RENEWABLE ENERGY GROUPS COVET FUSION'S BUDGET

A group called the Energy Efficiency Education Project (1333 H St. NW, Suite 700, Washington, DC 20005-4707; 202-682-1270), claiming to represent over 80 environmental and citizen action groups, held a press conference November 16 calling for the shifting of $1 billion in the DOE budget out of fusion, fission and fossil energy research and into "more cost-effective and environmentally sound energy-efficiency and renewable energy programs." Rep. Philip R. Sharp (D-IN) and chair of the House Subcommittee on Energy and Power, appeared at the press conference and announced he would offer a resolution in the House of Representatives endorsing the concept. (Sharp subsequently introduced the resolution, H. Con. Res. 188). Sharp said "For too long, cost-effective efficiency and renewable energy initiatives have taken a funding back seat, while other energy options have received most of the attention."

Groups listed as supporting the proposals included the National Resources Defense Council, the National Association of State Energy Officials, the Sierra Club, the Solar Energy Industries Association, the Union of Concerned Scientists, the American Biofuels Association, the American Public Power Association, the American Wind Energy Association, Friends of the Earth, Midwest (WI) Renewable Energy Association, United Methodists Board of Church and Society, as well as Wisconsin Secretary of State Doug LaFollette.

The group issued a document entitled "Sustainable Energy Budget for the U.S. Department of Energy, Fiscal Year 1995." It was similar to a plan proposed by the same group last year, which was considered and rejected by the Clinton Transition Team. However, congressional sentiment towards long-range research has deteriorated during the past year, especially in the House, and thus this plan is likely to draw considerable attention next Spring during the budget hearings process.

The plan calls for increased funding for energy efficiency ($500 M) and renewable energy ($320 M) and decreases in fusion ($300 M), fission ($700 M), and fossil energy ($480 M). On fusion, the proposal states "After nearly a half century of taxpayer funded research, fusion power has not produced any energy." It states that "Deuterium-tritium fusion energy would still create some radioactive waste (though less than fission reactors), and there is little hope that it will be affordable." It notes that "fusion receives more DOE research funding per year than solar, wind and bioenergy sources combined."

The report further states that "Critics of the U.S. fusion program, including MIT professor Lawrence Lidsky, argue that the program should be significantly scaled back and redirected." It claims that "The Electric Power Research Institute has indicated that it does not believe DOE's fusion energy program has any prospect of producing a practical electricity source."

The group calls for reducing the magnetic fusion energy budget from its current level of $348 M to a level of $50 M. It cites a bill passed in the Senate this year (See our September newsletter) which contains the statement "In the event the Secretary (of Energy) terminates the (ITER) program, there is authorized to be appropriated to the Secretary $50 M for 1994, $50 M for 1995 and $50 M for 1996 for activities relating to magnetic fusion energy." This bill, sponsored by Sen J. Bennett Johnston (D-LA), seeks to get a firm commitment from the Clinton Administration to proceed with site selection and construction of the International Thermonuclear Experimental Reactor (ITER), as a joint project of the U.S., Europe, Japan, and Russia. The bill actually authorizes a fusion budget of $425 M for 1995.

The renewable energy group's report calls for "transforming the fusion program to basic R&D on cleaner, alternative fusion processes, such as the helium-3 and deuterium reaction which does not produce dangerous neutrons and cannot be used to breed or proliferate nuclear weapon fuel."

During the confirmation hearings for Martha Krebs before the Senate Energy Committee, which Johnston chairs, Johnston, a staunch nuclear fission power advocate, warned Krebs to avoid what he called "cheerleader research" conducted during the Carter administration on some renewable energy technologies. Johnston cited President Carter's placing a solar water heater on the roof of the White House as "not serious science," and said he objects to geothermal energy as "too expensive." Johnston also called, during the hearing, for President Clinton to get "personally involved" in the negotiations with other countries to get a commitment to construct ITER. He said "If you are not going to build ITER, you might as well forget the hundreds

of millions of dollars that you will spend otherwise on fusion energy."

