Nuclear Energy Research (Focusing on the NERI and NEPO Projects)

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Issue Definition

This paper examines the current state of nuclear energy research and development conducted by the Department of Energy (DOE) with the Nuclear Energy Research Initiative (NERI) and Nuclear Energy Plant Optimization (NEPO) projects. Both the programs themselves and the policy initiatives started by the two programs are investigated. Possible changes to both the policy and the structure of the programs are discussed along with the steps to create a grass-roots effort, which is needed to be taken to assure that the program is approved and that funds are appropriated in upcoming years.

This paper's findings may answer some questions about the NERI and NEPO projects. Members of the research community will want to know what constitutes a quality proposal that will help them receive funding. The nuclear industry will want to know what the future holds for it in the long run with the NERI program, and how its current facilities can be improved in the short term with the NEPO project. The average taxpayer may want to know where his or her money is going and the reasons this program is important. Members of Congress will want to know why they should appropriate money for this program.

Energy can be called the life-blood of any economy. In fact, there is a direct correlation between the standard of living in a country and its supply of energy. An affordable and dependable source of energy is essential for an economy to be competitive. Approximately 20 percent of electrical energy production in the United States currently is

generated from nuclear power. Running a nuclear power plant is among the most economical forms of electrical production. Using nuclear, electricity is often generated at a price that is competitive with coal fired generation. This production of electricity is also accomplished without the release of greenhouse gases that pollute the atmosphere and may cause global warming. This energy source does not depend on scarce, limited natural resource, such as oil and natural gas. Further, unlike solar energy, it can run twenty-four hours a day, be placed near cities that have smog blocking much sunlight, and does not entail the environmental consequences of covering large amounts of land with solar panels.

Nuclear energy does, however, have its drawbacks. With the possible use of the atom as a powerful weapon, some people fear a nuclear power plant exploding with the same force. This concern is unfounded, since nuclear power plants do not have the same structure as a weapon and cannot explode in the same way. However, since the fuel does contain some of the same material as a nuclear weapon, a related concern is prevention of proliferation, i.e. making sure the materials do not fall into the wrong hands. Nuclear waste is another problem associated with nuclear energy. Many in the nuclear industry view this more as a political problem than a technical problem. The main dilemma is that many support the current solution of a deep geological repository but do not want the waste buried "in their backyard." Economics is another problem nuclear has to face. The capital costs to build a nuclear power plant are high. Although in the long run, the initial costs are balanced by the lower production cost of electricity, they are high enough to frighten many investors away. Utilities also may not be able to balance the initial costs of a plant to cover their investments in a deregulated environment.

Without research in nuclear energy, the initial capital costs of a power plant, proliferation issues, and nuclear waste may ultimately result in phasing out the use of nuclear power in the future. Nuclear plants are, in general, licensed for forty years and many plants will be nearing the end of the cycle within the next 10-15 years. Research has to be performed to ensure that safety, proliferation, economic, and waste concerns are addressed in the next generation of nuclear reactors. New and innovative solutions to these problems can help nuclear power be a major supplier of electrical energy well into the twenty-first century.

Background

History:

In January 1997, the President's Committee of Advisors on Science and Technology (PCAST) was requested by President Clinton to evaluate the United States' research and development (R&D) programs involving all forms of energy. One of the findings of the committee was that nuclear energy was a viable solution to the energy and environmental needs of the future, and the committee recommended that the DOE implement a comprehensive R&D program to address technological obstacles in nuclear energy. PCAST said, "R&D (research and development) is needed to solve the problems associated with nuclear-waste storage and disposal, proliferation, operational safety, and plant economics ." PCAST recommended that NERI and NEPO be created to meet these goals. It recommended that a budget of 50 million dollars be appropriated for the initial year, rising to 103 million by 2003 for the NERI program, and that 10 million dollars be the yearly investment for the NEPO program.

For nuclear R&D, President Clinton requested 24 million dollars for NERI and 10 million for NEPO in FY 1999. Although Congress did not fund the NEPO project, it did agree to fund the NERI project. On May 7, 1999 the DOE funded approximately 19 million dollars of research through NERI. A total of 308 proposals were received and 46 different organizations are participating in the award, which have been distributed in FY 1999, as either the lead or collaborating organization. The recipient organizations of the award spanned academia, national research laboratories, and industry. The main issues addressed in the awards were nuclear proliferation, basic nuclear science, advanced reactor design, advanced nuclear fuels, and nuclear waste disposal.

