation methods (surveys and market-related measures, respectively) can reduce the uncertainty the analyst faces in estimating the values for resources. These joint applications could involve collecting information that allows estimation of individuals' values for environmental resources as well as their demands for other goods or services supplied by the market. By comparing the demands for marketed goods with results derived from other sources, it is possible to gauge how individuals perceive the constraints described to them in a survey format. This comparison may allow analysts to gauge how perceptions are formed with surveys involving valuation questions for nonmarketed resources.

Scale

In contrast to the project orientation of the 1950s, most resource-related applications of benefit–cost analysis today involve situations in which decisions are likely to affect the national economy. The wide-ranging effects of a policy decision in such cases can be purely economic, working through markets, or they can involve a large component of the ecosystem and hence the environment of several nations simultaneously.

The extent of change in the scope of resource issues over the years—and the corresponding expansion of the implications of policy decisions—are easily illustrated. Executive Order 12291 requires that benefit–cost analyses be performed for regulations that are expected to have major effects on the economy (i.e., annual impacts of at least $100 million). Thus, the very screening criteria require benefit–cost analyses for cases where the assumptions of small scale are likely to be violated. Equally important, several of today's resource problems resulting from human activities—acid deposition, climate change, sea-level rise, and marine pollution—are affecting the environment on a global scale.

As the scope of the problems and of related policy decisions has broadened, the range of issues to be considered in evaluating any individual policy has also expanded. Scale now matters. Policies no longer exist in isolation. Their mutual interaction is important (although this is not universally appreciated in the current body of literature on resource evaluations).

A recognition that scale changes the types of assumptions that can reasonably be made in developing resource evaluations raises a number of important issues. For instance, it is more difficult to estimate individuals' values for resource changes when these changes affect other commodities that people value.

Before practical methods can be developed for taking account of scale, several questions must be answered. Even when resource evaluations can use indirect methods for valuing commodities (i.e., market prices as yardsticks for assigning values), under what conditions can the indirect effects of large-scale price or regulatory changes be expected to affect the approaches used to measure the values of both marketed and nonmarketed commodities? Clearly, the answer reveals something about how sensitive the indirect methods for valuing nonmarketed commodities will be to the effects of scale.

Nor does the use of direct methods—i.e., surveys—for valuing commodities automatically provide solutions. A major question here is whether it is possible to determine the conditions that survey respondents assume will affect them in their other decisions. Their reported valuations for environmental resources will be affected by their perceptions of the constraints facing them. Learning what respondents assume in giving their answers seems to offer a more promising strategy than framing survey questions so they include all possible side conditions to respondents' decisions.

The long time scale associated with many resource evaluations of today also presents new challenges for resource evaluation. Regulation of chlorofluorocarbon emissions, policies on carbon-based fuels, and selection of a site for the long-term repository of commercial nuclear waste, for example, involve long-term effects crucial to the analysis.

Conventional practice has been to use present value as the basis for summarizing streams of costs and benefits over time. Since the issues under analysis have often been cases where benefits are conveyed to the current generation and costs imposed on the future, the timing of when costs and benefits are realized and the selection of the rate converting future dollars into current "equivalents" have been crucial to the use of conventional methods.

Which research issues might reduce the scope of conflicts involved in making decisions with effects over such long time spans? At least two deserve further evaluation. The first involves a recognition that the conflicts are greatest where there is uncertainty over and some degree of irreversibility in the outcomes of decisions.

The second research issue involves a different type of irreversibility—the inability to change the sequence of indirect effects that accompany large-scale decisions. For instance, suppose that a public investment decision which increases access to coastal areas for recreationists must be evaluated; it is known that these areas will be inundated as a result of progressive sea-level rise over the next fifty to seventy-five years. The enhanced access resulting from the investment will promote development of second homes, private recreational facilities, and complementary public infrastructure—all of which ultimately increases the cost of a sea-level rise in the future.

In many respects, the problem is akin to development in a flood plain after public investments are made to reduce the likelihood of flooding—the costs of subsequent floods increase dramatically.

In this case, however, there is one important difference. As knowledge of the causes of temperature change increases, the timing of change in sea level becomes more predictable. Thus, climate change is different from the case of floods or coastal hurricanes, where, after public action to reduce the prospects for flooding there is often sufficient diversity of opinion to permit the existence of insurance markets.

This difference implies that private indirect effects must be treated differently. To the extent that there are limits on the *ex post* losses that society will allow private citizens to experience, it is especially important to recognize how the secondary effects of current public investments could serve to increase future costs.

Evaluation

Finally, policy research itself should not be free from evaluation. As experience is accumulated in valuing nonmarketed resources, analysts must learn how to learn from that research and integrate the findings into improved use of what is on the proverbial "research shelf."

The mandating of benefit–cost analysis has created a "procedural" demand for literature reviews. Moreover, much of the legislation leading to this demand has at the same time precluded new estimates, advocating instead the use of the "best available" findings. At present, learning from the record has become a procedural step in the development of a regulatory impact analysis, in much the same way that the environmental impact statement of the National Environmental Policy Act has typically been a procedural document without insight into the potential environmental problems involved in any specific decision.

These criticisms are especially relevant to reviews of studies of the valuation of nonmarket resources. Although there is a growing body of findings from such studies—models used to estimate the marginal values of air pollutants, travel-cost/recreation-demand models for gauging the value of a variety of recreational resources, wage models for the valuation of risk changes, and direct surveys for the values of a range of environmental resources—analysts do not know how to systematically learn from them. Such learning would result in a better match between off-the-shelf estimates when they are applied to new valuation problems as well as a better understanding of the research needed to make what is on the shelf more useful.

Defective policymaking?

Resource economists, especially those associated with the use of applied welfare methods to address policy issues, have increasingly been questioned on their "naive view" of policymaking. Critics argue that the emergence of applied welfare economics is actually a story of manipulation, that those interested in water projects used the analysis to meet their predefined objectives. In the water resources area, they say, there was a social consensus favoring public works in water development. Benefit–cost analyses were simply gauges of the feasibility of projects and of the implications of small design changes. At most they served to set priorities among a slate of projects to be undertaken, never to decide whether such projects were desirable.

These are not new arguments. Benefit–cost analysis was never intended to be the exclusive basis for decision making. However, the more analysts can narrow the sources of error in the use of methods over which, admittedly, reasonable people can disagree, the greater the precision of our measuring rod.

Opportunities for manipulation are reduced by improvements in methods and consensus over best practice. This allows the terms of the debate to be more clearly defined. Decisions will always imply values for the outputs and interests served by them. What is at issue is defining a standard that allows these values to be compared.

The decade of the seventies was one of stating broad environmental and resource goals—clean air and clean water, preserving our natural heritage with wilderness and wildlife preserves, and reducing energy dependencies. At the outset of the decade, it was assumed that most of these goals could be achieved with reasonable costs and thus, if conflicts arose, they would not be large.

In the eighties, we have learned that this assumption was wrong. As policies required to meet some of the goals began to be implemented, there was a greater appreciation of the large costs and growing conflicts over the use of natural and environmental resources. Not everyone can win; some people will have the nuclear waste repository in their backyard. Air and water quality are unlikely to be uniformly clean nationwide. Risks will be unequally distributed. Arbitrating the conflicts that naturally precede the decisions on each of these issues requires a standard with which to compare those whose interests are served with those who experience a disproportionate share of the costs.

In the nineties, we will be forced to make increasingly difficult decisions over resource use. The quality of those decisions, as well as the ability to make them in a reasonably democratic society, requires the ability to compare consequences. Resource evaluation methods can provide this standard—but the methods and their application must meet the demands of the problems at hand. ■

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Resources for Freedom in retrospect

Hans H. Landsberg

In 1952, President Truman's Commission on Materials Policy issued a report entitled Resources for Freedom. *The founding of Resources for the Future was a direct consequence of the report. To commemorate its recent 35th anniversary, RFF reprinted a limited edition of the first volume of the report. The following article is adapted from the afterword written by Hans Landsberg to accompany the reprinted edition.*

When the Paley Commission report was written between January 1951 and June 1952, the end of World War II was only five years in the past, with continuing reconstruction in Europe as a constant reminder, and the Korean War in full swing. Hostilities in Korea threatened to spill over into China, and the specter of war with the Soviet Union was more than the fanciful product of someone's feverish imagination. With the memory of World War II shortages still fresh in people's minds, readiness for a war emergency and the search for means of command over the wherewithal of war, that is, materials and energy, were a recurrent theme and in a way represented the raison d'être of the commission. "Almost all major war instruments now make much heavier materials demand," the report of the commission states, than was true in the past, especially in World War II. But having entered through the security door, the commission found itself in an arena infinitely more profound and far-reaching, in both space and time. The stage was set for a general discussion and analysis of materials problems, of "choke points," as we would say today, and relevant policy recommendations.

It is important to stress the word "materials," not only because it is in the commission's name, but because some major "resources"—as distinct from materials—are dealt with only lightly. These are agriculture and water. The report does contain calculations on projected food needs and what measures are needed to meet them—increased yields, a change in land use, and a more flexible farm income support system—but the materials label assigns only a minor role to not only food but, with the exception of timber, also agricultural materials, such as fiber. Similarly, only a slight bow is made in the direction of water, largely on the grounds that a presidential commission had just reported on it. The bulk of the summary report of volume I, which reflects the basic thrust of the five-volume opus, then addresses materials (and mostly minerals at that) and energy, and the pillars on which they rest, science and technology.

Thirty-five years after the report emerged, three aspects are of interest:

1. What was the commission's mind-set and how valid does it strike us today?
2. How good were its quantitative "sensors"; that is, to what degree did it have a reasonable, realistic notion of the path from 1950 to 1975?
3. Were there major intervening events, foreseeable or not, that, in hindsight, rendered irrelevant or fundamentally erroneous the commission's findings or recommendations?

