ronment is management, which has not only the *right* but the *responsibility* to seek and support competent investigation and consultation from the academic community. Indeed, they should be considered remiss (frequently the case in past years) if they do not make it possible to generate objective, unbiased data from studies of the occupational environment and health status of their workers. The polarization engendered by the thoughts expressed by Samuels will serve to accomplish exactly the opposite. Credibility of scientific data and conclusions resulting from industry-supported research or, for that matter, research supported by any other segment of society should be judged by the integrity of the investigators and by peer review of the study design, collection of data, analyses, and interpretation of results. We have always welcomed such critical review on the merits of our research, for which personal attacks based on "perceptions" are no substitute.

Although Samuels makes sweeping comments concerning how my colleagues and I are perceived by various public interest groups, the eloquent statement by J. M. Calhoon (Letters, 17 Nov., p. 694) of the Marine Engineers' Beneficial Association which follows Samuels' letter makes it clear that Samuels does not even speak for the labor movement. I suggest that he redirect his energies toward substantive activities which will promote the health of the American worker and abandon his philosophy that all scientists working in this area must be identified with one camp or the other. I also suggest that he visit our unit at Tulane in order that he might better know his "adversary"; I predict that if he came with an open mind, he would be convinced of the dedication and credibility of the scientists working in our multidisciplinary group. In any case, we will not be intimidated or discouraged from continuing our investigations, which we hope will, as before, be with the full cooperation and support of workers, management, and government research and regulatory agencies.

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Lovins' Data Source

Amory B. Lovins (Letters, 22 Sept., p. 1077) gives the impression that the "Bechtel data base" is the foundation for his arithmetic on capital costs of conventional energy technologies and, implicitly, his conclusions on the comparative economic advantages of soft energy paths. The purpose of this letter is to record my reservations about the methods employed by Lovins in his use of this data base.

Lovins refers to the Bechtel data base in 6 of the 19 citations in his letter and, in a previous reference (*1*), cited it as "probably the most detailed, authoritative, and up-to-date [data] available." Statements such as "In fact, they are Bechtel's data . . ." (referring to his assumptions on the capital costs of nuclear-electric systems) and "derived from the Bechtel data base" (regarding his assumptions for cost of 1980's U.S. frontier oil and gas) are used to authenticate his numerical analysis.

In all these citations, Lovins is referring to the data base of the Bechtel Energy Supply Planning Model (ESPM), which was developed initially by Bechtel under contract to the National Science Foundation (*2*). As codeveloper of the model and principal investigator responsible for its development since April 1975, I am familiar with the characteristics of the model and data base and with Lovins' use of the data base in his stream-of-numbers logic. In my judgment his data and conclusions bear little relation to the ESPM data base with which he purports to have started.

My principal criticisms, which I will elaborate in more detail below, are four:

- *Use*. He stretches the use of the data base for purposes which go beyond its design objectives.
- *Consistency*. He makes selective use of the data base and thereby loses consistency across technology comparisons.
- *Extrapolation*. He adds various factors not part of the data base to the basic model data.
- *Currency*. He continues to base his calculations on information published in 1975 despite the availability of extensive literature documenting updates of the ESPM since that time.

1) *Use*. The ESPM was designed to provide a tool for calculating the magnitude and timing of resources (capital, labor, materials, equipment, land, and water) required to implement alternative energy development programs. This required the development of resource data on the requirements of individual energy supply and transportation facilities. We recognized that this facility resource data base might, in addition to serving the specific needs of the ESPM for which it was designed, be useful as a starting point for other research efforts.

However, as stated in the model's

original documentation (*2*), we also recognized that the data base was inappropriate for some uses:

> If the primary purpose of a model is to optimize the technology to be used in a future energy system, data are required that state explicitly technology-cost relationships. This information, while extremely significant by itself, tends to be of secondary significance in relation to the purpose of the present study, since the emphasis is placed on obtaining information on the resources required, not on the technology best suited.