DOE DECLASSIFIES SOME INERTIAL FUSION DATA

Finally completing a declassification review that took over three years (see our October 1990, July 1992, January 1993, and November 1993 newsletters), the DOE announced on December 7 that it was declassifying most aspects of the design of the small fusion fuel pellets that are used in conjunction with high power laser and ion beams to study inertial confinement fusion. The U.S. has previously refused to publicly disclose the dimensions and other detailed physical characteristics of the pellets used in the research, although in most cases it has published the results of the experiments. Japanese researchers have published the details of their pellet designs for years, but U.S. researchers have not been allowed to discuss this aspect of the research with scientists from other countries (or with U.S. scientists not holding special DOE clearances).

DOE did not declassify any aspects of a series of inertial confinement fusion pellet irradiation experiments which it conducted during the 1980's using radiation from underground nuclear test explosions. (See our April 1988 newsletter and New York Times front page story by William Broad, March 21, 1988). It also did not declassify the LASNEX computer code, used by U.S. scientists to design experiments and to compare experimental data with theory.

A DOE spokesperson called the inertial fusion declassification process "the most contentious and resource-consuming classification issue since the program began in the 1960's." It is widely known that DOE classification officials have been willing for years to relax restrictions on inertial fusion pellet design, but that officials in the nuclear weapons non-proliferation office at the State Department have resisted declassification. For the past year, declassification has been bottlenecked by a staffer at the National Security Council (See our January 1993 newsletter).

Scientists at the DOE laboratories are elated by the declassification actions, since the past restrictive policy has resulted in many awkward experiences at international conferences and a tempering of the scientific stimuli that comes from open exchange of scientific data and ideas. There have also been several instances where DOE has forbidden U.S. scientists from attending international conferences.

At the December 7 press conference, DOE claimed that until now 70% of inertial fusion research was classified and that now only 20% remains classified because it is "related to weapons research." FPA president Steve Dean called the 70% number a "gross exaggeration" and the amount of declassification an "overestimate."

Commenting on the DOE security clearance system during a recent speech in Bethesda, MD, sponsored by the Public Employees for Environmental Responsibility, Energy Secretary Hazel O'Leary said "Those terrible cards that hang around people's necks reflect a secrecy hierarchy and a system of first, second and third class citizenship." She pledged to change the system, saying "I am committed to providing openness."

1994 MEETINGS

March 14-16 International Sherwood Fusion Theory Conference. Dallas, TX. Contact Saralyn Stewart, fax (512)471-6715.

April 6-8 Seventh Boulder International RF Workshop. Topic: RF Current Drive and Profile Control for Advanced Tokamaks. Boulder, CO. Contact Lodestar Research Corporation, fax (303)449-3865; e-mail dasd@csn.org

June 5-8 Canadian Nuclear Society Annual Conference. Montreal, CA. Contact Mr. H.M. Huynh, Hydro-Quebec, fax (514)344-1538.

June 19-23 Eleventh Topical Meeting on the Technology of Fusion Energy (American Nuclear Society). New Orleans. Contact John Gilligan, fax (919) 515-5115 or Wayne Houlberg, fax (615)576-7926.

June 20-24 Tenth International Conference on High Power Particle Beams. San Diego. Contact Amanda Ness, fax (619)576-7659.

June 27-Jul 1 Third International Symposium on Fusion Nuclear Technology. UCLA, Los Angeles. Contact Mark Tillack fax (310)825-2599; e-mail MST@fusion.ucla.edu

Fusion Fueling Technology May Lead To New Metal Surface Treatment

Martin Marietta Energy Systems Inc. has signed agreements with two companies seeking to adapt a fusion fueling technology to removing paint and surface radioactive contamination.