Unlike other nuclear R&D programs sponsored by the DOE, the selection process for programs is based on peer review and competitiveness, and the research proposals are researcher initiated. The independent peer technical review system follows Title 10 of the Code of Federal Regulations, Part 600 (10CFR 600.) Three reviewers from organizations independent of those submitting the proposal reviewed each proposal. The experts represent research institutions, academia, and industry. However, there are more university professors than others because in the past, they have been the least bias. These experts rank the proposal based on innovation, scientific merit, and reasonability of budget from 1 (low) to 10 (high). The reviewers describe the proposal to a panel of 10 people experts in the subject matter of the proposal. A grade of A (most favorable) indicates a program that they feel must be funded; B (average to meritorious) denotes a proposal that should be funded, and C (unsatisfactory) designates a program should not be funded. The scores then go to the Office of Nuclear Energy, Science, and Technology (ONEST) in the DOE to assure that the proposals follow the DOE's policy initiatives, and to confirm the

proposal is consistent with NERI goals. ONEST then makes recommendations to Dr. William Magwood, head ONEST, who makes the final decision based on whether or not the project is consistent with the DOE's policy directives. In general, the final decisions were very close to the peer reviewers' recommendations. For example, of the 45 research proposals that received the award, 42 were given a ranking of A.

The awards were made by the DOE's ONEST with guidance from the Nuclear Energy Research Advisory Committee (NERAC). NERAC's role was to ensure the DOE successfully advances nuclear technology in the NERI program. The members of NERAC represented many different perspectives and research backgrounds.

Funding

The NERI project follows a financial low in nuclear research funding. In 1998, Congress ended the liquid metal and gas cooled reactor programs while the Advanced Light Water Reactor project was completed. The DOE did not fund any further nuclear energy research and development. Figure 1 shows the DOE's nuclear energy R&D

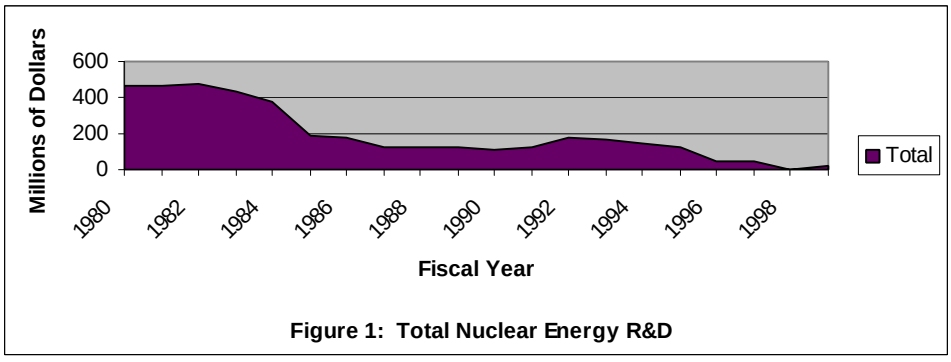

Figure 1: Total Nuclear Energy R&D

investment since FY1980. For its initial fiscal year, NERI received 19 million dollars, and the DOE has requested 25 million dollars for the FY 2000, which is far short of PCAST's recommendation of 70 million dollars for that year. A majority of the FY 2000 funding

goes to continue to the initial NERI projects, while the rest will be used for new research. The Senate has approved the budget request for FY 2000; however the House of Representatives approved the NERI project for only 20 million dollars, allowing very little money for new NERI projects. Both the House and the Senate approved the NEPO project for 5 million dollars for the 2000 fiscal year. The final appropriations bill should be in both houses of Congress in September.

The goal of the NERI project is to tackle the main problems with the expansion of nuclear energy; namely, the PCAST findings, which were economics, proliferation, and nuclear waste. NERI is to find new and innovative solutions to these problems so that they can be implemented to help the United States' energy needs in the long run. DOE hopes that NERI can be a birthplace of new ideas, and that programs show promise of future energy possibilities and can one day be full programs of the DOE.