The mind-set

It is nothing short of remarkable that, in the midst of a wartime environment, one of the clearest messages pervading the report is what it calls the "least cost principle." Buy wherever you get the best price, the commission advises, adding some such qualification as "with due regard to security considerations." To quote a pivotal sentence: "The overall objective of a national Materials Policy for the United States should be to ensure an adequate and dependable flow of materials at the lowest cost consistent with national security and with the welfare of friendly nations." The theme pervades the report. At times it turns up as favoring a specific procurement policy, as in the above citation, and at times it takes the form of rejecting self-sufficiency, which it calls a "self-imposed blockade," a policy it denounces, because "it costs too much" and would be a blow to our friends and allies in the sense that such a policy would deny them opportunities for growth and development.

The report does concede that there is a case for transition assistance to domestic industries hurt by the consequences of lack of international competitiveness. To appreciate this attitude, one must recall that, for example in the case of petroleum, the country was in the process of changing from a net exporter to a net importer and that its principal foreign supplier was Venezuela, a nearby country with its oil industry then firmly under the effective control of U.S. corporations. So, in a sense the proposed least cost principle, at least in this instance, imposed no burden, either economic or political. Nonetheless, the strong and unequivocal language denouncing self-sufficiency, trade barriers, and the like, stands out as a courageous act in the face, even then, of vociferous calls for protection of domestic industries, in fact or allegedly struggling to stay alive.

There was no pussyfooting either in the commission's attitude toward growth. It was for it! Not only was it feasible but it was also desirable. Disarmingly and engagingly, the report acknowledges that it cannot find "any absolute reason for this belief [in growth]" but that "it seems preferable to any opposite, which to us implies stagnation and decay." Still, the report recommended—though without further elaboration—that we must "examine such apparent limits as present themselves." A foretaste of *Limits to Growth?* Hardly, as is borne out in the

commission's view of technology as having the potential for overcoming such "apparent limits," but rather, one is inclined to think, a concession to reasonableness.

Concern with growth is linked with another pervasive theme: resource depletion not as a physical absolute but as expressed through rising costs. As some observers have remarked, the report's greatest contribution to the perennial resource adequacy debate is its abstention from sounding the "running-out" theme. It is a mistaken notion, it comments, that on a given day the world will find that the last ounce or foot of a given resource has been used up. *At a cost* there is always more. What we are running out of, says the commission in the kind of terse and graphic language that characterizes the entire summary report, is "the evident, the cheap, the accessible."

In a similar vein, the commission usefully provides conservation with the often missing economic dimension. Conservation is not the "hairshirt," not deprivation, but using a resource more efficiently. Thus it is compatible with growth and with high consumption. Similar reasoning applies to waste. Don't confuse physical waste with economic waste, the report cautions. To save and preserve may under some circumstances be economically quite wasteful. At a time when war-induced shortages were very much on people's minds, these were truths not willingly or easily accepted by everyone. One might remark parenthetically that they were not understood more widely two decades later when the country had to cope with the consequences of the first energy shock and was trapped in the belief that every Btu saved was by definition a beneficial event.

Another pervasive belief is that, as contrasted with government intervention, private enterprise equates with efficiency. Profits and prices are the institutions on which the economy relies to get results, and government interference must be held down. But the dogma is not absolute. To believe in minimizing government interference does not mean that "the minimum must be set at zero." Indeed, coexistence of private and public strength is the desirable state of affairs. This is stated as a principle, and it motivates many of the commission's recommendations that suggest establishment of both incentives to private behavior and new public institutions. The philosophical stance of the report is that government's role is to enhance the conditions under which private enterprise may flourish.

THE ASSOCIATION OF AMERICAN RAILROADS

Demand for coal between 1950 and 1975 fell short of the Paley Commission's expectations, in part because it was difficult to project the speed with which diesel propulsion would replace steam-propelled locomotives. Shown is Great Northern steam locomotive No. 2039 at Hillyard, Washington.

While not strictly part of the commission's mind-set, the report's perception of technology's role is worth comment. Regarded as the agent that pushes into the distance any stringencies set by depletion or exhaustion, it too is considered poorly perceived unless related to cost. Technologies abound. That is not the problem. Whether the country can afford this or that technology, that is the issue. Moreover, the report calls attention to a disturbing gap created by the limits—often close by—beyond which private enterprise will not go in the search for innovation, on the one hand, and the inadequacy of government funding aggravated by what the report calls the "headlessness" of government structure in the technology field, on the other. Lots of agencies, it notes, but no coordination or plan.

In the same vein, there is scattered through the report and highlighted at the end the call for a government mechanism or institution to provide a focal point for policy, review, intelligence, and the like, regarding materials, to be situated in the Executive Office of the President so as to have visibility and clout. For those who have followed the sequence of committees or commissions that have succeeded the Paley Commission, this has a familiar ring. Every one of them has pleaded for that "mechanism" that would enable the materials community to get close to the "ear of the President." The plea is usually coupled with a ringing call for a "consistent and comprehensive national materials policy." The most we have to show for it thirty-five years later, is the Critical Materials Council, set up not long ago by Congress, its three members appointed by the president and, so far, honored basically in being ignored. The Paley Commission had a different idea. It suggested that the task be given to the then-existing but slightly modified National Security Resource Board. But before any action could be taken to implement that suggestion, the board itself had been abolished and the coordinating-planning-reviewing body was never created. In a sense, and in part, RFF fell heir to that function, which was the reason William Paley founded it.

The forward look

The Paley Commission's projections of supply and demand twenty-five years into the future were truly a "calculated" risk, or a risky calculation. They were also a first. Preceding it was another landmark project, J. Frederic Dewhurst's *America's Needs and Resources,* published in 1947 and revised in 1955. It was more comprehensive in that it also encompassed human resources (which in the Paley Commission structure served only as "basic parameters"), but it projected for only fifteen rather than twenty-five years, and it was far less ambitious and detailed in its resource demand and supply calculations. There have been other projection efforts since, including RFF's *Resources in America's Future* (1962) of which I was the senior author, undertaken at the urging of William Paley. There have been many others since 1973 when the energy crunch

shook up whatever resistance there had been to engaging in projections that some misconceived as steps to a planned economy. But there is no doubt that the Paley Commission was a true milestone, indeed the milestone marked with a large Number One.

How well did the commission do? This is not the place to engage in a line-by-line examination. Nor are the numbers the one meaningful test. The commission itself emphasized that to test resource adequacy, the core of its task, orders of magnitude were for the most part sufficient. Looking back, a better question is: did they sense the direction in which the materials and energy segments of the economy—and their component parts—were moving? Were they pedestrian accountants, extrapolating and correlating without imagination, or were they impractical dreamers, ignoring the constraints of the real world? The verdict is that more often than not the commission's guesses pointed in the right direction. When they erred they missed the bull's eye, but generally not the target. The instances where this evaluation does not hold are those in which the commission failed to sense future developments on a very far horizon, or even below it, a failing they shared with equally surprised subsequent observers not ten or twenty years but at times only days or months before the events occurred. About this, more below.

Let us start with a quick tour of the basic parameters. The commission did not anticipate the prolonged baby boom. Population, at 151 million in 1950, was estimated to rise to 193 million by 1975. That estimate, arrived at in consultation with the Bureau of the Census, was conservative: population, in fact, rose to 216 million. The labor force, at 63 million in 1950, was put at 82 million for 1975. In fact, it turned out to be 95 million (what was missed here, as it was equally in later projection efforts, was the rapid growth in the female labor participation rate). The work week was expected to decline by 15 percent, and productivity, defined as output per worker-hour, was to grow at a steady 2.5 percent per year. Instead the work week declined by only 10 percent, and productivity, on the average, rose by 3 percent. Out of these factors the commission saw emerge an annual GNP growth rate of 3 percent, about the same, said the commission, as it had "averaged over the last century." Put differently, by the commission's estimate, GNP was to double in the twenty-five-year span under consideration.

Reality matched expectation closely: GNP rose at a compound rate of 3.3 percent. All factors exhibited a greater dynamism. Population rose faster by 23 million, yielding a working force greater by 13 million, which worked only 10, not 15 percent less per week, and productivity registered a better record than expected. With GNP functioning as a yardstick for many of the projections, its correctly anticipated path imposed useful bounds on the more detailed estimates.

The commission had a hunch that its basic indicators might be on the low side. It called them "unquestionably conservative." Correctly, we believe, downplaying numerical "accuracy," the commission is content with noting tersely that "demand for everything can be expected to rise substantially" and that history records "more estimates of the future that were too small than those that erred on the other side." Ironically, the commission's macroeconomic estimates add one more example to those that were too small, though by only very little.

Uncertainty on particulars

When it comes to particulars, that is, the demand for agricultural products, minerals, energy, and some other resources, the picture becomes more uncertain. In the case of energy, the commission made a straightforward assumption: its use would rise at the same rate as GNP, that is, by 3 percent—the famous "lockstep" syndrome. That turned out to be close. Energy use rose by 3.1 percent, not quite as fast as the 3.3 percent GNP growth rate. In this instance, the commission's numbers were better than its reasoning. Having stressed the theoretical potential for greater efficiency in use, the commission's actual calculations assumed no improvement and thus overestimated energy consumption in 1975 (by which time the first reverberation of the OPEC shock undoubtedly had begun to pull down energy consumption).

Other estimates are less easily summarized, as the commission emerged with wide-ranging differences in growth rates. For example, it estimated iron, copper, lead, and zinc consumption to rise only slowly—by 40 to 50 percent—but bauxite, a proxy for aluminum, by 200 percent, and magnesium, lo and behold, eighteen to twentyfold! Timber demand would rise by only 10 percent, but within that estimate was embedded demand for pulpwood that would grow by 50 percent.

Let us look at mineral consumption in a bit of detail. This is the table that appears in the summary report of volume I (actual percentage changes added by us).