Under the non-exclusive agreements, Cryogenic Applications Inc., Clinton, Tenn., and Alpheus Cleaning Technologies Corp., Rancho Cucamonga, Calif., will improve and market the cryoblasting cleaning technology developed by scientists from the Fusion Energy Division (FED) at the Department of Energy's (DOE) Oak Ridge National Laboratory, Oak Ridge, Tenn.

In cryoblasting, a centrifugal accelerator propels pellets of frozen carbon dioxide or argon against the surface to be cleaned.

The accelerator was originally developed by Christopher Foster and Paul Fisher from FED to fire pellets of frozen tritium or deuterium into hydrogen plasmas to refuel fusion devices.

Foster and Fisher are conducting a project for the U.S. Air Force at the Warner Robins Air Logistics Center at Robins Air Force Base in Georgia. As part of the Robins project, they are developing a robot-compatible cryoblaster for stripping paint from military aircraft so metal parts can be inspected for cracks and corrosion.

They hope to demonstrate to the Air Force that their cryoblasting process for stripping paint from aircraft is faster, more efficient and cleaner than conventional techniques.

The usual procedure for removing aircraft paint involves bathing the plane in methylene chloride. However, the Environmental Protection Agency is discouraging the use of methylene chloride because it can contaminate ground water.

A paint-stripping technology that uses compressed air to propel dry ice pellets is on the market, "but our technology strips paint at a higher rate," Foster said.

Cryoblasting also may replace sandblasting because it does not leave a sand-contaminated waste stream in applications such as removal of surface radioactive contamination.

At DOE's Y-12 Plant, also in Oak Ridge, Tenn., researchers are developing argon cryoblasting as a replacement for iron-bead blasting to remove oxides from metal surfaces. Because it is inert, argon will not react with reactive metals. Unlike iron beads, the argon pellets evaporate into air and do not add to the solid waste stream.

Conservative Analyst Blasts Both Fusion and Renewables

Renewable energy has been a boondoggle, but fusion has been an even bigger boondoggle, argues energy analyst Michael McKenna in *Policy Review*, the quarterly journal of the Heritage Foundation, a conservative think-tank based in Washington, D.C.

Fusion-bashing has become popular recently with some segments of the environmental community who see fusion's loss as a gain for solar and other renewable energy technologies (**FPR**, December 1993, p. 119). Now it seems that the right has weighed in with the argument that both are a waste of government money.

McKenna, in his article "Power Failure" sees an energy future in which there is greater use of imported oil; more attendant efficiency in its use; a greater dependence on natural gas; and less dependence on coal, nuclear or renewable energy.

Like his opponents on the left, McKenna repeats that, after 40 years and billions of dollars, fusion "has never produced a single watt of electricity."

"Then-Secretary of Energy James Watkins, who worked on the program in the 1950s, recommended in 1991 that it be pared back. Despite this recommendation, funding has increased from $287 million in FY '91 to $337 million in FY '92," McKenna argues.

The "party line since the 1950s" has been that ignition is just a few years away — but it never happens." McKenna dismissed recent deuterium-tritium experiments at Princeton as "really a demonstration of how far away we are from nuclear fusion. The experiment consumed more than four times the amount of energy that it produced."

He concludes that "Fortunately, the grand viziers of the fusion program have provided taxpayers with a schedule of when we might expect to see results from our investment. In the DOE's *National Energy Strategy*, it is noted that a commercial fusion plant may be on-line, with a little luck, as early as 2040. At that rate, we will need to spend about another $30 billion before we see any harnessed energy."

Contact: The Heritage Foundation, 214 Massachusetts Ave., NE, Washington, DC 20002-4999, (202) 546-4400.

Counterpoint

Fusion diverts valuable resources

I wonder how many ANS members would join me in pointing out that the emperor has no clothes? The "emperor" in this case is the fusion reactor. A disgraceful amount of taxpayers' money has and is being spent on this welfare program for plasma physicists, Department of Energy bureaucrats, and university faculty. We are now well into the second generation of people "working" on fusion and it has taken on a life of its own. These people travel the world, attending meetings where they try desperately to find something optimistic to put into a press release so that future funding will be forthcoming.

