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Public Hearing Transcript

Federal non-nuclear energy R&D Program

foreword

Section 11 of P.L. 93-577, the Non-nuclear Energy R&D Act of 1974, directs the responsible agency to carry out a continuing review of the Federal Non-nuclear Energy Research and Development Program to evaluate its adequacy of attention to:

(a) energy conservation method, and

(b) environmental protection and the environmental consequences of energy technologies.

The President's reorganization transferred responsibility for this review from the Council on Environmental Quality to the Environmental Protection Agency. The Office of Energy, Minerals and Industry (OEMI) within EPA's Office of Research and Development has been assigned the responsibility for conducting the review.

"Section 11" requires EPA to hold yearly public hearings as part of its R&D review responsibilities. This report presents the edited transcripts of a Public Hearing on the Federal Non-nuclear Energy Research and Development Program held March 29-31, 1978 in Washington DC. Information acquired at the hearings will be of particular value as a mechanism for surfacing problems and issues in Federal Non-nuclear Energy R&D. EPA plans to improve the understanding of these problems and issues, to confirm their significance and to further explore their dimensions.

The 1978 hearings were organized by David Graham, senior staff engineer with OEMI.

Readers of this report may wish to comment on the issues presented here or on other issues concerning the non-nuclear R&D program's adequacy of attention to energy conservation and environmental protection. We would greatly appreciate receiving such comments; please send them to:

Section 11 Coordinator
Office of Energy, Minerals and Industry (RD-681)
U.S. Environmental Protection Agency
Washington DC 20460

Steven Reznek

Steven R. Reznek
Acting Deputy Assistant Administrator
for Energy, Minerals and Industry

EPA **Public Hearing Transcript**

Federal
non-nuclear energy
R&D Program

March 29, 30, & 31, 1978
GSA Auditorium
Washington DC

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WEDNESDAY 29 MARCH 1978

PANEL:

DR STEPHEN GAGE, Assistant Administrator
for Research and Development, Environmental Protection Agency

DR STEVEN REZNEK, Acting Deputy Assistant Administrator
for Energy, Minerals and Industry, Environmental Protection Agency

MRS ADLENE HARRISON, Regional Administrator, Environmental Protection Agency

MS VIRGINIA VAN SICKLE, Office of State Planning,
State of Louisiana

DR JAMES MACKENZIE, Council on Environmental Quality

Federal
non-nuclear
energy
R&D Program

contents

MORNING SESSION

AFTERNOON SESSION

29 MARCH 1978

The hearing convened, pursuant to Notice at 9 am
Dr Stephen Gage and Dr Steven Reznek presiding:

introductory remarks

DR. GAGE: Good morning. I'm Stephen Gage, the Assistant Administrator for Research and Development in the Environmental Protection Agency.

This morning's session opens three days of public hearings on a subject which is crucial to our nation's future -- the relationship between energy development and environmental protection. Energy and environmental problems are now so widely recognized and debated that we're becoming accustomed to them, and perhaps overlooking their fundamental importance to our society.

An era of the world's history is rapidly coming to a close. The inherent limitations of the traditional wisdom, that investment of money and labor to develop natural resources will be rewarded by a growing economy, have now been demonstrated. We know that in the short term the cost of energy -- that is the capital and labor required to produce usable energy -- will increase.

Furthermore, the potential environmental problems of coal and nuclear energy are much greater than those of petroleum and natural gas, and will require increased expenditures if they are to be solved.

Although we have all witnessed some of the near term economic, political, and environmental implications of the closing of the petroleum age, none of us can forecast accurately what the future has in store. The energy crisis may mean a protracted and gradually worsening economic recession, lack of opportunity for our young people, and decreasing social mobility. It may mean rapidly degrading environmental quality and exhausting our supplies of clean air, clean water, and productive land.

On the other hand, the energy will rise to the point where widely available and environmentally benign sources will be used to meet society's economic and social needs.

The exact course of our future cannot be predicted. However, the Federal government is investing immense resources on research, development, and demonstration projects which may shape that future.

This hearing will examine two aspects of Federal programs expending approximately two billion dollars per year for non-nuclear energy technologies. The purpose of this hearing is to gather information on the proper degree of emphasis given by those programs to environmental protection and energy conservation.

The Federal Non-Nuclear Energy Research and Development Act of 1974 requires this hearing as a review forum. The President's Council on Environmental Quality held four previous hearings. The last was in Austin, Texas, a little over fifteen months ago. Originally with CEQ, the President's reorganization plan transferred responsibility for these hearings to EPA. This is the first of the hearings that we have held.

Each of the three days will emphasize slightly different questions relative to the appropriate emphasis of environmental protection and energy conservation in the Federal program.

Today we will examine the question of future energy patterns and the levels of coal use.

