found that the risk of lung cancer was much higher among those who left the vinyl chloride industry than among those who remained in it as evidence that "without using the terminated employees, one would tend to underestimate the risk or miss the risk."

The fracas with Maguire has left Du Pont officials miffed. "We were trying to do the right thing and we took some lumps for it," Richard E. Heckert, a senior vice president, told a recent seminar for science writers that was hosted by Du Pont in an effort, in part, to overcome the bad press Du Pont thought it was getting. "Our cancer study dates back 20 years," Heckert added. ". . . it's only by judging with 1976 standards and expectations that one finds our approach to be deficient."

Bruce W. Karrh, Du Pont's assistant medical director, notes that most of the weaknesses in Du Pont's methodology were pointed out by the company itself in its own analyses. He adds that Du Pont compiled its cancer registry for 20 years without making a big splash about it and only turned it over to the subcommittee under threat of subpoena. "Had we wanted to do a public relations snow job, we could have done it for 20 years," he says. "We feel we've acted responsibly and in good faith. We have nothing to hide. People have been very free with their criticism but no one has come back with any suggestions as to what we should do."

Perhaps the chief lesson to emerge from the fracas is that it is difficult even for a sophisticated, relatively enlightened corporation such as Du Pont to measure the health effects of exposure to chemicals in the work place. It seems clear that the failure to measure the health of workers who have left the company could, at least potentially, bias the statistics and mask a possible health problem. But it is by no means clear—either to the company, the subcommittee staff, or other observers—who, if anyone, should accept the responsibility for keeping track of those former employees. Some think the federal government should establish a master registry to follow employees as they move through various work places with varying exposures to carcinogens. But whether that is feasible or desirable is a matter that has received little sustained thought. The subcommittee may focus on the tracking problem as it delves further into the issue of occupationally caused cancers.

—PHILIP M. BOFFEY

Solar Politics: Lame-Duck Officials Initiate a Major New Study

Only months before the start of a new Administration that is expected to favor solar energy development, one of the top officials of the Energy Research and Development Administration (ERDA) has called into question the economic feasibility of direct solar electric power generation on a large scale and asked for an immediate study of the issue.

The proposed study is meeting strong criticism from proponents of solar energy on Capitol Hill and from environmental and public interest groups. The critics fear that the study may be used to keep future funding for this alternative energy source at a low level compared with that for development of coal, nuclear power, and nuclear fusion. While the 22-month-old agency has labored to create a different image from that of its predecessor, the Atomic Energy Commission, the critics see in the circumstances of the study—including the reported near-firing of one ERDA employee—evidence of a continuing organizational bias in favor of nuclear power.

The official requesting a reevaluation of solar electric power is Robert L. Hirsch, ERDA's assistant administrator in charge of the development of solar, geothermal, and nuclear fusion systems. He wants a review to determine whether the solar R & D funds, which have burgeoned from almost nothing in 1970 to $115 million in fiscal 1976, should be distributed differently among the various solar options. Hirsch tends to be pessimistic about systems that would convert sunlight directly into electricity, but more sanguine about those that would derive energy from the indirect effects of the sun, such as plant growth (or biomass), wind, and ocean temperature differences. Many of these are "technologically immature" in his view, and could be hurt by too rapid program growth. (Solar energy systems for heating and cooling are technically advanced, in his view, and do not need further review.) He particularly questions the "ultimate economics" of the two types of solar-electric systems to which most of ERDA's research money is now devoted, namely photovoltaic systems and systems that would employ fields of solar collectors to focus sunlight onto a central boiler or "power tower."

Speaking at a little-noticed public meeting on 6 October, Hirsch called for a "blue ribbon" panel to address these questions and make recommendations for the solar program. Although the request was made in October, planning for the study did not get under way until after the presidential election in November, when ERDA's general advisory committee, which had been asked to oversee the study, began looking for someone to direct it. By that time, Gerald Ford had lost the election, and Hirsch, who is one of eight presidential appointees at ERDA, found himself in the awkward position of possibly being a lame-duck administrator trying to influence solar policy for many years in the future.