	Percentage, 1950–1975	
	Estimated	Actual
Tin	18	–50
Zinc	40	27
Copper	43	7
Lead	53	–27
Sulfur	110	155
Phosphate rock	150	383
Potash	150	242
Bauxite	200	274
Titanium	325	112
Cadmium	325	–31
Cobalt	345	54
Magnesium	1,845	425

To find the underlying rationale for the enormous differences in projected change among those resources, one needs to go to the supporting volumes that contain the detailed calculations. This we do not have the space to do systematically. But it is obvious that much of this type of speculation is based on expectations in vogue at the time, nor could it be otherwise. An interesting example is magnesium (often dubbed the "Cinderella metal" because it has consistently failed to make the big time). Instead of growing nearly twentyfold in twenty-five years, magnesium demand actually rose only by 425 percent. Obviously, the commission had the right hunch about a steep increase; it just overdid it, but since resources could be shown to be ample, the misjudgment was without consequences. Then and later on, others erred in the same direction when (a) great hopes were pinned on titanium in whose production magnesium is a critical ingredient; (b) the idea of a magnesium engine block was bruited about (and was moved from the planning stage to the assembly line in an experiment by the Volkswagen producers); and (c)

magnesium had attained high levels of output as a war material. As it was, the anticipated titanium boom withered in less than a decade and the magnesium engine block did not work out. As for titanium, the commission declared with disarming honesty that it was not feasible to predict its future consumption even within wide limits. The high number merely symbolizes expectations of rapid growth in the dawning space age.

On the other hand, the commission was reasonably on target when it foresaw no bright future for tin, zinc, copper, and lead, but vigorous growth for the fertilizer chemicals and aluminum. Looking at direction rather than at point estimates, one must give the commission high marks in this twenty-five-year forward look.

Nearly 20 percent of the summary report is devoted to energy. Indeed, energy is at the core of the study; thus a few comments are appropriate. We have already seen that in the aggregate the commission expected energy use to grow at the GNP rate, that is, double in twenty-five years, and that, in fact it just about did so. But within that total there are embedded widely differing rates of change. Among the conventional broad use categories, transportation energy was to rise less than the average, industrial use more, and the balance at the 3 percent average rate.

But the "soaring sixties" made quite a difference. Consumption in household and commercial uses raced ahead at 4.1 percent per year, transportation use, at 3.1 percent, expanded at the aggregate energy use rate, and industry use lagged behind at 2.4 percent. Rising incomes and the availability of a large variety of new household appliances—air conditioners, freezers, and the like—and fuel use for the rapidly expanding number of households pushed up the household use, but it is less clear what held back energy use in industry if not the phenomenon of the "turn to services." Indeed, statistics show that energy use in industry remained virtually constant from 1969 to 1975. Moreover, single terminal-year comparisons are hazardous, and 1975 was a deep recession year, suffering from the effects of the OPEC price shock and the policies instituted to cope with it. Thus the actual growth rates are biased on the down side.

When we look at sources of energy and their respective growth, we find the commission projecting liquid fuel use to more than double, coal consumption to rise by 60 percent, and electricity—from all sources but with nuclear not yet a factor—and natural gas to at least triple. (For reasons beyond these paragraphs, the detailed projections put the rise of coal at only 40 percent, significantly closer to reality.)

The commission was correct on liquid fuel, which rose by about 150 percent; on natural gas, which did indeed more than triple, rising by 240 percent; and also pointed in the right direction for electricity, which did considerably better than triple: it just about quintupled in terms of utility kWh sales and probably more than quintupled when industry self-generation and losses are taken into account. As for coal, the commission foresaw the reversal of the secular decline, primarily because of increased use for power generation; but because petroleum, and, increasingly, natural gas, proved competitive longer than anticipated, recovery fell short of the commission's expectations. Most of the sluggishness came early on, in the 1950s when households shifted to gas and oil and electricity, and railroads to diesel propulsion. Whether the speed of these developments was sufficiently clear to be perceived by 1950 is doubtful, and hindsight is a poor guide. Even so, the commission's proposed goal was reached only a few years "late."

USDA—SOIL CONSERVATION SERVICE

Detergent-choked streams like this one had yet to appear when President Truman's commission issued *Resources for Freedom* in 1952. Shown is Sandy Run stream in Montgomery County, Pennsylvania, two decades ago.

Unforeseeables, oddities, and hobbyhorses

As one looks through the index of the report, one is struck by the absence of such words, now in everyone's vocabulary, as environment, pollution, ecology, although water pollution does turn up. There are but two references to atomic energy (which at that time presented a net drain on the energy system, being focused solely on weapons production and expected to remain so for some time). Nor does the Middle East figure in the index. On the other hand, one finds solar energy as well as synthetic fuels.

It is a sobering exercise to transport oneself back to the world of 1950. The first nuclear power plant had not yet been erected. Detergent foam was not yet floating on water courses, nor were acid rain or the greenhouse effect household words. The Persian Gulf was a large body of water not yet viewed as of crucial significance to the well-being of Western

Europe, Japan, or this country, and Iran's Mossadegh had not yet set off alarm bells. The Korean War was fought with conventional weapons and the threat of nuclear annihilation, or the mechanics of deterrents, and the like, while recognized, had not yet become a persistent theme.

Only with supreme arrogance or uncommon wisdom could one judge what was and was not then foreseeable. Possessing neither, we shall refrain from making those judgment calls and merely remind the reader of the fundamental differences between 1950 and 1987. In that context it is remarkable how close to target many of the 1975 projections turned out to be.

The reverse of missing events that did occur is to predict with a fair degree of confidence developments that failed to materialize. For example, synthetic fuel obviously intrigued the commission. In what now reads like science fiction, a finding by the National Petroleum Council was cited that fuel from an approximate 200,000-barrel per day synthetic fuel plant could be placed on the Los Angeles market for 14.7 cents per gallon, compared to petroleum-derived gasoline at 12.7 cents. Possible barriers mentioned were the shortage of capital, monopolistic restraints, "or the like." We have only recently learned better, but the dream, especially of turning superabundant oil shale into a competitive commercial liquid, at a cost that for a long time was believed to be just 25 cents above that of a barrel of crude oil, loomed large in the commission's speculations and was to survive in subsequent projection ventures to the present. Two other energy sources figured prominently in the commission's speculations but not in its calculations: solar and the breeder. Neither was to make it. The first largely because costs were too high and the second because of growing hostility toward any kind of nuclear power technology and particular opposition to the plutonium-associated breeder.

Clouded future

In 1950 none of this was evident. It was the era of President Eisenhower's Atoms for Peace plan. Here the commission's praiseworthy concern with the *cost* of resources rather than their physical aspects led it into dealing inadequately with noncost factors, not only in the instance of nuclear energy but similarly in assessing the prospects of hydroelectric power, and the "bads" of coal use. The breath of "technological optimism" emanating from the report is refreshing, but at times resulted in false expectations. On the other hand, the commission did not fully anticipate the enormous revolution in agricultural technology and the resulting yield increases, and because it underestimated population growth, it also underestimated the demand for food. Nor is there any inkling of the coming revolution in electronics, communication, and biotechnology. But then the report was written by mortals.

Since national security is a major theme of the report, so, naturally, is concern with means of achieving it. Stockpiling looms large in that respect, but apart from commodities, it focuses heavily on standby capacity. Various schemes are proposed. For example, offshore oil exploration, still an unexploited source, is seen as having usefulness largely as a spare "reservoir" in case of war. Therefore, the government would prescribe well-spacing and withdrawal rates that would slow down draining of reservoirs and ensure their availability in military emergencies. Similarly, "resource agreements" with other countries, on a government-to-government basis, would be concluded under which the United States would assist financially and otherwise in locating reserves of minerals, not for immediate exploitation, but to constitute standby capacity. There are other proposals along similar lines, that is, designed to provide ready facilities when needed. It is a mechanism still at times proposed but more generally discounted as unrealistic. Perhaps, it was the image of another long-drawn-out conventional war that lay at the base of these proposals. Faced with the specter of nuclear war, semi-ready offshore oil wells or unmined copper-bearing ores on other continents now hardly seem strong reeds to lean on.

There are some other oddities, or rather passages or thoughts that strike one as odd in view of today's reality and perceptions. Discussing the crucial role of technology, the commission approvingly cites a statement that "...the Nation has been far more industrious in putting scientific facts to work than in increasing basic knowledge." Reading the statement today one would unquestionably take it to refer to Japan, not the United States. Then there are allusions to all manner of technological advances that did not make it or were hardly ever attempted. Among them, suction pipelines to extract coal from coal mines and production facilities that jointly turn coal into electricity, chemicals, and liquid fuel all in the same industrial complex.

On the other hand, the report, while bullish on solar energy (which, together with nuclear energy, it labels as "tremendous possibilities"), finds that means of collecting it are "not yet at hand." It also is bearish on natural gas, understandably so since widespread availability of natural gas has been a more recent phenomenon and the rapid increases that had occurred by 1950 were judged unlikely to continue at that pace. Its use, the report predicts, will decline prior to the end of the century or "conceivably sooner" and prices will increase. It based that assessment on the assumption that gas could not be imported and on the fact that there was no substitute available to dampen any price rise. To offset the assumed fact that the nation's reserves of natural gas were short, the commission supported the philosophy of reducing so-called "inferior" uses, that is, basically the burning of gas under industrial boilers. Pipelines should not be built to give access to these inferior users, but should be extended to so-called "high advantage" users, that is, household and commercial consumers. In today's era of the persisting "gas bubble" and with recent repeal of the Fuel Use Act that had placed restrictions on the use of gas as a boiler fuel, this sounds like a strange doctrine, but happily the commission argued that proper pricing would in itself channel the gas to the appropriate users and that regulation would not be the way to do it. We cite this stand as only one example of a generally antiregulatory attitude, which, however, stopped short of depriving government of useful functions when private initiative has, for good and sufficient reasons, failed to operate at all or operate successfully.

As intriguing and absorbing as are the quantitative details of the commission's work, they speak primarily to the expert. They are helpful in gaining a better un-

derstanding of how ideas are formed that eventually yield numbers, the extent to which prognosticators are captives of fashion or, to the contrary, are fascinated by the not-yet-feasible. They provide a measure of the limits to which one can sense major societal upheavals, for example, the enormous increase in the female labor participation rate, or even the changes in the size of the population. But no report of this kind can or should hope to be remembered because it got its numbers "right," or more nearly so than some other study. What stamps the commission's report as having value is its stress on the economic rather than physical attributes of resources, from which follows the rejection of the "running-out" concept, and the "abstention" interpretation of conservation; of its courageous advocacy of the least cost principle in securing materials and energy, a stance that at all times finds vigorous opponents; and its judicious judgment of the respective roles of the private sector and government. These are lasting legacies that have influenced debate about resource problems ever since.