Tomorrow we will examine the topics of solar energy, the so-called "soft" technologies, and energy conservation.

On our last day, Friday, we'll devote the hearing to testimony on advanced energy systems, particularly synthetic liquid and gaseous fuels derived from coal and oil shale.

The available handouts summarize some of the issues for each of these three days. I would now like to introduce the members of today's hearing panel.

At my far left is Adlene Harrison, the Regional Administrator for EPA's Region VI. She's located in Dallas Texas.

Next to me is Steven Reznek, the Acting Deputy Assistant Administrator for Energy, Minerals, and Industry, in the Environmental Protection Agency.

At my immediate right is Virginia Van Sickle of the Office of State Planning for Louisiana.

And next to her is Jim MacKenzie, the Senior Staff Member for Energy of the President's Council on Environmental Quality and a veteran of such hearings.

I believe Dr. Reznek has a few words about the conduct of this hearing, and then we'll take our first witness.

Steve?

DR. REZNEK: Yes, according to the schedule, each witness is allotted approximately twenty minutes. As an experiment, we would like to use half of each speaker's time for questions. We are going to delay questions from the audience until the end of each session. We will provide three-by-five cards for written questions. Please address your questions to specific panel members or to the witness and turn them in to the receptionist in the back of the room.

The record for this hearing will be held open for three weeks beginning next Monday. We'll accept written testimony and written comments during that three-week period.

If any of the witnesses have brought along extra copies of their testimony today, or if we can have copies made, they will be available for the press from the receptionist at the back of the room.

Those are my comments. If there are any questions about the proceedings today, please ask either the receptionist or me. We're going to publish both a summary and a direct transcript of all the proceedings. These documents can be obtained by writing to either Dave Graham or to me at EPA. Ask the receptionist for our mailing address.

Our first witness today is from the University of Oklahoma. The name in the program is Irvin L. White, but I always call him Jack. Jack White.

STATEMENT OF DR. IRVIN L. WHITE
SCIENCE AND PUBLIC POLICY PROGRAM
UNIVERSITY OF OKLAHOMA

DR. WHITE: As you know too well, Steve, I've always had an identity crisis.

Mr. Chairman, members of the hearing panel, I wish to thank you for this invitation to participate in this hearing on the environmental protection and energy conservation aspects of the Federal non-nuclear research and development program.

Since I'm confident that you will hear from numerous witnesses during this hearing who will identify research needs in specific scientific fields and for particular environmental and energy conservation programs, I would like to take the few minutes available to me this morning to discuss several needs which are likely to receive much less attention.

In identifying these needs I will be assuming a broad definition of research and development and a policy sciences orientation. That is, I will focus on research and development which I believe is needed: first, to improve the current capability, to use existing knowledge and data efficiently and effectively, to inform non-nuclear environmental protection and energy conservation policies and programs; and second, to improve the current capability to plan and implement research and development programs which will effectively meet both the present and the future, near and long-term needs of policy makers when they attempt to deal with environmental protection and energy conservation problems.

The three closely related categories of research and development needs which I wish to discuss briefly are: one, research needs in the policy and decision sciences; two, public-private sector relationships; and three, broadened participation in public policy making.

I will speak most extensively on the first of these three.

We all recognize the need to attempt to anticipate the consequences of policy choices before they are made and implemented, and of developing and deploying technologies before they are developed and deployed.

While this means that knowledge and data are needed, it also emphasizes the need for a valid, reliable, and creditable capability to integrate and synthesize knowledge and data, to reconcile conflicting research results, to reduce uncertainty, and to facilitate making choices.

In short, it emphasizes a need for a capability to link the scientists and technologists and the policymaker more effectively.

When research and development programs are formulated and research and development dollars are allocated, the tendency is to emphasize needs that are easiest to identify and define, that is, knowledge and data needs, and these tend to get defined in terms of specific, "hard science" disciplines, particular technologies, or specific on-going programs.

As the current non-nuclear research and development budget shows, the search is aimed at improving the existing capability to use current knowledge and data more efficiently and effectively, and to improve the existing capability to plan and implement research and development programs receives much less attention than does the acquisition of knowledge and data.

Much more attention needs to be given to the policy and decision sciences. Specifically, more attention needs to be focused on improving existing capabilities in the following areas:

First, to develop and use multiple measures of cost risk and benefit.

Second, to establish the credibility of the knowledge and data base used in making public policy choices.

And third, to plan strategically, including the capability to forecast technological developments, assess technologies, analyze trends, evaluate and compare contingencies, and use a broad range of analytical tools to attempt to better inform present choices and to guard more successfully against future surprises by reducing our vulnerability.