Congressional and public interest groups, already suspicious of ERDA's intentions because of the agency's caution in funding solar research, apparently found out about the study from a report in an energy-trade newsletter. Representative Leo Ryan (D–Calif.), who is chairman of the energy subcommittee of the recently rejuvenated House Government Operations Committee, called the study "unnecessary and duplicative," saying that the initiation of such a study at this time "is most unwise and could hardly be more untimely." Ryan and other solar energy supporters in the Congress regard the study as a device to change the direction of solar energy development laid down by the Congress, which wants a broadly based solar program pursued with all possible speed. To that end, it appropriated $290 million in the budget for fiscal 1977, whereas ERDA only asked for $160 million. One observer on Capitol Hill characterizes the new study as an attempt to "swim uphill against the will of the Congress." Another observer notes that it is "presumptuous" for ERDA to mount a major study at this time

because "it's not their program anymore, it's Carter's."

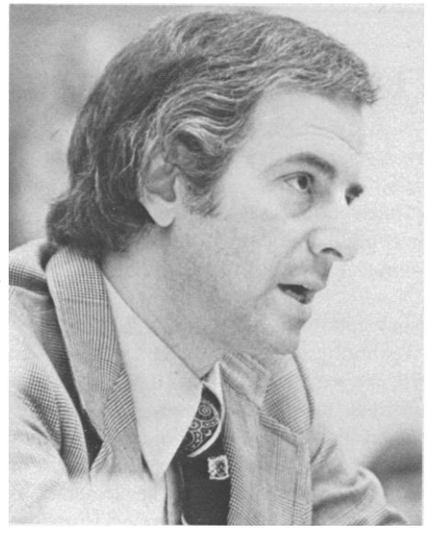
To try to head off the study, four legislators who have led the fight for solar research wrote to ERDA administrator Robert Seamans recommending that he postpone it until the new Administration takes office and ERDA can confer with Carter's energy advisers. The four, Representative James Jeffords (R–Vt.), who coordinated key solar amendments in the 94th Congress, Senator Gary Hart (D–Colo.), who is a member of the Senate Public Works Committee and represents a strong environmental constituency, Representative Richard Ottinger (D–N.Y.), on the House Science and Technology Committee, and Representative Berkeley Bedell (D–Iowa), questioned the "wisdom" of the study as well as the method of selecting a study design.

As a subcommittee chairman, Representative Ryan went one step further and asked for immediate postponement of further action on the study. Otherwise, "I am prepared to require that the whole matter be examined" at a hearing, he wrote to Seamans.

Environmental groups also reacted quickly to news of the proposed study. "The deep concern I have," Thomas Cochran of the Natural Resources Defense Council wrote to Hirsch, "is that any benefits from the technical review will be offset by the political use of the document in some quarters to cut back on the solar R & D budget, particularly photovoltaics, relative to nuclear and fusion."

Remembering that the first time solar energy was accorded a high national priority was in 1975, when ERDA gave solar-electric systems equal status with the fission breeder and fusion as long-term energy options, the environmentalists fear that a move to devalue the promise of solar electric systems could undermine the status of the entire solar program. (ERDA did not give solar heating and cooling such a high priority.) In that view, the study could have much broader implications than those suggested by ERDA's characterization of it as an intra-solar technical review. The agency is currently spending $788 million per year on the breeder, $428 million on laser and magnetic fusion programs, and $160 to $290 million on solar energy—depending on whether the figures of ERDA or the Congress are used.

Thus the breeder now appears to be the leading energy option, and solar energy and fusion seem to be in a play-off to determine which will be the challenger. The fact that Hirsch was head of the magnetic fusion program for 5 years before he became an assistant administrator last February causes some to worry that solar energy is being handicapped. "It must appear suspect in many eyes when an administrator with a fusion background thinks that the two solar systems with the nearest-term electric potential should be slowed down," says Garry DeLoss, a spokesman for Ralph Nader's Public Interest Research Group. At a minimum, DeLoss and other critics argue, Hirsch has the problem of the appearance of a conflict of interest.



Robert L. Hirsch

The environmentalists are also concerned about the procedures that will be used to choose a study director, as well as the possible connection between the study and the episode of an ERDA employee who planned an earlier solar report that turned out to be quite positive. Over a longer period of time, a number of critics think that substantial organizational changes need to be made in ERDA to ensure that solar energy can get a fair break.