Recently I plotted the estimated number of years to commercialization against the year in which the estimate was made. I started with the first estimate I heard in school (ORSORT '53). It was estimated that the problems with the "Stellerator" (as it was then known) could be ironed out in a few years so that a commercial reactor could be on line in about 20 years. There was considerable urgency to the development of a fusion reactor because, at that time, electrical power demand was doubling every 10 years, and it was clear that there was not enough low-cost uranium to meet the demand. In 1953, the cost of generating electricity in a fission reactor was estimated to be 0.7 cents/KWh at the station bus, and about half of that was fuel cost. So when the physicists announced that a fusion reactor was feasible and would burn deuterium at essentially zero fuel cost and with an inexhaustible supply (the oceans were FULL of it!), there was much rejoicing.

Since that time, of course, most of the original bases for pursuing fusion power have evaporated. Proponents of fusion reactors now seek justification on the grounds that fusion reactors, if they were to actually work, would be safer and produce less radioactive waste than fission reactors. This implies, of course, that we cannot make a safe fission reactor and that we cannot adequately deal with the waste. Nonsense, of course, but that is what our fusion colleagues are telling their supporters. Since they have never produced a detailed design of a commercial fusion reactor, they can be less than candid about their plans for the removal and disposal of the extremely expensive and radioactive "first wall" whose life will probably be measured in weeks. Since they have given up on the D-D reaction and are now focusing on the D-T reaction, we can expect some heavy-duty tritium containment problems as well. But all of this is academic since it assumes that a commercial reactor will be built and operated.

In an article published in the April 1992 issue of *Scientific American*, authors B. W. Conn et al. state that the $7.5-billion ITER, scheduled for completion in 2005 and for 15 years of operation, might demonstrate the technology needed to build a commercial reactor. In other words, in 2020 we might begin the design and construction of a 1000-MWe plant to be on line in, say, 2030, or about

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Fusion's potential justifies research

I agree with many of the points Mr. Dusbabek raises. The tokamak, the lead approach to magnetic fusion energy, has emerged as the main candidate for an electrical power plant. Its R&D costs have grown, and, with the shrinking fusion budget (over a factor of two in the last 15 years), it has nearly crowded out alternative approaches to fusion energy. This lack of breadth of concepts, as opposed to focusing on one concept, is troubling. It is especially troubling in view of the opinion of many people both in and out of the program who believe the tokamak will not result in a good power plant in the sense of a combination of being practical, safe, environmentally clean, and economical. We arrived where we are today because the tokamak is working far better in the laboratory than any other fusion concept—that is why it has grown to its position of dominance—but the next step is predicted to be very costly, just under $10 billion. I am in favor of the next step, called the International Thermonuclear Experimental Reactor (ITER), because it advances toward a fusion power plant by igniting and burning tritium. Much will be learned and, being international, the costs will be shared.

Mr. Dusbabek raises the point of feasibility of operating superconducting magnets at ultra-low temperatures near such a hot plasma. I would point out that more than a meter of space is provided for thermal and radiation shielding, and the state of the art of superconducting technology is, by now, quite advanced. The superconducting magnet seems costly but feasible. While the tokamak is pulsed, there are ideas, not fully tested, to drive it steadily with RF power or beams, albeit at a high cost. Other magnetic fusion concepts, notably the Stellerator, are steady state.

There are still other approaches to magnetic fusion, many of which have gone through cycles of birth, growth, evolution, death, and rebirth with new twists and new technology. This search for better concepts, judged by better

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Counterpoint

Fusion diverts...

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40 years. Therefore, the time to complete is doubling every 40 years. This means that in the year 2030, completion will be forecast to be 2110!