One of the strengths of the NERI project is the collaboration among universities, industry, and national laboratories. A total of 21 universities, 8 national laboratories, 16 industrial organizations, and a governmental research and development agency were

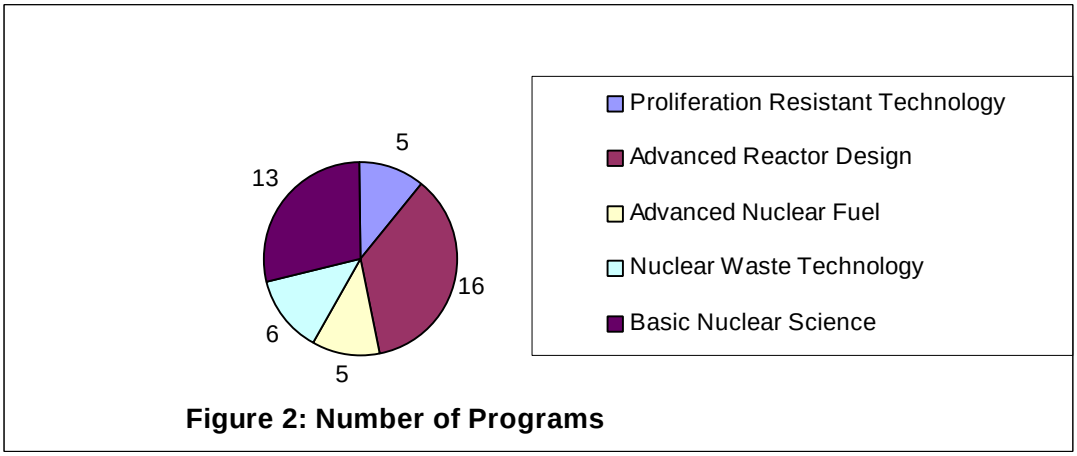

Figure 2: Number of Programs

involved. NERI also involved collaboration at the international level with the involvement of 4 universities, 5 members of industry, and a governmental research and development organization outside the United States' borders. The amount of money and number of projects in nuclear proliferation, basic nuclear science, advanced reactor design, advanced nuclear fuels, and nuclear waste disposal were based on the number of proposals in each category. Figure 2 shows the distribution number of awards for each area. Figure 3 shows the proposed initial funding for each area.

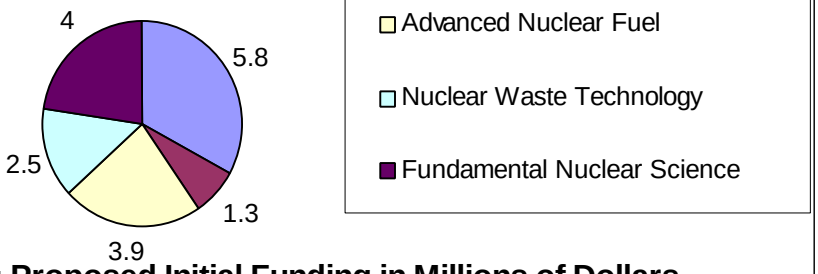

Figure 3: Proposed Initial Funding in Millions of Dollars

Key Concerns with NERI:

With the initiation of a new research program, one worry is how to distribute the limited funds the best possible way. ONEST created a workshop that was held April 23 and 24, 1998, at the American Association for the Advancement of Science in Washington, DC. ONEST stated, "The purpose of the workshop was to assist the DOE in developing the direction for nuclear energy research and development for the next

decade." Over 120 people attended of the conference, spanning industry, academia, international research agencies, and government agencies.

The workshop began with speakers who spoke on such topics as "The Importance of a Federal Nuclear Energy R&D Program," "Lessons Learned from the Fusion Program Restructuring," and "Congressional Perspective on Nuclear R&D." Later in the day the members broke into many working groups to better explore topics and identify the key concerns that the NERI program was attempting to solve. The groups were:

- Working Group 1: Proliferation-Resistant Reactors and Fuel Technology
- Working Group 2: New Reactor Designs with Higher Efficiency, Lower Cost
- Working Group 3: Lower-Output Reactors
- Working Group 4: New Technologies for On-Site and Surface Storage and Permanent Disposal of Nuclear Waste
- Working Group 5: High Efficiency Nuclear Fuel (ultra-high burnup)

After spending a majority of their time and expertise in the working groups, the attendees presented their findings for a guiding policy on the second day. This was followed by a round table discussion with the committee and panel chairs. The meeting was adjourned after a discussion about the required next steps for the program.