Multiple measures of cost, risk and benefits are needed because all policy choices distribute cost risks and benefits differently, and no existing single measure adequately indicates what interest and values are being distributed and how they're being distributed, despite the tantalizing appeal of the bottom line for policymakers. In most cases there isn't one, no matter what analysts are willing to tell you.

In my opinion we rely far too much and far too often exclusively on economic measures at the present time. Such measures are important, but they need to be supplemented, for example, with energy, environmental quality, and health effects measures.

Considerable research is required if this capability is to be developed and made understandable.

My colleague in the Science and Public Policy Program at the University of Oklahoma, Don Kash, who is scheduled to testify this afternoon, will emphasize the need for adequate, reliable, and creditable knowledge in his testimony.

Let me simply note that while policymakers almost always have to make choices under conditions of uncertainty, the level of their uncertainty can be quite different depending upon the relative adequacy, reliability, validity, and creditability of the knowledge base available to them. The lack of an adequate, reliable, valid, and creditable knowledge base concerning energy resources, energy technologies, and their impacts, largely determines the level of confidence that policymakers, other interested parties, and the general public can have in non-nuclear energy policies and programs.

The lack of adequate, reliable, creditable knowledge about energy technologies and their impact is illustrated by the absence of data on most synthetic fuel technologies at a commercial scale. With the exception of Lurgi high-Btu gasification, data exist for only bench or pilot scale facilities.

The lack of data and experience are handicaps that make impossible the anticipation and analysis of the impacts or effects that can be expected to occur when these energy technologies are deployed.

If the existing knowledge base is inadequate because of the lack of theoretical understanding, no amount of data will eliminate the high level of uncertainty policymakers will confront. For example, at the present time the understanding of how trace elements were chemically bonded in different types of coal, and how different chemical bonds will affect what happens when coal is burned in various types of boilers, is quite limited. Considerable analytical chemical and bench or pilot scale testing in different kinds of boilers will be required to acquire the empirical knowledge base that may eliminate this knowledge gap and make it possible to predict what will happen when a coal with known characteristics is burned in various kinds of boilers. For example, results of such a search would make it possible to predict what portion of the trace elements would be admitted as air and water pollutants.

Policymakers are constantly confronted with a dilemma when dealing with the uncertainties associated with making policy choices in the absence of an adequate, reliable, credible knowledge base. As noted earlier, policymakers always -- almost always -- have to make choices under conditions of uncertainty, and at times the level of uncertainty is so high that they have to decide whether it would be socially more responsible to choose not to do something or to delay doing something until a test has been conducted, more and/or better data collected, and more analysis completed.

This is the case in several areas of non-nuclear energy policymaking, as, for example, in the case of government funding and guarantees for support of the development of synthetic fuel technologies.

More policy sciences, decision sciences research is needed to help policymakers know how to deal more confidently with this kind of policymaking problem.

The final policy analysis research need which I identified is a greater emphasis on developing a more creditable, diversified, strategic, long-range planning capability. While such a capability should be intended to identify potential future problems, in order to help avoid them, or to help responsible agencies to be ready to deal with them more effectively when they do occur, it should also provide help for those who are dealing with current problems.

What is needed is the capability to scan the horizon while constantly upgrading the quality and extent of knowledge about current technologies, the consequences of deploying these technologies, how they can be configured or regulated to achieve policy and program objectives, and so forth.

To be effective, developing and utilizing such a strategic planning system has to be an iterative, integrated process, and it must contribute to the further development of the capability to integrate and synthesize knowledge and data, reconcile conflicting research results, reduce uncertainty, and facilitate policymaking choices, which I mentioned earlier.

Among the relevant research tools whose development warrant more attention are technology forecasting, technology assessment, and trend and contingency analysis. In particular, what is needed is a much more developed capability to pick up signals of technological change and to monitor this change as it actually develops.

This is, of course, closely related to my next topic, public-private relationships. They are related because both require a more profound understanding of the process of innovation and the diffusion of innovation, including the commercialization of non-nuclear technologies developed by Federally funded research and development programs.

Technology assessment has become an overworked label which can apply to anything from characterizing technology in a descriptive sense to a full-blown assessment of the consequences of the decision to develop and deploy technologies such as those upon which the non-nuclear energy research and development program is focused.

I wish to emphasize the need for more research of the latter type. These kinds of technology assessments are conducted to achieve two kinds of objectives: first, to inform public and private policymakers and interested citizens about the likely consequences of a decision to develop and employ a technology, and second, to identify, evaluate, and compare alternative policies and implementation strategies for dealing with the problems and issues that either are perceived or are actually likely to arise when a technology is deployed.

Three questions must be answered to achieve the first objective. Are the consequences that have been anticipated actually likely to occur? Are there also likely to be consequences that have not been anticipated? And if either or both kinds of consequences occur, how serious will they be?