Epilogue: When published in June 1952, the summary report was available from the Government Printing Office for 25 cents. ■

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Needed: a Bureau of Environmental Statistics

Paul R. Portney

The government is very keen on amassing statistics. They collect them, add them, raise them to the nth power, take the cube root and prepare wonderful diagrams. But you must never forget that every one of these figures comes in the first instance from the village watchman, who just puts down what he damn well pleases.

—Sir Josiah Stamp (1880–1941)

NO DOUBT TRUE, Mr. Stamp, but this nation's problems with the collection, analysis, and dissemination of environmental data go far beyond those created by the whims of village watchmen. Buffeted by budget cuts, policy redirections, and congressional and administrative indifference, our understanding of environmental conditions and trends is at, or near, an all-time low. Strong measures are needed to address this situation. One such action should be the creation of a Bureau of Environmental Statistics.

There are attractive models for the new office I propose. For more than a half century now, the Bureau of Labor Statistics in the Department of Labor has collected and published data about current rates of unemployment, labor force participation, layoffs, and related matters. The Bureau of Economic Analysis in the Department of Commerce has performed a similar function for data on foreign trade (since 1921), GNP growth (since 1942), and other economic measures. And the Bureau of the Census, also a part of Commerce, has been responsible for our decennial population count since 1902. All three bureaus were created in part to ensure the independent and nonpartisan treatment of data and measures that might be politically sensitive.

By most accounts, these bureaus have been very successful undertakings. While there have been occasional cries that population, unemployment, inflation, or GNP growth statistics have been "cooked" to suit political purposes, such charges are rare exceptions. Furthermore, when proposals surface for changing the way population, national income, or unemployment or inflation rates are measured, they are scrutinized and discussed openly.

While no one would argue that our current measures of population or economic activity are exact, it is impossible to imagine modern government operating in their absence. Indeed, these measures drive important federal grant and entitlement programs; they also help trigger, and then measure the success of, major tax and spending programs, monetary policies, and even foreign policy decisions related to economics, defense, immigration, and other issues.

An environmental analogue

It is time, for many reasons, to establish a Bureau of Environmental Statistics that will give the United States much-needed measurement capability in this field. Simply put, we have not a *single* data series for the environment that goes back as far as even the most recently established of the economic and demographic series listed above, nor one that is subject to the same quality control, careful measurement protocols, or subsequent thorough analyses.

Consider, for example, the beacon light of U.S. environmental monitoring programs—our national program to collect and analyze air pollution data. To begin with, even for the so-called criteria air pollutants (ubiquitous pollutants for which the Environmental Protection Agency [EPA] sets national standards), the nationwide monitoring program is inadequate in several ways.

For instance, such data as do exist on airborne concentrations of lead—a seri-

ous threat to health—come from a "network" of only fifty-three monitoring stations intended to represent the whole country. Similarly, despite cries that ambient ozone levels be reduced, in part to alleviate agricultural crop losses, virtually no monitoring is carried out for ozone in rural areas. Instead, we "interpolate" (guess at) rural ozone levels by taking weighted averages of urban readings often obtained hundreds of miles away. And as for the national program that monitors all the toxic air pollutants causing widespread concern? It doesn't exist.

The situation is even bleaker for water quality monitoring and for measurements of pesticides and other substances in soil, on foodstuffs, and in fish, bird, and other animal populations. The same is true for data on the levels of toxic substances in human body tissues, for which a small monitoring program was just eliminated, and for measurements related to wetlands and a host of other sensitive ecosystems.

In short, we are woefully ignorant of the current state of our environment, of how that state compares with the past, and of the role that current policies may have played in accounting for the differences between past and present. To make matters worse, the data that do exist are not at all accessible to interested parties.

Present problems

One reason for this poor state of affairs is the diffusion of effort among many federal agencies. At present, important environmental data are collected by the Environmental Protection Agency, the Geological Survey (in the Department of the Interior), the Forest Service (Department of Agriculture), the National Oceanic and Atmospheric Administration (Department of Commerce), the Departments of Defense, Energy, and Health and Human Services, and even the National Aeronautics and Space Administration, which has been responsible for recent measurements of stratospheric ozone depletion.

Even if this far-flung network of data collectors were well-funded and operating smoothly, it would still be necessary to gather the relevant measures and disseminate the most important among them in a single, accessible source. An excellent model is the annual *Economic Report of the President,* prepared by the Council of Economic Advisers (CEA). To prepare the report, economic data from many federal agencies are compiled, and findings are presented in about one hundred tables, many of which show annual statistics going back to 1929. Despite quibbles about the appropriateness of certain series or about changes in measurement techniques from one year to the next, the CEA report makes it possible to assess a number of important economic measures. In so doing, it provides a benchmark against which to measure the consequences of past policies and to anticipate the effects of new ones.

Before its gradual evisceration over the past seven years, the president's Council on Environmental Quality (CEQ) would have been the logical candidate for the compilation and dissemination of environmental data. In fact, CEQ is directed to perform this function by the National Environmental Policy Act of 1969. While CEQ used to take this responsibility more seriously, even in its halcyon days it never mustered the resources to present truly comprehensive and consistent environmental data on an annual basis. Recently the Conservation Foundation has stepped bravely into the breach and attempted to provide regular data on environmental trends. But this responsibility is clearly a federal, not a private, matter.

Unfortunately, current problems with environmental measurement go far beyond the lack of a coordinating body. First, it is probable that too little is spent in the aggregate on environmental measurement and analyses. It is difficult to be more definitive because no recent effort has been made to tally such spending. A 1978 CEQ report put total spending for air and water quality monitoring at more than $300 million per year, which I believe is implausibly high. Even if correct, however, it is not large in comparison with the $70 billion to $90 billion the United States spends each year to comply with federal, state, and local environmental regulations. If we are willing to spend this much money to protect our environment, we ought to care about whether the programs we establish make it better.

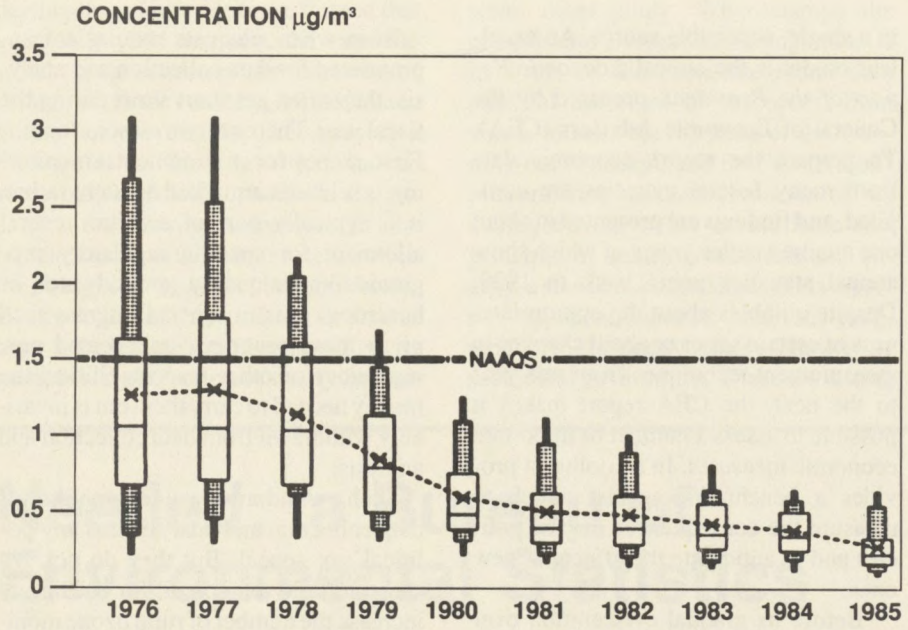
Even when adequate monies are appropriated for data collection and analysis, they often get short shrift during the fiscal year. There are two reasons for this. First, money for environmental monitoring is seldom earmarked as such; rather, it is typically part of a more general allotment for specific regulatory programs like air quality, groundwater, or hazardous waste. When Congress then gives these programs unexpected new regulatory or other responsibilities, the money needed to carry them out is invariably withdrawn from data collection and analysis.

Such a withdrawal would be unlikely if data collection and analysis had any political sex appeal. But they do not. *No* senator could reap credit for battling to increase the number of rural ozone monitors in the United States. Similarly, no congressman could benefit much from jump-starting the moribund water quality monitoring program at EPA, even though such a program is badly needed to help determine whether the hundreds of billions of dollars spent on sewage treatment plants and industrial water pollution controls are having the desired effects.

Addressing the problems

While no panacea, a Bureau of Environmental Statistics—with a separate line in the federal budget—would be much more immune to budgetary triage than are present programs. Such a bureau might even attract congressional champions who are currently unwilling to fight for separate appropriations for environmental data analysis in a handful of programs scattered around a dozen different agencies.

The creation of a strong Bureau of Environmental Statistics might also lessen the temptation to "fudge" environmental data. Although it may seem hard to believe, billion-dollar regulatory decisions can now hang on readings at a few pollution monitors. Consider, for instance, the difference it makes to a metropolitan area to be considered an "attainment" area—a region where national air quality standards are being met—rather than a "nonattainment" area under the 1970 amendments to the Clean Air Act. The deadline for meeting the standards of



Such data as do exist on airborne concentrations of lead—a serious threat to health—come from only fifty-three monitoring stations intended to represent the entire country. Chart shows trends in maximum quarterly average lead concentrations at these fifty-three sites over a ten-year period. *Source*: Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Quality and Emissions Trends Report, 1985* (Research Triangle Park, N.C., 1987).

the act was December 31, 1987, and, technically speaking, metropolitan areas that are not in conformance with these standards are now subject to hundreds of millions of dollars each year in nonattainment sanctions. Local officials in these nonattainment areas face having to notify local air pollution sources that they must install costly additional control equipment. Far more important, these areas face the threat of an EPA-ordered ban on all new construction, a ban viewed as a sort of environmental "death penalty."