Another concern with the program was the finding new and innovative solutions instead of repeating research that was done in the past. Professor Sekazi K. Mtingwa, Professor of Physics at Morgan State University and a member of NERAC, stated, "My hope (and I think that of most of the other NERAC members) is that the NERI program will foster new and interesting approaches to solving a myriad of problems involved with nuclear power generation. Just reviving old research ideas was not the goal." To prevent this, the historical knowledge of retired engineers and scientists a the major resource.

Policy Alternatives

Several Policy Alternatives are explored here for the NERI and NEPO programs. They are examined in terms of effectiveness, efficiency, equity, flexibility, and implementability. Additional comments are added at the end of each policy alternative, if necessary. For the remainder of the paper, I am assuming that NEPO will be funded at a level of 5 million dollars, will have a workshop much like the NERI workshop, and will be based on researcher-initiated proposals, like NERI.

Policy Alternative #1

The federal government could refuse to appropriate money for the NERI and NEPO programs. This would stop most of the government sponsored nuclear energy R&D in the DOE. This would appease many anti-nuclear groups. However, it would also result in wasting much of the money that was spent on the NERI project in FY1999 by not allowing the research to be completed.

Effectiveness: This alternative would be a short term solution to budgetary problems; however, this will not help address any of the United States' energy needs in the future. It will also not help the environment by supporting an energy source that is free of greenhouse gases. It will not solve the current problems that concern many Americans such as nuclear waste disposal and transportation.

Efficiency: The removal of funds from NERI does not guarantee that the funds will be used efficiently elsewhere. This decision would be reversible in the future, but many of the

current NERI projects would most likely have to start from scratch, since most of the current projects would not survive the discontinuity in funding. One of the many people currently involved with a NERI project, Dr. Thomas Downar a professor at Purdue University, states, "My primary concern for the program is its continuity. Sometimes it's difficult to sustain government programs more than one year. Research requires at least 3 year time horizons and it's important for this program to make that commitment(sic)."

Equity: In the short term, the taxpayer may benefit from this policy, which could save the taxpayer 125 million dollars over the next four or five years. However in the long term, the environmental and economic impact of an energy portfolio without nuclear is not known. Many people, such as Senator Bayh (D-IN) who is a member of the Energy and Natural Resources Committee, believe that a diverse energy portfolio is necessary in the United States.

Flexibility: The funding level could also be reduced; many against nuclear energy, however, will likely only be completely happy with an all or nothing policy and simply lowering the funding level will not be enough. Lowering the funding level will also "pull the rug out from under" many of the current programs in NERI and the end result could be half-completed research.

Implementability: This alternative would be simple for Congress to implement. It would simply not fund the NERI project for future years. However the long-term political implications of this approach are unknown. This alternative could be disastrous if there

were to be an energy crisis in the near future and energy generation methods that are an alternate to fossil fuels are not explored.

Additional Comments: This is directly opposed to the PCAST recommendation for energy and environmental issues.

Policy Alternative #2

In the first NERI workshop fundamental nuclear science was not was represented in a working group. If the NERI workshop were to be redone, it might be wise to create another group to encompass fundamental nuclear science other important nuclear issues.

Effectiveness: This new group would create a guiding policy for fundamental nuclear science and address other relevant issues such as education, the effects of radiation, and many other programs. This would create both long-term and short-term strategies for fundamental science in NERI.

Efficiency: Finding qualified people to recommend a guiding policy for such a broad topic will take much work. Although the effectiveness of this policy may be increased with multiple groups, that approach would also need experts to be found for each group.

Equity: The researchers may benefit from this policy because they can aim their proposals toward the policy. On the other hand, some researchers may feel limited due to restrictions on a topic that seemed to be fairly open to many subjects.

Flexibility: The number of groups can change with this policy. It can be one all-encompassing group or it can be several smaller groups. For example one group may explore materials science, another explores education, and so on. However, the more groups there are, the more difficult it will be to administer a straightforward policy since each group will have its own opinions.

Implementability: This would require the repeating of the NERI workshop. This will more fully explored in the Recommendations section.