The committee that will be conducting the study is the successor to the general advisory committee of the Atomic Energy Commission, which was once dominated by nuclear scientists, but the nine-member ERDA committee is now chaired by Charles Hitch, the president of the Washington-based research center Resources for the Future. The committee currently includes at least one environmentalist, Ruth Patrick of the Academy of Natural Sciences of Philadelphia, a number of academics, executives, a union official, and two scientists long connected with the agency. It does not appear to have special expertise in solar matters, but a number of "solar statesmen" will be asked to assist in that regard. The task of making an in-depth technical review was one frequently requested of the AEC committee in the 1950's, but not one routinely required of the committee in recent years.

Even though the timing of the study has turned out to be politically inopportune, the general advisory committee is "going ahead full tilt" with the study, according to the committee's executive secretary Fisher Howe. A fight over the matter with Congress and environmentalists would be "most unfortunate," says assistant administrator Hirsch, because every administrator has the responsibility to reexamine his programs.

The general advisory committee may nevertheless be hesitating. The committee originally planned to select a director for the study at its 1 December meeting in Chicago, but after the meeting Howe told *Science* that no director was yet named. The environmental and public interest groups had singled out the study-director selection procedure for particular criticism, saying that they objected "strongly to the exclusion of the public from any substantive participation in the process," in a letter to Howe signed by representatives of 13 organizations.

The procedure originally followed by the general advisory committee was to select five scientist-consultants and ask them to submit competing outlines for the manner in which the study should be carried out. They were given 2 weeks to prepare the plan, and were recompensed with a small fee, plus of course the chance of winning a larger contract for the 6-month study. The individuals selected were a fusion scientist working on the ERDA staff under Hirsch, a private consultant who had worked with Exxon, an MIT professor connected with the university's energy laboratory, the head of solar research at ERDA's Los Alamos Laboratory, and a private energy consultant who had worked under Hirsch for 1 year in the magnetic fusion program.

The environmentalists and public interest groups particularly objected that they were not given enough notice to find other candidates who would be available for the job of study director, and that two of the five candidates named by the general advisory committee had close ties to ERDA's fusion program. (The one who works under Hirsch on fusion matters was later dropped from consideration by the committee.)

When asked after the December meeting if the committee were considering additional candidates for study director or new study procedures, Howe said

that the committee is "still considering how to organize itself to deal with the project."

Many of the critics of the newly proposed study might agree that ERDA's solar program needs some reassessment. In fact, a number of solar advocates might not mourn too deeply the loss of the "power tower" concept, a huge, complex, and expensive system that does not appear to have the flexibility for decentralized applications that photovoltaics have. In a recent article in *Foreign Affairs*, a prominent advocate of nonnuclear energy futures, Amory Lovins, who is a British representative of Friends of the Earth, also criticizes the "ingenious, high technology" schemes that dominate ERDA's solar research budget but supply energy "at a scale inappropriate for most end-use needs."

While the critics might agree with some of Hirsch's technical views, the way his directorate handled a recent solar study that reflected unfavorably on nuclear power has heightened the critics' concern. The circumstance was the

Nuclear Power Economics: Report Heats Up Debate

The Council on Economic Priorities (CEP), a New York public interest group, has published a major study casting doubt on the reliability and economic advantages of nuclear power plants.

The principal finding, that the reliability of nuclear power plants declines as they increase in size, has angered utility executives and the nuclear industry. Currently, 87 percent of all new nuclear capacity planned to be added in the next decade will be made up of plants 900 megawatts and larger.

"A return to smaller unit sizes (400 to 800 Mw) could increase nuclear power's competitiveness with coal" the study concludes. And it reaches a related conclusion which will also delight the foes of new nuclear construction. "Overall, postponing commitment to new [nuclear] generating facilities, where possible, may reduce ultimate generating costs. Moreover, postponement could facilitate more reliable plant design."

Utilities with a heavy commitment to new nuclear power plants, such as Commonwealth Edison of Chicago, have called the CEP conclusions "distorted" because of a few lemons among large nuclear plants. Somewhat more mildly, the Atomic Industrial Forum (AIF) calls the CEP conclusions "premature."