If nonattainment sanctions were triggered by readings at only one or two monitors and for only a few hours per year, the temptation to shut monitors down at strategic times for maintenance or to relocate them to more "convenient" sites could be considerable. Yet these air quality data are currently collected under minimal EPA supervision by the same local governments upon which nonattainment sanctions would fall. While there is no evidence to suggest that our national air quality data have been compromised because of this, only now—with the 1987 deadline past—have these sanctions become a serious possibility. A credible, independent federal presence is badly needed to guard against this possibility. A Bureau of Environmental Statistics could be such a force.

Controversy about environmental data collection and analysis is hardly confined to the local level. Witness the recent contretemps over the 1986 annual report of the federal government's National Acid Precipitation Assessment Program (NAPAP). When the report was released in the fall of 1987, critics charged that the underlying scientific data and analysis were, at best, not adequately reflected in the executive summary or, worse yet, were irrelevant to the problem at hand. An independent Bureau of Environmental Statistics would be much better insulated from political pressure than is the interagency NAPAP task force for the job of collecting and presenting information on environmental trends.

There is another reason—more symbolic than substantive, but nevertheless important—that favors the creation of this bureau. Environmental issues matter to the public. While they generally rank below concerns about economic security, this is not always the case. In fact, in a recent public opinion survey by Cambridge Reports, Inc., 58 percent of those polled agreed with the statement, "We must sacrifice economic growth in order to preserve and protect the environment." Only 19 percent supported the opposite view. Support for the primacy of environmental protection in this hypothetical trade-off has grown steadily since 1976 when only 38 percent of those polled by the same organization agreed with the assertion quoted above. Thus, the public is intensely interested in what is happening to the environment; it deserves better answers than are now available.

Setting up shop

Several decisions must first be made if a Bureau of Environmental Statistics is to be established. The initial decision concerns its home in the federal government. In view of the success enjoyed by the Bureau of Labor Statistics and the Bureau of Economic Analysis, the best place for the proposed bureau would be within an existing agency–probably the EPA, because the EPA currently conducts, or should conduct, much of the monitoring and data analysis for which the bureau would be responsible.

However, the EPA is not the only possibility. The Interior Department would also be suitable, in view of the Geological Survey's water quality monitoring work and other department programs on wetlands, endangered species, and related issues.

Regardless of its executive branch "parent," the proposed bureau would have to be granted more independence than is generally given programs in cabinet departments. Greater independence could be achieved by ensuring that the person named as bureau director is a senior civil servant widely respected for integrity and experience in environmental measurement and management. Political appointments to this position should be avoided. In addition, the bureau chief's term of service should be six to eight years—in other words, long enough for program strength and continuity to be developed.

Another issue to be resolved before establishing a Bureau of Environmental Statistics is the scope of its activities. For instance, should it take over all of the relevant, on-going monitoring programs carried out by federal agencies? Or should it instead concentrate on coordinating these activities, taking on the primary responsibility for ensuring that the quality of the data collected is high and seeing to it that the data are disseminated in a timely and usable form?

The latter strategy makes more sense, particularly in the early years of the organization. While the bureau might eventually be vested with some data collection responsibilities—perhaps for gathering data not now collected by any other group—it would have its hands full in its start-up years with these functions:

- identifying a comprehensive and standardized set of environmental quality measures on which to report, including traditional indices of air and water quality as well as measures of wetland acreage, stratospheric ozone concentrations, and groundwater pollution;
- determining where, when, and how these measurements are to be taken;
- establishing quality assurance procedures for each data series and ensuring timely reporting by the collecting agencies to the bureau; and
- reporting this information to the public frequently, by way of annual reports and other appropriate means of communication.

A final matter to be resolved is whether the bureau should concern itself only with monitoring environmental quality or whether it should also become involved in what is known as compliance monitoring. In contrast to monitoring ambient air levels of pollution, the latter responsibility would involve the measurement or estimation of pollution emissions by cars, power plants, factories, wood stoves, sewage treatment plants, feedlots, and the multiplicity of other *sources* of pollution. Here again, the more narrow objective seems appropriate, for two reasons. First, taking responsibility for the development and coordination of a comprehensive ambient monitoring system is ambitious enough without the mission's being expanded even further. Second, compliance monitoring cannot be separated from the enforcement of our environmental laws, and the proposed bureau is not intended to be a cop.

Is the timing right?

There is some reason to believe that a proposal to create a Bureau of Environmental Statistics would not fall on deaf ears. First, Congressman James H. Scheuer (D-N.Y.) has on several occasions introduced an "Environmental Monitoring Improvement Act" to create a temporary national commission that would investigate this country's efforts to collect and publish environmental information and report on ways that these efforts might be improved. His initiatives deserve more serious consideration than they have received. They might be given more notice if his idea for a temporary commission were replaced with the proposal of an independent and permanent Bureau of Environmental Statistics.

There are other indications that the time may be right for the creation of such a bureau. First, a new president will be elected in less than a year, and both parties will have something to gain from espousing the establishment of this entity. For their part, Republicans have consistently and justifiably decried the lack of data on which to base major environmental or natural resource policy decisions. They rightfully claim that debate on a number of pending issues, such as acid rain, groundwater pollution, and stratospheric ozone depletion, suffers from a lack of adequate data. But Republicans have been singularly unwilling to *remedy* this situation by spending money to fill the information void. If they wish to be seen as credible participants in environmental debates rather than as obstructionists whose excuse is a lack of data, they have to be willing to back up their concerns with new programs to help solve the problem.

Democrats, too, have much to gain from the creation of this bureau. They are often portrayed as being too quick to legislate in the absence of hard evidence of an environmental problem. No data collection system—however complete—will ever be able to "prove" definitively that action is required. But such a system would make it easier to separate serious from less serious problems and would provide details to help tailor programs that effectively address the problems.

Make no mistake about it: any proposal entailing new federal spending will—and should—have hard sledding in future congressional debates. Nevertheless, there is growing support for spending federal money to set up a body such as this bureau. The public cares greatly about the quality of the environment and the condition of the natural resource base. A great deal of money is spent each year because of these concerns. Yet there is no comprehensive and reliable system for collecting, analyzing, and disseminating information about how these expenditures are linked to environmental quality.

This state of affairs makes little sense, and it is hard to see how one could think otherwise. The creation of a Bureau of Environmental Statistics, preferably within the EPA, would not remedy this situation overnight. But it would be a sensible and politically feasible step in the right direction. ■

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The IAEA at thirty

Lawrence Scheinman

LAST YEAR THE International Atomic Energy Agency (IAEA) celebrated its thirtieth anniversary. How should we evaluate its three decades of international public service? What should we expect in the fourth decade? These are entirely appropriate questions in their own right. But they take on added significance at a time when concerned nations are scrutinizing international organizations generally, assessing how effectively these institutions, created to facilitate international cooperation, are functioning.

In reflecting on the past, two sectors of IAEA activity stand out as meriting special attention—nuclear safeguards and nuclear safety. This does not, of course, detract from the role that the agency has played more generally in "accelerating and enlarging the contribution of atomic energy to peace, health and prosperity throughout the world," as mandated by its statute.

Indeed, the IAEA has been prominent in facilitating the transfer of experience, information, and technology to a large number of states. More than 11,000 fellows from all regions of the world have received training through agency-sponsored fellowships in nuclear and basic sciences. More than 10,000 expert assignments have been carried out, their purpose being to provide member states with expertise for the application of nuclear techniques across a broad spectrum of fields including food and agriculture, medicine, hydrology, and industry in general.

In addition, IAEA has dispensed nearly $150 million worth of equipment to advance the introduction of nuclear applications and to facilitate hands-on experience in training and application. The agency has also provided in excess of $28 million in the form of research contracts with particular emphasis on sponsoring integrated research programs involving institutes in both developing and industrial nations. It would not be too much to say that the organization of science in a number of developing nations has benefited directly from activities of the IAEA. Even so brief a reference to some of the agency's assistance and development programs underscores its role as a key multilateral organization for the peaceful use of nuclear technology.

Nuclear safeguards

This consideration notwithstanding, if one were to single out the IAEA's most distinctive international contribution, pride of place would have to be given to the safeguards system that it operates. Not only have safeguards made possible the extensive international cooperation and trade in nuclear materials and equipment that have characterized the last three decades, but as a critical element of the nonproliferation regime, international safeguards have contributed significantly to national security and international stability.

This is not a matter of cursory judgment. The parties to the Non-Proliferation Treaty (NPT), which designated the IAEA as the instrument for verifying non-nuclear-weapon-state obligations under the treaty, asserted in the Final Document of the Third NPT Review Conference (1985) that "IAEA safeguards provide assurance that states are complying with their undertakings and assist states in demonstrating this compliance. They therefore promote further confidence among states and help to strengthen their collective security. IAEA safeguards play a key role in preventing the proliferation of nuclear weapons. . . ."

Despite frequent reference to safeguards, they are not well understood by the public. The very word "safeguards" is misleading, for it evokes the "cop-on-the-corner" image in which executive authority and the ability to take preventive measures inhere. Domestic nuclear safeguards, carried out under the authority of the state, include physical security measures, pursuit, and restitution. International safeguards, however, do not. Rather they are in the nature of an auditing system in which records and reports submitted by those subject to the safeguards are examined and reviewed and in which direct physical verification of inventories is independently conducted by international civil servants carrying out on-site inspections.

These on-site inspections, which are the truly unique feature of IAEA safeguards, include a variety of destructive and nondestructive measurement techniques and the application of containment and surveillance measures, all of which help to ascertain the presence, movement, quality, quantity, and characteristics of the nuclear materials under safeguards. Safeguards constitute, in other words, verification of a state of affairs which confirm, or not, the fulfillment of obligations undertaken by parties to safeguards agreements concluded with the IAEA.

In conducting its verification activities, the IAEA is not authorized to attempt to prevent the diversion of nuclear materials or to seek out and uncover the existence of clandestine nuclear materials or facilities. In planning its inspection activities, however, the agency does make certain assumptions that take these possibilities into account.

But if this kind of approach helps the agency refine its goals and strategies for verification, it does not give it the power to conduct intelligence-gathering activities beyond those required to verify that material under safeguards can be adequately accounted for. What the agency can do is report its inability to account adequately for all material under safeguards, thereby alerting the appropriate authorities—i.e., the IAEA Board of Governors and the international community at large—that assurances cannot be provided and that the possibility of diversion and nuclear proliferation exists.