Additional comments: Another program that is not currently in NERI or NEPO, but which would be a powerful addition, is an education program. This type of program would fit under the working group of other important nuclear issues. Education programs at both the K-12 and worker level would benefit the nuclear community. The K-12 program should be focused on issues to be consistent with the grade level of the student. A very young student's nuclear education can focus on such questions as: "How does electricity effect our lives?" The student could point out things in the room that use electricity, or they bring in objects from home that uses electricity. A mid-level student can focus on such questions as: "What does an atom look like?" and "How is electricity made?" To help answer these questions, demonstrations of hand-held, turn-the-crank

generators, or simply passing a magnet through a coil of wires connected to a light bulb in a circuit, can show energy changing from mechanical to electrical forms. At higher levels, students may be interested in such topics as: "How does a nuclear reactor work?" and "What happened at Chernobyl and Three Mile Island?" Such an education program may both increase public support of nuclear energy and inspire a new generation of nuclear engineers and other scientist. However the DOE must know the importance of differentiating between propaganda and education. The DOE can, for example, only teach how a reactor works, and not that a reactor is beneficial. Also, new and innovative ways to train workers would be a valuable part of NERI to improve reactor safety. Such methods could include computer simulation of many possible accidents to train the operator to find the best way react in a given situation.

Policy Alternative #3

Research on nuclear waste programs should investigate non-technical issues, such as political issues and their possible resolution. The working group on nuclear waste disposal dealt with the technical issues of waste disposal; however, many in the nuclear industry do not feel that nuclear waste is a technical issue, but instead is a political one. Both NERI and NEPO lack support for a program that explores the political feasibility of a waste disposal site or method of disposal.

Effectiveness: Implementation of this alternative would depend on the quality of the proposals received involving non-technical aspects of nuclear waste. An increase in new

and innovative proposals dealing with this subject will increase the chance of this research topic becoming a funded project. Allowing a political solution as part of NERI or NEPO would encourage more participation with experts involved with public policy and political science.

Efficiency: The time scale of such a program would depend on the proposal itself. Results of the research would normally be finalized in one to three years depending on the program. The program may help NERI and NEPO gain support in Congress by showing that the program can work directly for Congress.

Equity: Funding of research into a political solution could be very beneficial to both the NERI and NEPO projects. Although the issue has been debated for more than 20 years, no political solution has been found for the waste disposal site for either short-term or long-term storage. Congressional support of the program could possibly increase because the program would be seen to be functional, useful, and highly visible. This may, however, take funds away from important technical issues.

Flexibility: The NEPO committee should focus more on the interim storage of nuclear waste while the NERI project focuses more on long-term storage and disposal of waste. Since NEPO deals with current issues in nuclear energy, while NERI deals with the future. This type of program would only be part of NERI or NEPO if a quality proposal dealing with the subject matter were received.

Implementability: Implementation of a research program concerning a political issue would depend on the submission of proposals that are new, innovative, and high quality. The program may not need the type of budget that a highly technical program would need, and therefore will be easier to choose.

Policy Alternative #4

The advanced reactor design workshop could address the issue of technology transfer from the NERI program. The NERI project has experts in science and engineering working on many programs, and their expertise can be transferred to many industries other than fission energy.

Effectiveness: Transferring technology from NERI to other uses can gain support for it from non-nuclear industries and others involved in non-nuclear R&D. A new energy conversion method could, for example, increase overall efficiency and output of current power plants. Also, NERI may serve as a birthplace for many non-energy-related ideas.

Efficiency: NERI should focus its funds on fission research, but the knowledge gained could be used in other ways. One example of a program currently in NERI that accomplishes such a goal is the direct energy conversion fission reactor. The direct energy conversion technology may be used with current fossil fired and future fusion reactors.

Equity: This policy alternative will help many other technologies. Advanced materials that have enhanced with resistance to radiation and high temperatures can be employed in the aerospace field. Computer simulation techniques could benefit fields like fluid dynamics, especially those involving two-phase flow.

Flexibility: Technology transfer would only be one of the many criteria used to compare proposals. Such an addition would help projects that do have technology transfer possibilities express that fact.

Implementability: This can easily be added to the NERI funding application form by asking for the possibility of technological transfer for each individual project.