Selection of best-suited technologies is precisely the type of analysis Lovins is engaged in, but it is *not* the type of analysis for which the ESPM and its data base were developed.

2) *Consistency*. The primary strength of the ESPM and data base derives from its internal consistency, that is, the resource requirements data have been developed under common ground rules by a single organization. However, Lovins did not take full advantage of this consistency because he did not use the ESPM's cost data for solar space heating and cooling technologies (2 of the model's 98 technologies), which he considered "unreasonably high" (*3*). As these were only decentralized technologies in the data base, his integrated analysis relies on the ESPM only for centralized energy technology data, and he pulls together data from a myriad of sources (with accounting conventions different from those of the ESPM) for the various soft energy technologies he considers.

3) *Extrapolation*. The intent of the ESPM analysis is to calculate direct resource requirements in specific categories which are felt to be potential constraints to energy development, rather than to calculate total dollar costs of alternative energy futures. Our documentation (*4*) states that, "Reported dollar costs do not cover the total dollar costs of energy programs. . . . In particular, the excluded cost factors represent a major fraction of total energy costs." Lovins apparently recognized this fact and proceeded to add to the basic model data various factors that were not part of the data base. However, his resulting data are often dominated more by the factoring assumptions used than the original ESPM data base.

Lovins' treatment of capital costs for coal-electric and nuclear-electric systems in (*1*) clearly illustrates this fact. Lovins comes up with capital costs of $2476 per kilowatt delivered for coal-electric systems and $3179 to $5000 per kilowatt delivered for nuclear-electric systems. [Here he says in (*1*) that "the estimate of over $3000/Kw seems unrealistically low" and "A realistic calculation would yield a nuclear capital cost nearer . . . $5000/Kw delivered."] Contrast these figures with the original ESPM data of approximately $1100/Kw installed capacity for both coal and nuclear systems (in 1974 dollars, including transmission and distribution). The figures cited by Lovins appear to be strongly influenced by arbitrary assumptions on his part having nothing to do with the Bechtel work, and such statements as, "In fact, they are Bechtel's data" are thus extremely misleading.

4) *Currency*. While I appreciate Lovins' comment in (*1*) that "Dr. Gallagher has generously shared the results of Bechtel's update of the model's data base," the fact is that no significant update had yet occurred at the time of that writing. However, since that time 13 reports have been published which describe updates, refinements, and uses of the model and data base. None of these updates appear to have been incorporated by Lovins in his arithmetic. At least three of the published reports (*5–7*) are directly relevant to Lovins' use of the ESPM data in that they describe significant modifications of the basic data originally developed in 1974–1975. As an example, in (*6*) detailed engineering statistics are developed on the escalation in costs for 98 types of energy facilities from 1974 to 1977. Even a cursory glance at the current ESPM data base as described in these reports indicates the need for substantial reworking of Lovins' estimates.

Lovins has stated in (*1*) that "a serious question can be raised whether economic calculations are particularly relevant today." Without debating that issue, I would argue that if economic calculations are to be a component in the analysis of centralized versus decentralized energy strategies, the calculations must be based on consistent and current information.

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References

1. A. B. Lovins, "Scale, centralization, and electrification in energy systems" (paper presented at a conference on "Future Strategies for Energy Development: A Question of Scale," Oak Ridge, Tenn., October 1976).
2. M. Carasso, J. M. Gallagher, K. J. Sharma, J. R. Gayle, R. Barany, *The Energy Supply Planning Model* (final report to the National Science Foundation, Bechtel Corporation, San Francisco, August 1975, vols. 1 and 2; available from the National Technical Information Service, Springfield, Va.).
3. A. B. Lovins, personal communication, 4 October 1976.
4. J. M. Gallagher, M. Carasso, R. Barany, R. G. J. Zimmerman, "Direct requirements of capital, manpower, materials, and equipment for selected energy futures" (Bechtel Corporation, San Francisco, April 1976; available from the