This power to expose, based on the conduct of effective and comprehensive safeguards, is one of the most important preventive assets of the IAEA.

The ability of the IAEA to be effective and to sustain credibility depends on a number of factors, three of which are especially significant: (1) comprehensiveness of coverage, (2) cooperation of states under safeguards, and (3) adequacy of resources. Of course it goes without saying that even though safeguards may contribute to developing and maintaining a climate of confidence, their effectiveness is dependent on the political atmosphere in which they function. A weak or deteriorating political-security situation (for example, in the Middle East) inevitably minimizes reliance on safeguards and diminishes their opportunity to contribute to international stability.

Ninety-five percent of all nuclear activity in non-nuclear-weapon states is under safeguards today. As impressive as this figure is, even more striking is the 5 percent not under safeguards. Unsafeguarded nuclear activities in Argentina, Brazil, India, Israel, Pakistan, and South Africa account for that 5 percent. These six principal non-nuclear-weapon-state holdouts from participation in the NPT or Tlatelolco regimes (the latter treaty established a nuclear-weapon-free zone in Latin America) are the subject of worldwide concern. For one reason or another, they have failed to bind themselves in multilateral instruments to abjure nuclear weapons or explosives and to accept comprehensive international safeguards.

While even comprehensive safeguards do not guarantee absolute assurance, the existence of unsafeguarded nuclear activities in such states creates uncertainty and places distinct limitations on the ability of an international institution like the IAEA to provide the requisite degree of verification. Thus, comprehensive safeguards in *all* non-nuclear-weapon states would be an important step in strengthening the overall effectiveness and credibility of verification safeguards. To say this is not in any way to ignore the broader issue of achieving universal nuclear disarmament and global verification.

State cooperation, another key factor in safeguards effectiveness and credibility, entails many complex considerations. At the risk of oversimplification, suffice it to say that verification is not direct control. The ability of a verifying institution to carry out its responsibilities efficiently and effectively depends on a well-structured and well-operated national accounting and control system that produces the necessary records and reports on a timely basis; it involves cooperative nuclear plant operators who help facilitate inspector access to carry out safeguards tasks; and it requires national legislative and executive measures to ensure that the application of safeguards techniques and measures and the carrying out of safeguards procedures are not impeded.

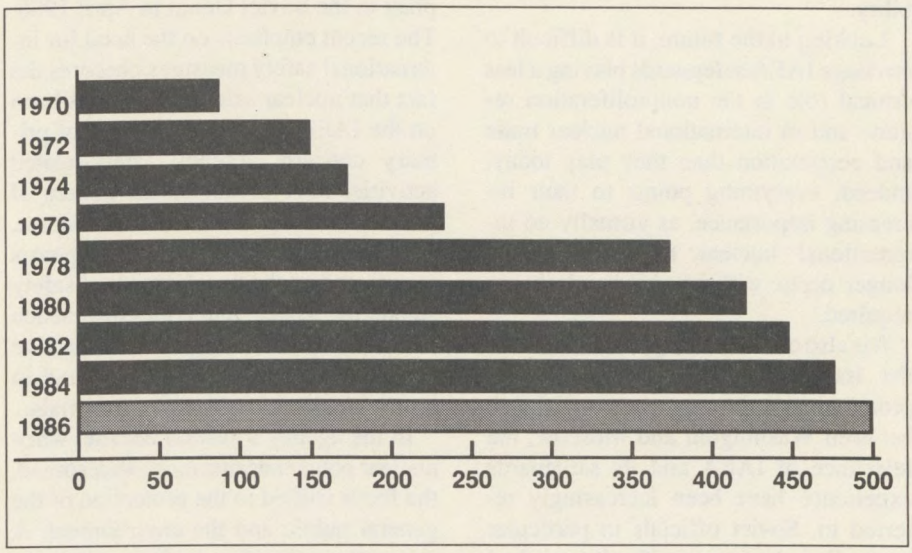
Despite a considerable degree of cooperation on the part of most states, problems do exist. In some instances, operators refuse to carry out certain requests of the inspectorate. Or, they may prevent the introduction of new instrumentation or procedures—either on the ground that the changes were not specifically provided for in the subsidiary arrangements of the safeguards agreement or because they do not want to risk, and the agency cannot assume, liability if damage occurs as a result of a proposed activity.

In other cases, some states impose restrictions on the particular agency-designated inspectors to whom they will permit access to their territory and facilities. This long-standing problem has affected the rational allocation of IAEA manpower resources and placed limits on the ability of the safeguards department to maximize efficiency—an especially serious matter in a period of financial stringency.

These problems of cooperation are perhaps not surprising in light of the fact that safeguards are a novel enterprise and do involve a degree of intrusion on national privacy. They are not overwhelming, but they are important enough to require attention and redress in the name of effective international verification.

Adequacy of resources is a third significant area. For several years, international organizations including the IAEA have labored under the constraint of zero-growth budget. At the same time, the agency's safeguards responsibilities have increased as new facilities have come on line and the amounts of nuclear material subject to safeguards have grown. In the past two years, for example, the number of installations in non-nuclear-weapon states under safeguards or containing safeguarded nuclear material has increased by twenty-five. Despite the slowdown in the growth of nuclear power, that pattern will continue for some time. Furthermore, member states exhort the agency to continue to improve the level of attainment of inspection goals, which is itself in no small measure resource-dependent.

Meeting new obligations and improving safeguards performance are incompatible with a no-growth budget. Improved efficiency can help ameliorate this problem. But beyond that, continued credibility of safeguards activities will



Growth in number of nuclear facilities under IAEA safeguards or containing safeguarded nuclear material, 1970–1986. *Source*: Redrawn from International Atomic Energy Agency, *IAEA Newsbriefs* vol. 2, no.13 (Sept. 20, 1987), p. 4.


IAEA—PFEIFER

The headquarters of the International Atomic Energy Agency (IAEA) on the banks of the Danube River in Vienna.

depend on additional resources—be they taken from other agency programs or provided through increased funding. Drawing resources away from other programs of principal interest to substantial segments of agency membership entails political problems concerning program priorities, equity, and balance of objectives. This option is not feasible. The only plausible alternative is increasing resources, which would be fully compatible with the contribution that safeguards provide to international security and stability.

Looking to the future, it is difficult to envisage IAEA safeguards playing a less critical role in the nonproliferation regime and in international nuclear trade and cooperation than they play today. Indeed, everything points to their increasing importance, as virtually no international nuclear transactions any longer occur without safeguards being required.

It is also of no small significance that as the issue of verification has gained prominence in the arms control dialogue between Washington and Moscow, the relevance of IAEA and its safeguards experience have been increasingly referred to. Soviet officials in particular have alluded to or specifically invoked IAEA experience as their country has shifted toward a more positive view on the need for effective verification of arms control agreements. This reflects the confidence that agency safeguards have earned and adds to the urgency of ensuring that this faith in the system is not only sustained but strengthened.

Nuclear safety

The role of the IAEA in nuclear safety achieved public prominence in the wake of the accident at the Chernobyl nuclear plant in the Soviet Union in April 1986. The recent emphasis on the need for international safety measures obscures the fact that nuclear safety always has been on the IAEA agenda as a matter of primary concern. Agency safety-related activities have paralleled the pattern of nuclear development in member states. During IAEA's first decade, emphasis was placed on the development of safety standards, guides, and codes of practice in the safe handling of radioactive sources, in radiation protection, and in transportation of radioactive materials.

In the agency's second decade, when nuclear power became more widespread, the focus shifted to the protection of the general public and the environment. A program to develop an internationally accepted frame of reference for safety, including codes of practice and safety guides for nuclear power plants, was initiated in 1974. In the course of eleven years, five codes covering governmental organization, siting, design, operation, and quality assurance and fifty-five supporting safety guides were prepared. While these are guidelines, not mandatory rules of the road, they are applied to all agency-assisted projects and have been incorporated in the national legislation of many countries.

The accident at the U.S. Three Mile Island (TMI) plant in 1979 led to a review and further expansion of the IAEA safety program. The Division of Safety and Environmental Protection was supplanted by a separate Division of Nuclear Safety, and a number of new activities were created. These included operational safety review teams (OSARTs), which carry out in-depth reviews of operational practices and procedures at nuclear power plants and make recommendations for improvement; radiation protection advisory teams (RAPATs), which assess radiation protection needs and provide advice on strategies for strengthening them—a service of particular value to developing nuclear nations; and the incident reporting system (IRS), which receives and disseminates information on safety-significant events occurring at nuclear facilities in participating states, thereby helping to identify and correct problems that could cause accidents.

The international developments that followed TMI were, of course, well known in the nuclear community. But they were known only slightly, if at all, by the public at large. It was the Chernobyl accident that galvanized international public concern about the safety of nuclear energy, for unlike TMI, Chernobyl involved a spectacular accident with significant quantities of radioactive debris being released (none was released at TMI) and disseminated over a wide area involving many countries; furthermore, as a result of this accident, some people died and others received substantial radiation exposure (neither of which occurred at TMI). Chernobyl underscored the irrelevance of national boundaries in nuclear accidents and, consequently, the potential vulnerability of anyone to a nuclear accident anywhere.

After Chernobyl, the focal point for international action once again was the IAEA. The agency was seen as the forum

to which the international nuclear community could turn in its effort to deal with the global implications of nuclear energy.

Exceptional progress was made in that forum. Two conventions were negotiated. One relates to early notification when there has been an uncontrolled release of radioactive material from any source that might result in transboundary effects of potential radiological significance. The other convention establishes an international framework for emergency assistance in the event of a nuclear accident. Conventions covering these matters were urged following TMI but lacked the necessary support among agency members. By contrast, it took only four weeks to negotiate both conventions after Chernobyl, and both went into effect shortly after being opened for signature.

Also following the Chernobyl accident, the IAEA's nuclear safety program was expanded, with emphasis on measures to help minimize the consequences of accidents and, more importantly, on preventive measures. In the latter regard, increased attention is being given to the incident reporting system and to a new, related program (ASSET) designed to analyze abnormal safety-related events in depth—not only the causes of the event but also the appropriateness of the corrective measures taken.