Additional Comments: This could in general improve the selling of NERI to Congress if the NERI program can point out other ways that the program has help the country in addition to just the nuclear power industry.

Policy Alternative #5

The low-output reactors working group could consider potential commercialization of the reactors as a criterion on for evaluating proposals.

Effectiveness: Adding commercialization as a goal emphasizes the eventual manufacture of the technology in the private sector as an objective of the program. Commercialization

also is in line with the spirit of NERI, since this will allow NERI to be the birthplace of new ideas that eventually become full projects in the DOE and private sector.

Efficiency: Commercialization of the reactors could create jobs within the private sector for both technical and non-technical workers. The hope is that a mass-produced reactor will create jobs in manufacturing, sales, new reactor construction, reactor operation, and eventually reactor decommissioning. These new reactors can also be marketed overseas and exported. Also, commercialization can help the United States continue to be a leader in nuclear technology and innovation.

Equity: Private companies will be able to use NERI results. The final decision on whether to commercialize a product is made by the company, based on its assessment of the profitably of the final product.

Flexibility: Commercialization would not be the only criterion when the proposal is reviewed, but if a program has promise of eventually being commercialized, it would be a positive factor in its consideration. After the NERI program is complete, the commercialized reactors will have a strong economic impact and show a great return for the research and development investment.

Implementability: Again, this will be easy to implement with a paragraph on the commercialization potential on the application form for NERI funding.

Additional Comments: This approach would help satisfy the one of the goals of most government-sponsored R&D programs, which is to improve the United States' economic competitiveness on a global scale.

Policy Alternative #6

The award recipients should have a more frequent communications with ONEST. Currently, the NERI projects must publish yearly in a peer-reviewed journal. One way to increase communication is to have the award recipients present their status and progress on either a monthly, bimonthly, or quarterly basis. This need not be peer-reviewed, but can be presented informally. The presentations could even be done electronically, posted on the Internet, and might only need to be a few lines to about a page long.

Effectiveness: Better communications will keep the programs "on their toes" and help avoid procrastination. This policy could also help those interested with the NERI programs to follow their progress on a regular basis.

Efficiency: This cost of this policy would be only the man-hours to write the reports and put them up on the Internet. This could, however, cause a short discontinuity in their research and could cause problems if the researchers need to drop everything and write a report. The lower level of formality will, however, shorten this time. A relatively small amount of a researcher's time could make a significant contribution to the program.

Equity: The participants in the program may at first not support this policy, since it forces them to do additional work, but might find it very helpful when writing their peer-reviewed papers.

Flexibility: The flexibility in implementing this policy would come in the number of messages needed. A decision would need to be made on whether each collaborating organization should be required to independently send a report or if each project should send one report.

Implementability: ONEST should keep the process as informal as possible for ease of implementation. However, the decision on whether current recipients of the award need follow this policy, or whether they would be exempt as a result of implementation of the policy after the start of NERI, would have to be decided.

Additional Comments: The information should be available to the public on the NERI website, to encourage its widest possible dissemination.

Policy Alternative #7

A new committee for NEPO should be created that better represents industry. Currently, many members of NERAC are national laboratory staff and university faculty. The new committee would have many more members who are involved in the electricity generation industry. This could help the projects in NEPO be more suited for immediate use by the

power industry. The United States Nuclear Regulatory Commission (USNRC) and the Electric Power Research Institute (EPRI) should also be represented on this committee to ensure that research conducted by NEPO is different from research performed currently and in the past by both of these organizations.

Effectiveness: A danger of conflict of interests exists because the members may only choose proposals that affect their companies on an individual basis, rather than the nuclear power industry as a whole. Balanced committee membership, however, the lessens the chance of this happening.

Efficiency: More involvement with industry, USNRC, and EPRI could be beneficial in the long run, since the new committee will tackle current problems with reactors more successfully. However, the creation of another panel could be a wasted resource since NERAC is already a large group of nuclear experts.

Equity: A strong NEPO program could help the power industry and could result in lower prices in the near future for the consumers of electricity.

Flexibility: A committee, if created for NEPO, could be dissolved or combined with NERAC if it is found not to be a necessity.

Implementability: The largest obstacle in a program such as this is to find a large group of experts who are both knowledgeable and unbiased. Engineers, scientists and current

members of NERAC could also be on the NEPO committee, though they might find membership on both committees too time consuming.