Why do I assume that the time to commercial fusion energy will continue to increase as it has in the past? Well, for one thing, the physics of the D-T plasma operating at necessary conditions for commercial reactors is not completely understood and, if the past is any guidance, some unexpected behavior will occur which will require an ITER-2 to study. More important, however, is the fact that the ITER is designed to demonstrate only 5 percent of the energy deposited at the first wall that will exist in a commercial reactor. I doubt that anyone will commit upwards of $10 billion to the design and construction of a first-of-its-kind plant whose most critical technology rests on a scaleup factor of 20!

Consider what is asked of the barrier around the fusion chamber. It must first separate the fusion chamber operating at a temperature higher than the surface of the sun from the superconducting magnets operating at near absolute zero. It must then absorb and remove an energy flux consisting primarily of fast neutrons equivalent to about 3000 MW delivered in pulses since a fusion reactor using magnetic containment cannot operate at steady state. While performing all of this, the wall must also serve as the production site for tritium and a tritium removal system. And, finally, the inner, or "first" wall, must be designed to be removed and replaced using remote handling devices! The wall must be extremely compact and of a very complex geometry because of the toroidal shape required of the magnetic fields.

I say that we in the American Nuclear Society should disassociate ourselves from the fusion energy folks whose very existence rests on the premise that there is no future for fission power reactors. Furthermore, the fusion program offers a refuge for those politicians who won't support nuclear power, but who can point to their support of the fusion program as evidence of their understanding of the long-range global energy picture.

It is obvious that the people directing the fusion energy program are incapable of an objective assessment of its true status. Furthermore, they would reject any assessment made by anyone not in the program as being not knowledgeable.

Why not put the proposal to remove the fusion division from ANS to a vote of the members? Surely it warrants a discussion at least.

— Mark Dusbabek, ANS Charter Member

Fusion's potential...

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power plant embodiments, should be maintained and enhanced. Some of these concepts employ a liquid wall and blanket with no solid first wall at all, avoiding the serious problem pointed out by Mr. Dusbabek. This search for new concepts and maintenance of breadth of concepts has been sacrificed in the magnetic fusion research program. The decision to build a large superconducting non-tritium-burning tokamak at Princeton is a major reason the alternative fusion concepts are being severely squeezed.

The major alternative to the tokamak is inertial fusion (funded almost exclusively by the defense program in DOE in the past) with lasers or ion beams used to produce microexplosions. These concepts appear quite promising—for example, the heavy-ion approach. The energy program funding of this alternative, however, has been cut by a factor of two due to the growing commitments to the tokamak approach, and to the decision not to maintain breadth of concepts as a principle irrespective of funding level.

Fission power has proven to be practical, safe, environmentally clean, and economical with only a limited number of exceptions. There are even safer versions in the works. In my opinion, work on these should not slow down, but just the opposite: it should go forward. Mr. Dusbabek is correct in saying many fusion advocates and fission foes use fusion's promise for their own purposes.

The reasons to pursue fusion research vigorously are its potential in the long term for a truly large fuel supply; its inherent lack of an energy source to drive a massive accident; its activation of materials, which—being up to the designer—can in principle be very low; and, finally, its potential for economical power production. Since the potential is so great, we should not focus too exclusively on one concept, which does not appear to exhibit enough of the good features mentioned above, but rather we should maintain a healthy breadth of concepts.

The role of ANS is not to advocate or condemn any particular line of nuclear energy research, but rather to provide a forum for the discussion of the issues involved. The Fusion Energy Division is helping by providing a forum for that discussion, and opinions like Mr. Dusbabek's are highly valued. The role of government funding agencies is to make funding decisions based on judgments of the merits of various concepts partly coming out of these discussions. Drumming the Fusion Energy Division out of ANS would not promote that ongoing discussion, while answering questions like those raised by Mr. Dusbabek would.

—Ralph Moir, 1993–94 Chair, Fusion Energy Division