The study compared the capacity factors (CF's) of 38 nuclear plants which came into operation from 1968 to 1974 and 250 coal plants which operated from 1961 to 1973. Capacity factor—the percent of time in which the plant actually operates—is a key index of the reliability of generating plants. Utilities build nuclear plants, as well as most coal-fired plants, to supply base-load power for their generating systems. Whenever a plant has to be shut down for some reason—maintenance, repairs, or refueling, for example—the utility must buy substitute power, often at much higher prices. Hence it is very important to the efficiency of the system, as well as its cost, that such plants operate as much of the time as possible.

Nuclear power plants, when proposed by utilities or the nuclear industry, have often been justified on the grounds that they will operate at CF's of 70 to 80 percent. However, the CEP study found that commercial nuclear power plants have had an average CF of 59.3 percent. Commercial coal plants have had an average CF of 66.9 percent, considered only a little better. The larger versions of both types of plant are less reliable than average. The best reliability, with CF's in the 60 to 70 percent range, have been achieved by both coal and nuclear plants of the smaller, 600-Mw type. This finding is in dramatic contrast with the arguments that the industry has sometimes made that nuclear plants will become more reliable as they become larger.

The CEP study also partially rebuts another pronuclear argument, namely, that, as nuclear power plants age (or "mature" as the industry says), their CF's will rise. Indeed, CEP found that pressurized water reactors do get more reliable with age. But boiling water reactors, CEP found, show no such improvement.

Why so many difficulties with larger scale nuclear plants? "It seems that the industry has been scaling up too rapidly," says study director Charles Komanoff, an applied mathematician. He notes that the timetables for nuclear plant construction have not permitted much learning from older, smaller plants to be fed into the construction of newer, larger ones. The CEP report recommends, on the basis of this argument and several other ones, that it may be more cost-effective, in the long run, to slow down construction and make fewer errors.

The principal line of attack on the CEP study has been the argument that the size of the sample of nuclear power plants, of only 110 unit-years of operation, is not large enough to justify such sweeping conclusions. A. David Rossin of Commonwealth Edison, for example, argues that the conclusions would be different if Komanoff had left out the Palisades 800-Mw plant and the Brown's Ferry 1100-Mw plant, both of which Rossin calls "one of a kind" in their unusually poor operating performance. Komanoff answers that if he took out two "lemons" as well as two of the reactors that have performed unusually well (only four plants have CF's above 70 percent), his charts would remain the same. As for the small-sample argument, Komanoff notes that additional data for operations in 1975 and the first part of 1976, published in the report's appendix, bear out his initial conclusions.

According to several experts, a genuine public debate, both at the national level and locally, where utilities are selecting power plant types and sizes, has been hindered by lack of data on the operating history of U.S. plants. Robert Hanfling, a deputy assistant administrator of the Federal Energy Administration (FEA), says that the collection of consistent data for so many different plants is "a major contribution" of the CEP study. In fact, FEA has bought the public interest group's data base outright. Initial FEA studies of nuclear power plant performance do not agree with the CEP conclusions. However, Hanfling says FEA will put forward some more definitive conclusions when agency spokesmen testify before the New York State Public Service Commission at hearings on the economics of coal and nuclear power early in 1977. In the meantime, he notes, utilities around the country are making half-billion and billion dollar commitments to new power plants "on the basis of very erratic information and a finite number of choices."—D.S.

Biologists Asked to Shun U.S.S.R.

An appeal on behalf of the imprisoned biologist and human rights activist Sergei Kovalev has been issued from Moscow by Academician Andrei Sakharov and 20 other signatories.

Kovalev, a physiologist of some distinction, was sentenced in December 1975 to 7 years in a strict regime labor camp for making known various violations of human rights by the Soviet state (*Science*, 5 November 1976).

The Soviet authorities in the prison camp "are trying to 'rectify' Kovalev's convictions by isolation, hunger and humiliation," Sakharov and his co-signers say in the appeal, a copy of which was sent to the Federation of American Scientists. Kovalev is being deprived of the right to receive food parcels for the first 3½ years of his sentence and is also being denied medical treatment to cure a painful chronic disease.

The Sakharov appeal asks world scientists "to make use of every opportunity for drawing public attention to the tragic fate of Sergei Kovalev" and to appeal to Soviet authorities on his behalf.