Significantly increased use is being made of the OSART service, not only by newer entrants into the field of nuclear power but by the most advanced nuclear states as well, including the Federal Republic of Germany, France, and the United States. The knowledge that human error was a critical element at both TMI and Chernobyl has focused agency attention on the question of the interface between man and machine.

Perhaps the most striking event during this period, however, was the readiness of the Soviet Union to provide detailed information about the Chernobyl accident at a post-accident review hosted by the IAEA and attended by more than 500 experts from around the world. The comprehensiveness and candor of Soviet participation in this exercise are, more than a year later, a point of frequent comment in the nuclear community. It is difficult to envision such an exchange in any other arena, which again reflects the degree of confidence that the IAEA has earned among its members. It is for this reason that safety is singled out, along with safeguards, as meriting special attention in an assessment of the IAEA's first thirty years.

In the decade to come it may be anticipated that the IAEA will continue to play a critical role in the field of nuclear safety. Mandatory international safety inspection along the lines of nuclear safeguards inspection is implausible, and the agency's nuclear safety standards are unlikely to achieve mandatory status. The responsibility for nuclear safety at this level lies first and foremost in the hands of national governments, which have the authority and the power to impose and enforce safety rules.

The IAEA, however, through its programs and its presence as a forum for dealing with nuclear safety issues, can affect what is viewed as an appropriate standard and what kinds of operational norms and measures are needed to ensure safe nuclear power. By focusing attention on issues of nuclear safety, identifying the areas most in need of attention, coordinating national nuclear safety efforts, servicing agreements such as those related to early notification and emergency assistance, and providing a framework and a forum within which states can, in confidence, harmonize safety measures and procedures, the IAEA acts as the linchpin of nuclear safety around the world. The degree to which it achieves success in these activities may bear substantially on the public acceptance—and the future—of nuclear power. With respect to both safety and safeguards, IAEA's record of achievement is an enviable one. Indeed, if the organization did not exist, it would have to be invented. ■

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Electric utilities face increased competition

Michael J. Dodman

MAJOR CHANGES WILL confront electric utilities for the rest of this decade and probably beyond. Still reeling—both on the balance sheet and on the public relations front—from the impact of cost overruns and construction delays at new power plants, utilities recently have had to begin adapting to a more competitive market in electric power generation. Within the next few years, companies which for most of the century have been generating and distributing power as "natural" monopolies under relatively benevolent state regulation may find themselves operating in an increasingly deregulated and more fully competitive marketplace.

Proposals for such an open market in electric power generation are just now starting to receive serious attention and debate among regulators and legislators. In large part, these proposals are an outgrowth of the Public Utility Regulatory Policies Act (PURPA) of 1978, which was passed in reaction to the "energy crisis" that had occurred several years earlier. The act was designed primarily to promote conservation, reduce oil imports, and encourage the use of renewable energy sources.

One of PURPA's major impacts has been the introduction of increased competition in the electric utility industry. In essence, the act has forced utilities to accept and work with designated nonutility suppliers of electricity in two respects.

First, utilities are required to accommodate selected nonutility generating facilities, which has entailed establishing transmission lines between these generators and the power grid. In addition, and more disturbing to the utilities, they are obligated to purchase any excess electric power from this group of generators at state-approved, "avoided cost" rates. In general, these rates are equivalent to the price that a utility would have to pay for providing such power, either by generating the power itself or by purchasing it from another utility.

Requirements for special status

Not all nonutility-owned electric generating facilities are accorded preferential status under PURPA's provisions. In the parlance of the act, only "qualifying facilities" (QFs) receive this and several other benefits, including tax incentives to spur their development and a guarantee that they will not be regulated as "utilities." Thus, they can operate as private-sector entities with relatively few restrictions.

Generating facilities that do not have QF status can also sell excess power to electric utilities. A major difference between this group and QFs, however, is that non-QF generators sell their power at market rates rather than at avoided-cost rates.

Under PURPA provisions, a generating plant receives QF status from the Federal Energy Regulatory Commission (FERC) only if it meets certain operating and efficiency standards. These standards were established for each of two classes of plants. Small power producers, the first class, run plants fueled primarily by renewable energy sources (e.g., wind, sun, water) or by burning such combustible products as municipal trash or waste products resulting from manufacturing or agricultural processes.

Cogenerators, the second class, are facilities designed to produce both electric and thermal power (steam or heat) for use in industrial or commercial applications. Replacing a conventional generator with one configured to capture both electric and thermal outputs can result in substantial fuel savings. Such generators are common both at large industrial plants that require substantial amounts of steam or heat for production processes and at small commercial sites such as schools and shopping malls where the steam is generally used for space heating.

A cogeneration plant must meet certain standards before it receives QF status: thermal output must equal no less than 5 percent of total energy output and, if fueled by oil or gas, the facility must meet an operating efficiency standard requiring useful energy output of these two fuels to be approximately 45 percent of their energy input.

Slow but significant reaction

Although PURPA was enacted in 1978, five years passed before FERC's guidelines for implementing its provisions were finalized, thus enabling generators to apply for and receive QF status. In any case, being forced to deal with potential unknowns was a most unwelcome change for the utilities, which for many years had obtained all their power needs from their own generators or through purchase from neighboring utilities. Furthermore, they strongly objected to the avoided-cost principle by which the rates for the purchase of QF power were set, particularly since each state was allowed to use its own method of calculating the costs that a utility avoided when purchasing QF power.

PURPA did not fully take effect until 1983 when the Supreme Court responded to legal objections from the utility industry and upheld the validity of both the act and FERC's guidelines for its implementation. Since that time, several thousand nonutility generators have obtained QF status.

In the meantime, utilities have contin-

ued to complain that states, sometimes intentionally, have set avoided costs too high, resulting in extremely high payments from utilities to QFs. In 1986, for instance, California lowered its avoided-cost rates after determining that utility customers had suffered as the result of artificially high prices for QF power; this action, in turn, attracted thousands of nonutility generators and forced some utilities to substitute power from their own, lower-cost generating plants with higher-priced QF power. In other cases, however, utilities have come to rely on QFs as a source of generating capacity that allows them to avoid building costly new generating stations.

The Edison Electric Institute (EEI), an association of the nation's major private electric utilities, conducted a survey of its members in 1986 to determine the level of nonutility electric power generation in the United States. The survey included not only QFs but also other nonutility facilities that generate power but do not meet the standards set under PURPA for QF status.

The survey findings show that nearly 95,000 gigawatt-hours (GWh)—1 GWh is equivalent to 1 million kilowatt-hours—of electricity were generated outside the U.S. electric utility industry in 1985 (see table). This figure represents 3.7 percent of the more than 2.5 million GWh generated in the country. Of the 95,000 GWh, utilities purchased over 27,000 GWh of power from nonutility sources. Initial EEI data for 1986 indicate that the amount purchased rose significantly above that purchased in 1985, suggesting progressively greater reliance by utilities on nonutility generators.

Regional variations in development of nonutility power are quite striking. Texas and California are clearly the leaders among the states, the former because of widespread development of cogeneration facilities in the petroleum refining and petrochemical industries. In fact, much of this capacity in Texas was already in existence when PURPA was enacted. California is a leader for two other reasons: broad acceptance of alternative power sources and the initial calculation of high avoided-cost rates by state regulators.

New England also has a sizable amount of nonutility production, much of which stems from the region's reliance on small hydroelectric dams and several wood-burning facilities. In each of these areas—Texas, California, and New England—between 4 and 10 percent of all power is generated outside the utility industry. By contrast, throughout the rest of the country, the figures range from less than 1 percent to 3 percent.

Perhaps the most striking figure is found in the data that the utilities provided to the North American Electric Reliability Council in 1985 on their ten-year plans. Nearly 10 percent of all planned additions to generating capacity were expected to come from nonutility sources through 1995. This figure contrasts sharply with the information that the utilities had supplied only a year or two earlier, when utilities did not state that they were planning to meet *any* future demand with nonutility sources—even though they were already obtaining approximately 2 percent of their supplies from such sources.

Changes under debate

During the spring of 1987, prompted in particular by criticism about the avoided-cost pricing mechanism, FERC began to hold hearings on the need for changes in PURPA. It was generally agreed that the commission must establish more specific guidelines regarding avoided costs, since the states now rely on a wide range of methods for calculating these costs—some methods based on rigorous economic analysis but others apparently arbitrarily fixed.

Utilities have also complained about insufficiently stringent efficiency standards set for cogenerators. Also, many utilities object to being obligated to purchase power from so-called PURPA machines: nonutility generators that produce only the minimum required thermal output and thus do little to further the intent of the law with regard to energy conservation.

Criticism of PURPA and the existing system by QFs primarily relates to the lack of a provision for the mandatory "wheeling" of their power. Wheeling customarily refers to the transfer of power from one utility to another via the transmission lines of a third utility. Currently, most utilities are willing to provide wheeling services over their transmission networks to other utilities but not to QFs. Most QFs are therefore limited to one buyer for their excess power.

Clarification is also needed on the role of nonutility generators that do not qualify either as cogenerators or as small power producers and therefore do not receive QF status. This group of facilities would clearly become a player in a deregulated and competitive market for electric power. Yet PURPA, as enacted, leaves the status of these non-QFs undefined.

In general, there is little consensus among affected groups—utilities, QFs, non-QFs, generating equipment manufacturers, regulators, and consumers—

U.S. Electricity Supply, 1985

Source	*Net generation (000 GWh)*	*% of total supply*	*Capacity (000 MW)*	*% of total supply*
Utilities	2,469.8	96.3	688.7	97.2
Nonutilities	94.9	3.7	20.1	2.8
QFs	(82.0)	(3.2)	(17.1)	(2.4)
Cogeneration	(70.4)	(2.7)	(13.4)	(1.9)
Small power	(11.6)	(0.5)	(3.7)	(0.5)
Other nonutility	(12.9)	(0.5)	(3.0)	(0.4)
Total U.S. supply	2,564.8	100.0	708.8	100.0

Notes: GWh = gigawatt-hours; MW = megawatts.Figures in parentheses indicate breakdown of nonutility generation.
Source: Edison Electric Institute.

on the impact of PURPA to date beyond the fact that the development of nonutility generators has turned out to be much greater than was anticipated. It is widely acknowledged that much more information is needed to guide modification of the existing system.