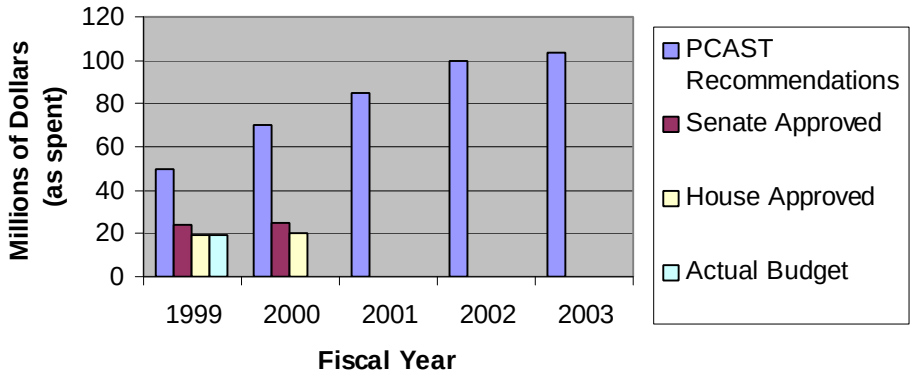

Figure 4: NERI Project Funding

Recommendations

First and foremost, fission power sources cannot be abandoned in the United States. Currently, the United States generates about 20 percent of its electrical energy using nuclear power. Nuclear power is the second largest electricity provider, trailing only coal. In six states nuclear generates more than half the states' electricity. Electricity produced with nuclear energy also does not emit gases that can possibly cause the greenhouse effect. According to the PCAST report, "Nuclear power is a major factor in restraining the growth in emissions, and it will be more difficult for the United States to meet emission goals without nuclear power. Since 1973 the generation of electricity by U.S. nuclear power plants has resulted in approximately 2 billion metric tons less carbon emissions than if the same amount of electricity had been produced by coal plants."

Further, a belief that nuclear energy has reached its full potential is a poor assumption. Many steps can be taken to make reactors safer, to deal with waste, and to create reactors that can be used in many application in which they were never used previously, such as hydrogen production, which can be used in greenhouse gas free fuel cells.

The level of funding for NERI needs to be raised to the PCAST recommended levels. Figure 4 (above) shows the funding levels for the current various fiscal years and the PCAST recommendations. Both the House and the Senate have approved the NEPO project for 5 million dollars, half the PCAST recommendation, for FY2000. The DOE should judge the relative success or shortcomings after the initial year or two of the NEPO project to decide whether to request funds consistent with the PCAST recommendations. Figure 5 (below) shows the approved funding levels for the NEPO project, along with the PCAST recommendations. Note that no funds were appropriated for the 1999 fiscal year.

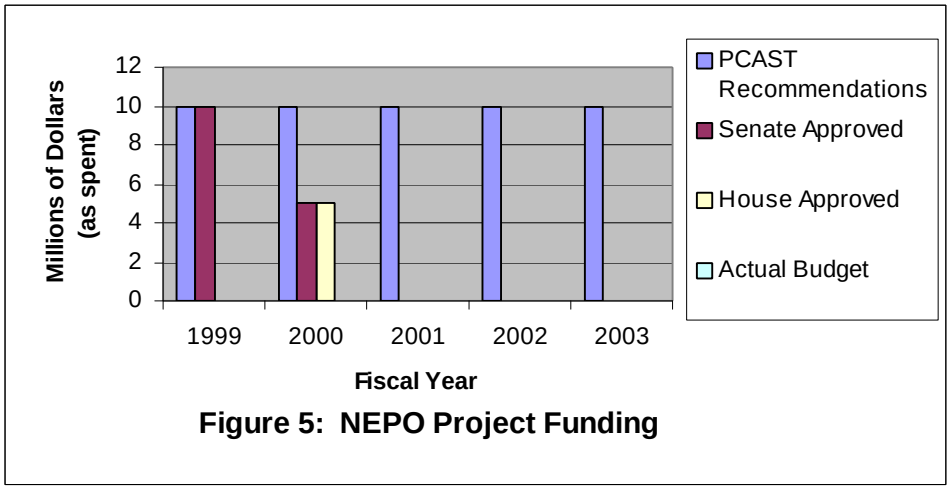

Figure 5: NEPO Project Funding

The workshop should be repeated if funding levels increase significantly. For example, with the House appropriations bill, the workshop would not be necessary since most of the funds will be used to finance the projects from FY 1999. Funds would not be

available to for a large number of new programs and continuing the status quo would be better attempting to start new policies for a small number of programs. However the workshop should be repeated if significant additional funds become available to support more projects. If the Senate's 25 million-dollar appropriation is in the final appropriations bill, the workshop would be worthwhile to repeat and the issues reviewed.

