Global Energy Study Under Fire

An influential study of global energy supplies, published in 1981 by the International Institute for Applied Systems Analysis (IIASA) in Vienna, has become the focus of some searching criticism. The study, whose conclusions were widely disseminated in a report entitled *Energy in a Finite World*, concluded that rapid development of all energy resources would be needed to meet growth in global energy demand over the next 50 years.

At issue is whether the study was made to appear unduly objective by emphasizing its use of computer modeling techniques in order to bolster the credibility of its findings—in particular to support its case for the rapid development of fast breeder reactors and synthetic fuel technologies.

In two related papers in the current issue of *Policy Sciences* (published in Holland), two former visiting research workers at IIASA argue that, in contrast to the impression given by several published accounts of the study, computer models in fact played a relatively small role in determining the results. The models did little more than reproduce input on energy supply and demand calculated by less formal means, the researchers argue.

Wolfe Häfele, the director of the study who is currently the managing director of the nuclear research center at Jülich in West Germany, disagrees. Such criticisms, he says, reflect a misunderstanding of the difference between forecasts and predictions. Computer modeling is a "a craft and not a science or an art" whose main contribution to the IIASA study was in forcing "the systematic organization of otherwise overwhelming amounts of data," he says.

The study concluded that even though global energy demand was likely to expand between three and four times over the next 50 years, potential energy sources and the technologies to harness them exist to satisfy this increase. It warned, however, that if the demand was to be met, the full use of all available energy technologies—including large-scale solar plants and fast breeder reactors—"will be required." Despite the claims of the "soft energy" community, small-scale solar and renewable resources would not be sufficient, the study found.

These conclusions have been widely cited in national energy studies. Equally significant for IIASA, which was founded in the early 1970's as a meeting place for scientists from East and West, the energy study has been widely quoted both to the public and the scientific community as evidence of IIASA's ability to conduct world class research.

However, according to William Keepin of the Beijer Institute of the Royal Swedish Academy of Sciences in Stockholm, although the study contributed valuable understanding to many aspects of the global energy problem—such as providing systematic studies of the global potential of fission energy sources—the quantitative analysis behind the two hypothetical scenarios presented in the report "does not support the conclusions drawn from them." These conclusions, he suggests, should therefore be described as "opinions rather than findings."

Keepin bases his claim on a technical assessment he carried out while he worked at IIASA on various aspects of the modeling techniques used in the study. In one case, he claims to be able to show that the output produced by the model can be obtained from the given inputs by means of a few simple back-of-the-envelope calculations. As a result, the computer analysis produced results that "are essentially carbon copies of various unsubstantiated assumptions and arbitrary projections that were supplied as input to the mathematical analysis."

Keepin's second charge is that the credibility of the scenario is undermined by its apparent sensitivity to minor changes in some inputs. For example, he claims that a relatively small increase in the price of nuclear energy would, according to the models, result in its virtual complete replacement by coal.

Both charges are strongly denied by Häfele. In a telephone interview with *Science* last week, he said that the first resulted from a failure to understand that a computer-based model was not meant to act as a description of the real world, but primarily as a way of organizing a mass of data by ensuring its internal coherence.

"It was used as a paintbrush," says Häfele. "The idea was to paint the outline of an overall picture in order to gain greater sensitivity in the input data." Keepin has "missed the point" by overlooking the fact that the use of mathematical modeling to produce consistent scenarios was only 25 percent of the total project, and that many qualifications whose absence he had complained of were contained in the nonmathematical part of the study.

Häfele also claims that the models are considerably less sensitive to minor perturbations than Keepin has suggested. He will make his case in detail in a response to be published in the next issue of *Policy Sciences*.

Häfele argues that Keepin's challenge is part of a "religious war" between supporters of "hard" and "soft" energy power, and that a bias against "hard" technologies such as nuclear power is even more evident in the accompanying paper by Bryan Wynne, a sociologist from the University of Lancaster in England. Wynne, who met Keepin while working at IIASA last year, claims in a companion paper that the limitations to the modeling technique have been frequently played down in public discussions of the study's results.

Häfele admits that it was "the spirit of the decade to believe in forecasts," but adds that "there is enough language in our report to preclude such judgment." Indeed, he suggests that the IIASA study was one of the first to make the distinction between scenarios dealing with various possible futures and forecasts dealing with only one.

However, Wynne notes that this distinction was not always made clear. For example, he cites the study team's own assertion that "our scenarios are globally comprehensive and allow for no escape."

Officials at IIASA's headquarters outside Vienna admit to some embarrassment at seeing a public dispute break out over one of their flagship research projects at a time when withdrawal of support from several governments—including the United States—is forcing them to look to foundations and the private sector for continued support.

However, they claim that the controversy itself can be interpreted as a sign of scientific vitality, pointing out that although they disagree with many of the conclusions in the two critical papers, they have not tried to prevent their publication.—**David Dickson**