A major stumbling block in assessing PURPA's impact is the difficulty of isolating changes in the industry resulting solely from the law's enactment. This is so in part because QFs are not required to file reports on their operation or profitability.

Therefore, it is not clear how effectively PURPA has furthered its goals of energy conservation and security, whether consumer rates have been positively or negatively affected by the use of QF power (although the problems related to QF pricing in California indicate that consumers can be hurt by improperly calculated avoided costs), and whether the market for electric power is operating more efficiently as a result of increased competition from nonutility generators.

Ripple effect

What does appear certain, however, is that PURPA has produced results that go well beyond its original goals. It seems to have taken on a life of its own as a stepping-stone to what may ultimately emerge as a fully competitive electric power generation market. Some utilities, primarily those with large and costly nuclear plants soon to come on-line, appear to wish that PURPA would simply go away, while other groups, primarily those representing cogenerators' interests, are in favor of keeping PURPA as it is.

Neither of these extremes is likely to occur for three reasons. First, partly as a means of diversification, private utilities' parent companies are themselves establishing "nonutility subsidiaries" under the provision of PURPA that allows a utility to own a minority share in a QF. Of the approximately 175 major American investor-owned utilities, some 35 already have a nonregulated subsidiary formed to undertake joint QF ventures.

Second, FERC, as well as several of the larger state public utility commissions, appears to be convinced of the wisdom of a more competitive, market-based electric power industry, though not necessarily under PURPA's existing provisions. Several states have already put into effect a system whereby QFs must bid competitively to supply utilities with power, as opposed to selling their power at rates calculated by state regulators.

This emphasis on competition reflects the belief (or bias) of economists at FERC and elsewhere that only such a competitive market can efficiently and "correctly" determine electricity rates, supply, and demand. Comments during the past year from FERC officials have made it clear that while there is a definite intention to remedy some of the complaints about PURPA, these corrections will be accompanied by a decisive movement toward a more economically efficient electric power industry.

The third reason, evident throughout the past decade in the United States and other Western economies, is the trend toward deregulation of state or state-regulated enterprises. Increased deregulation has occurred when technological advances have begun to render the "natural monopoly" argument unconvincing (as in the case of long distance telecommunications) or when the regulatory scheme has proven to be grossly inefficient, as with natural gas pipelines.

Arguments for deregulating electric power generation have been made on both counts. Recent advances in technology, partly spurred by environmental considerations, have made it clear that smaller, cleaner, and cost-effective generating plants can compete with the very large scale generating stations operated by utilities.

Undoubtedly, PURPA already has introduced a dose of competition into the electric power industry. From a broader perspective, it is not yet clear just how far federal and state authorities are willing to go toward deregulating the market for electric power generation, particularly in light of the problems and confusion that many associate with the deregulation of other U.S. industries.

Before wide-ranging policy decisions on these matters can be made, FERC must decide how to deal with PURPA on two fronts: that is, how to remedy the many complaints about the act and how to reconcile PURPA's energy conservation and security objectives—for which special benefits are provided to certain generating facilities—with the current objective of a more efficient marketplace. Such efficiency would require placing all generating facilities, irrespective of ownership, size, and technology, on an even and competitive footing. ■

Before joining the Foreign Service in November 1987, Michael J. Dodman was a research assistant in RFF's Energy and Materials Division. This article is based in part on ongoing RFF research into electric power issues.

Annual Index

Nos. 87 through 90 (Spring 1987–Winter 1988)
(For previous cumulative indexes, see nos. 72, 75, 79, 82, 86.)

Inside RFF
news and publications

RFF research aired in public affairs radio series

Research carried out at Resources for the Future on patterns of food consumption in the United States and on risk management was the subject of two recent radio programs heard by thousands of listeners across the nation. RFF staff members and their guests discussed the topics on a weekly public affairs radio series called FOCUS. The series is sponsored by a consortium of four nonprofit organizations located in Washington, D.C.

Each FOCUS program features staff members from one of the four sponsoring organizations and their guests in a half-hour interview-and-discussion format. Topics span the spectrum of interests represented by RFF, the coordinating organization, and the other three members—the American Association for the Advancement of Science, the National Health Policy Forum, and the International Law Institute.

Weekly programs are produced throughout the year and are distributed through two outlets. The first is the Longhorn Radio Network that operates out of the University of Texas at Austin; the network distributes FOCUS programs to some 100 stations—mostly public radio station—across the country. Combined, these stations have an estimated 5 million listeners. The second means of distribution is via satellite from National Public Radio (NPR) in Washington, D.C., to 300 of its member stations through NPR's extended program service.

FOCUS moderators are media veterans including Cokie Roberts, Mara Liasson, and Alex Chadwick of National Public Radio and Henry Trewhitt of *U.S. News and World Report*.

The producer is Robert Montiegel, a Peabody-award-winning audio documentarian with twenty years of radio production experience. Montiegel is an NPR veteran and is also currently producing a radio program sponsored by the Woodrow Wilson International Center for Scholars.

Over the past several years, RFF has contributed FOCUS programs on fisheries, oil and energy policy, nutrition policy, climate forecasting, Antarctica, water scarcity, the Chernobyl reactor accident, the International Atomic Energy Agency, world hunger, South African minerals, agricultural and trade policy, climate change, and pesticides.

New report

Impacts of World Development on Selected Characteristics of the Atmosphere, a two-volume report by Pierre R. Crosson and Joel Darmstadter of Resources for the Future and collaborators from several other institutions, has been published by Oak Ridge National Laboratory. Crosson is a senior fellow in RFF's Renewable Resources Division, and Darmstadter is senior fellow and director of the Energy and Materials Division.

The report presents information on atmospheric emissions associated both with global development and with regional development in four selected areas: the northeastern United States, the Gangetic Basin of India, Europe (excluding the USSR), and the Amazonian Basin of Brazil.

For each of these areas, the authors assess the relationship between emissions resulting from developmental activities and selected environmental problems—photochemical smog, acid precipitation, and atmospheric corrosion. They examine emissions from energy production and combustion, industrial processes, and agricultural practices, as well as from natural processes. The report also discusses the global effect of these emissions on the depletion of stratospheric ozone.

For information about the report's availability, write or telephone Joel Darmstadter, Director, Energy and Materials Division, Resources for the Future, 1616 P Street, N.W., Washington, D.C. 20036. Telephone: (202) 328-5050.

NCFAP invites applications for resident fellowships

The National Center for Food and Agricultural Policy (NCFAP) is inviting applications for resident fellowships in food and agricultural policy during the 1988–89 academic year. Up to three fellowships will be awarded, each for a period of six to twelve months, to young professionals who wish to pursue scholarly work on current or emerging national issues related to food and agricultural policy.

The award is open to individuals in any discipline who will have completed their doctoral requirements by the beginning of the 1988–89 academic year. Individuals from universities, government, and the private sector are eligible. Professionals who will be on sabbatical leave during the fellowship period are encouraged to apply.

The deadline for receiving applications is April 4, 1988. Awards will be announced in May 1988; an earlier decision may be made in the case of an applicant interested in beginning the fellowship during the summer.

For further information and application forms, contact George E. Rossmiller, Director, National Center for Food and Agricultural Policy, Resources for the Future, 1616 P Street, N.W., Washington, D.C. 20036. Telephone: (202) 328-5117.

RFF publishes proceedings of symposium on U.S. space policy

Economics and Technology in U.S. Space Policy, the proceedings of a symposium held in June 1986 by Resources for the Future and the National Academy of Engineering, was published recently by RFF. The volume editor is RFF fellow Molly K. Macauley.

The volume is based on the premise that a better understanding of the relationship between technology and economics is necessary if the United States is to realize further technical and scientific achievements in space. It contains suggestions for improving the management of space resources and discussions of the political and economic benefits of collaboration versus competition in earth observations and space transportation. The contributors make a number of significant points that in some cases represent departures from traditional views on U.S. space policy.

Issues discussed in the volume include the following: (1) Unresolved problems of resource allocation now impede virtually every space activity, from space transportation and planning for the space station to use of the geostationary orbit. (2) The pursuit of economies of scale and scope offers the best opportunity for affordable earth observations data and the conduct of associated research. (3) Leadership in space is best viewed as a means to an end rather than as an end in itself.

Molly K. Macauley, ed. *Economics and Technology in U.S. Space Policy*. 1987. 270 pages. $16.50 paperback (includes postage).

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Harold J. Barnett, 1917–1987

No account of the events of 1987 would be complete for those who have followed the fortunes of Resources for the Future since its founding thirty-five years earlier without noting with great sadness the death early in the year of Harold J. Barnett, or Barney as he was known to his friends and colleagues. While he served on the research staff for only a few years—from 1955 to 1959—his association with RFF endured long after he had moved first to a professorship at Wayne State University and then to Washington University in St. Louis.

His signal written contribution, *Scarcity and Growth: The Economics of Natural Resource Availability*, which he coauthored with Chandler Morse, was published in 1963 and has become a classic. As then-president of RFF Joseph L. Fisher said in the book's foreword, "It is not inaccurate to say this book is a reformulation of the theories of Malthus and his immediate associates and successors in the nineteenth-century stream of English classical economics."

In the quarter century since its publication, it has steadfastly held its place as a seminal work in the resource economics literature and a place of honor in the RFF publications list even as it has stimulated a wide-ranging and sustained debate on the important issues raised in the book. Indeed, the study served as the springboard for a major RFF follow-on inquiry, *Scarcity and Growth Reconsidered*, edited by V. Kerry Smith and published in 1979.

The topic never lost interest to Barney, and during his prolonged illness he was hard at work in extending the 1963 approach to other countries. His colleagues will long remember him for the spirited stimulus he provided for their own research, for his deep interest in RFF's future path, and for his warm and enduring friendship. He has left his mark and he will be missed. *—HHL*

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