National Technical Information Service, Springfield, Va.).
5. J. M. Gallagher, R. Barany, P. F. Paskert, R. G. J. Zimmerman, "Resource requirements, impacts and potential constraints associated with various energy futures" (annual report to the Energy, Research, and Development Administration, Bechtel Corporation, San Francisco, March 1977; available from the National Technical Information Service, Springfield, Va.).
6. P. F. Paskert and J. M. Gallagher, "Escalation in the costs of manpower, materials, and equipment needed for energy facilities" (Bechtel Corporation, San Francisco, October 1977; available from the National Technical Information Service, Springfield, Va.).
7. J. M. Gallagher, R. Barany, P. F. Paskert, R. G. J. Zimmerman, "Resource requirements, impacts and potential constraints associated with various energy futures" (annual report to the Department of Energy, Bechtel National, Inc., San Francisco, August 1978; available from the National Technical Information Service, Springfield, Va.)

Chemical Industry and Regulation

Philip H. Abelson's editorial, "Regulation of the chemical industry" (3 Nov., p. 473) describes problems for both the chemical industry and individual chemists and chemical engineers working in the industry. In view of the enormous quantities of chemicals manufactured and their wide distribution, these practitioners should be commended for their efficient use and disposal of chemicals to date. The uncertainty about toxic effects from chemicals in our environment, including the manufacturing facilities, suggests that the industry and chemists should not be subject to undue regulation at this time but instead should be given recognition for their effective track record. Regulation of the industry and the licensing or registration of chemists, as proposed in some states, does not appear justified except in cases where chemical use is directly related to the health of the public.

The American Institute of Chemists, through its new National Certification in Chemistry and Chemical Engineering, endorses the concept of encouraging voluntary self-development through continuing education and professional activities to offset technical obsolescence and to recognize those who make the extra effort to demonstrate their responsibilities within the profession. We believe this to be the preferred course for the profession to take in seeking solutions to the problems identified in Abelson's editorial. It may be true as pointed out in the editorial that there will be thousands of toxicologists obtaining their livelihood from the study of the toxicity of the products of the chemical laboratory. We would rather hope that this proliferation, which will be an added burden to the industry and to the consuming public who will eventually have to pay the costs, can be offset by evenhanded government policies established with the cooperation of the chemical societies. The president of the American Chemical Society, Anna Harrison, has worked extensively to fill this need and has done so with considerable success. Chemists, chemical engineers, and the chemical industry have shown responsibility for their activities in the past. I believe we can expect them to do so in the future.

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I am prompted to respond to Abelson's editorial wherein he relates the woes of the chemical industry that result from federal regulations. I take issue with the generally negative tone of the editorial and suggest that if Abelson wished to get a true feeling for the impact of federal regulation on chemical companies and the impact of chemical companies on the public, he made a basic error in visiting "six of the major industrial laboratories in the United States." To gain greater insight into the magnitude of public danger and the nearly insurmountable obstacles to efficient regulation, he should have visited some of the literally thousands of small and medium-sized chemical manufacturers which are virtually unregulated.

There seems to be a general image fostered by the industry that chemists are overworked, dedicated scientists hampered in their lifesaving research by overzealous, uninformed federal inspectors wielding unreasonable demands for quality and safety. As a manufacturer falling under the scrutiny of three federal agencies, I have yet to encounter a regulation that was not based on a sound knowledge of the field, or that imposed unreasonable demands on the manufacturer. Almost without exception, the "unreasonable" demands are those that prevent the companies from taking dangerous shortcuts.

Chemical manufacturers are profitable corporations, and they will resist any regulation that might diminish profit. If safety and accountability become the watchwords of the industry, it will only be after years of federal and public insistence have molded corporate policy and structure to ensure that safety and accountability are cost-effective.

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