A few of the policy alternatives should be seriously considered by NERAC to add to the policy for NERI. If the NERI workshop were repeated, another group should be formed to find a guiding policy for fundamental science. The waste program should expanded to include research into non-technical and political issues related nuclear waste disposal. The final application for the proposals should ask for technology transfer or commercialization potential to be expressed. The amount of communication with the DOE and the recipients should be increased; however NERAC should explore different options to find a way to facilitate the process as much as possible.

NEPO is not explored to a great extent in the PCAST report. PCAST stated, "If the United States were to implement a carbon-emissions policy that would require existing plants to operate longer than their owners would choose in a deregulated electric-power market, DOE should monitor operations and relicensing and be prepared to fund the R&D necessary to maintain operations. Such efforts might include R&D to reduce the cost of replacing major components, such as steam generators, or to reduce the cost of plant upgrades to meet USNRC requirements." PCAST also recommended that the funding be matched by industry. NEPO should be researcher initiated and competitive in much the same way as NERI. The formation of a committee that includes members of EPRI and

USNRC will be an essential resource in making sure that research is directed toward new topics.

A grass-roots effort, where the people who benefit from awards contact their representatives in Congress, may be the best way to ensure that the program continues to be funded. The recipients need to know it is their responsibility to contact their representatives in Congress. Although this contact cannot be forced on the recipients, they must be reminded of the importance of communication with their representatives. In fact, many of the congressmen are unaware of the extent of the NERI program, even if awards have gone to their state or district. For example, Senator Bayh's (D-IN) staff was unaware of the extent of research being conducted in Indiana under the NERI project even though five projects were awarded to universities within the state of Indiana: four to Purdue and one to Notre Dame. A representative's knowledge about the effect of the program on those in his or her district can be improved if those who benefit from the award contact their representatives in Congress.

The nuclear community itself should create a grass-roots effort. The best representative of all the diverse facets of the nuclear community is the American Nuclear Society (ANS). ANS can give members an e-mail addresses so they can e-mail their representatives in Congress. A message with the ending @members.ans.org may help the message have more influence. The address should have a "reply-to" address, or have the message forwarded to the member's main e-mail address. This will both save on disk space and increase the chance of a reply being received by the ANS member. The sender should be able to locate his or her representative by either entering their ZIP code or by clicking on a map. It can also beneficial to send this the information to important

committees in Congress, such as the House Science Committee and the Energy and Natural Resources Committee in the Senate.

For security reasons, it may be best to have the message say, “I agree with the American Nuclear Society’s position on,” the subject of the position statement. The member will then be able to click on the position statement that he or she would like endorsed. It will also be important for the message to say where the member is from, so the representatives know that the message comes from one of their constituents. The message can ask the representative to reply if they would like more information.

Sending messages this way may limit those who wish to say more or explain how the policy affects them. Another method would be to have the outgoing e-mail sent out as just a normal letter to one’s representative. Another advantage of this message system is that current issues that are not included in policy statements in the list can also be represented. This system does run the risk of members of the ANS members using the ANS name to endorse positions on which the ANS has no opinion or even opposes. Also, it may be possible for someone who is against nuclear energy to send anti-nuclear mail to the members of Congress using the ANS name. However this risk can be greatly reduced by having password protection for the mail system.

To find the best way to have the e-mail access, trial and error should be used. I recommend that the ANS start e-mail service where members can only choose which position statements they endorse. This also can have the benefit of being the least amount of work done by the member to send a letter and may increase the likelihood of a message being sent. If members complain that this is too constraining then the access can be expanded. It would also be good to consult with the American Institute of Chemical Engineers in this issue since they do have a service much like this for their members

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