Further, the appeal asks biologists in particular "to withhold scientific contacts with the Soviet Union until Sergei Kovalev is released."—N.W.

receipt of the first draft of a study of the social and environmental aspects of solar energy prepared by the Stanford Research Institute. The minidrama the SRI study reportedly caused was played out during the same time period when the groundwork was being laid for the general advisory committee study.

The SRI Affair

Commissioned by a new ERDA employee, James W. Benson, the SRI study made some novel comparisons between solar energy and nuclear power and found that solar energy came out surprisingly favorably. The study also asked such previously ill-advised questions as what energy scenarios would lead to the best chance of survival by society.

No sooner had Benson circulated the first draft of the SRI study within ERDA's solar division, say sources familiar with the agency, than he was told that his job was in jeopardy. The SRI contract was allowed to expire and Benson was told to keep the study and all information about it to himself, the sources say.

By virtue of an interlocking consultancy, Governor Carter's staff was privileged to receive a copy of the SRI report after one of the SRI study consultants became a full-time member of Carter's issues team. Other copies of the report leaked out, and so did the word of Benson's 8-week struggle to keep his job. As the political pressures grew, it began to appear increasingly unwise to cancel the SRI study altogether, and ERDA renewed the contract. Benson was nevertheless being forced out of the solar division, insiders at ERDA say, and had to fight to hold his job at least until the election.

Other segments of ERDA are said to have felt that transfer would be a wiser solution than severance, and on 6 November, a few days after Carter became president-elect, Benson was given another job, under assistant administrator James Liverman, in a different directorate of the agency. One of the ironies of the transfer is that his new responsibilities reportedly include reviewing environmental impact statements from the solar energy program.

Some observers link the upcoming solar study directly with the too-favorable conclusions of the SRI study and the scheduled completion, next June, of a third study, being prepared for ERDA by the National Academy of Sciences. The NAS study is to examine the breeder in the context of other long-range energy sources and is also expected to solidly reflect the environmental benefits of solar energy. Certain critics suggest that ERDA is rushing to complete the general advisory committee study in the same time period in order to offset the positive effect expected from the other two studies.

According to Hirsch, the National Academy study will try to determine how the breeder fits into the world as it will look in the future, and the SRI study will try to assess the environmental effects of solar energy, but "the question we are addressing here is the micro-problem," he says. "I'm not asking about the total solar research budget, because I'm bullish on that, but I want to know what my program balance ought to be to guarantee that the reemphasis would be achieved by upward valuation only, but Hirsch says that the purpose of the study is to get the committee's advice, and he "can't prejudge the outcome."

One of the puzzles of the whole episode is why Hirsch, who is widely regarded as a highly competent and politically astute administrator, chose the time just before a close election to act on such a politically sensitive topic. He could have prepared a brief showing the need for the study and let it sit at the back of his desk until January, at which time he could have either initiated the study with Carter's backing, and thus greater impact, or left it for his successor to initiate. The answer seems to be that the potential of solar energy is a very important question, with public expectations that may be unjustifiably high, and he stubbornly insists that the question cannot be ducked. Hirsch immersed himself in solar energy reports as soon as he assumed the assistant administrator's post 10 months ago, and by summer he was saying "We have only 2½ energy options for the future," meaning solar energy has a limited potential for base-load power. Thus his estimate of solar's potential has been consistently low-key.

"From a personal viewpoint I could be committing professional suicide," he says about his insistence on a new study. "It may be that people will be out for my neck at a time when necks are going to roll anyway, so I'm out of a job. But it is my view that when a question needs to be asked, the biggest crime is to push it under the carpet."

The new Administration is expected to reorganize a number of government agencies, including ERDA, which was singled out for discussion in a preelection position paper. In that case, the first thing that solar energy advocates would like to see is a new structure with a clearly identifiable solar spokesman. "To put fusion and solar energy under the same leadership is legislatively naive," says DeLoss from the Public Interest Research Group. "When it comes to reorganization next term, we will need some intra- as well as inter-agency changes."

Along with this judgment, there seems to be a general assessment that solar energy research is not quite out of its adolescence and that ERDA has not been a properly encouraging parent. "The problem with ERDA," says one congressional aide, "is that they have a lot of nuclear guys heading the solar energy program."—WILLIAM D. METZ