To achieve the second objective, the answer to these three questions must be related to the social and political context within which the technology will be developed and deployed. The questions to be answered in this case are:

First, what alternative policies and implementation strategies can reasonably be used to maximize benefits and *minimize* cost and risk when the technology is developed and deployed, and second:

How will these alternatives distribute cost, risk, and benefit throughout society?

This kind of research deserves much more emphasis that it presently receives, and it deserves to be approached from a variety of intellectual perspectives, not simply the complex formal modeling approaches which seem to dominate most current programs.

Let me hasten to say that none of my recommendations for a greater emphasis on policy and decision science research is intended to call for large expenditures for abstract methodological studies. Instead, I strongly believe that methodological development should be a standard required component of substantive studies, and I certainly am not advocating an exclusive focus on any particular kind of approach.

My sense is that proportionally too many of the dollars being spent in this area are being spent to develop complex computer models which often hide or tend to hide things from policymakers that they need to know.

Given the state of the policy and decision sciences art, what is needed is multiple perspectives and lots of hands-on, thoughtful analysis.

Let me turn now to a somewhat related topic, public-private sector relationships in non-nuclear energy research and development.

I happen to believe that existing problems in public-private sector relationships have to be overcome if we are to be successful in achieving stated national energy, economic, and environmental policy objectives.

While this is most obvious at the national level, it is also true at local levels as well, as for example in resolving problems which arise for small western communities that can potentially be overwhelmed by the consequences of nearby large-scale energy development projects.

I currently chair a subcommittee of the American Association for the Advancement of Science's Committee on Science and Public Policy, on this topic. This subcommittee is just now beginning to develop a research agenda for this problem area, focusing initially on public-private sector relationships and commercialization of new energy technologies, particularly non-nuclear technologies such as synfuels and solar.

I will append to my prepared statement a copy of a paper by Dr. Mary Hamilton, which we are using to initiate the subcommittee's identification and definition of commercialization problems and research needs, and I trust that this paper will be helpful to you as well.

Because of time constraints I'll leave my discussion of this topic at this point. However, I'll be glad to expand on this topic when you question me later.

I wish to turn briefly now to my final topic, broadened participation in public policymaking.

Broadened participation in public policy making, particularly in the environmental and energy areas, is now the norm, but we actually know very little about how to provide effectively for the meaningful participation which accomplishes the required accommodations among competing interests up front, while a policy is being made, rather than when it is being implemented.

There is very definitely a need for some focused research in this area, including some experiments or quasi-experiments with a variety of methods and techniques, for example, the kind of approach used by the recently completed National Coal Policy Study.

I focused on soft policy, policy oriented research needs in my testimony this morning. I elected to take this focus because the results of all the other kinds of research needs that you'll hear about during these hearings will be less useful than they might otherwise be if we don't improve our capability to use research results more efficiently and effectively. If there are any iron laws around, one of them has to be that public policy choices will always have to be made under conditions of some uncertainty.

That this is the case doesn't mean that we shouldn't continue to try to gain more knowledge and collect more data in our attempts to reduce that uncertainty. However, it does emphasize the need to focus more attention on research aimed at enhancing our capability to deal with uncertainty.

This is certainly an obvious need in the non-nuclear energy research and development research program.

Because of time limitations, and the nature of my recommendations, my remarks have tended to be quite general. When I submit my prepared statement I will append a summary of some specific recommendations for non-nuclear energy research and development based on our technology assessment of western energy resource development, and our final complete research needs report will be available to you within the next few weeks.

Thank you, and I stand ready to answer your questions.

DR. REZNEK: Thank you sir. Does anyone have questions for Dr. White?

QUESTIONS AND REMARKS

DR. REZNEK: I'm intrigued by your remark that one of the missing pieces in the Federal program is research on how to set policy. I believe that this sort of policy research is being done, but not very visibly, i.e., not as a separate program with its own resources. Thus it is impossible to make judgements on whether or not the program's resources are adequate or its substance properly focused. I'd be very interested in your specific proposals.

I believe I misunderstood another one of your remarks. It was a remark on synthetic fuels from gasification. It seemed that you were saying that we ought to stop the gasification experiments that are now on-going until we understand how to do it better. Could you elaborate on this point?

DR. WHITE: It really wasn't that point that I identified as a missing link. I think that there is a lack of adequate emphasis in the non-nuclear program on the acquisition of data on technologies that haven't been deployed at a commercial scale.

Don Kash will talk in more detail about a specific recommendation this afternoon, but basically, what the proposal in Our Energy Future calls for is going to a full scale plant at a demonstration stage in order to acquire the data while you still have an opportunity to turn it on or off, and to then make the decision about what portion of our future energy supply we want to come from that particular kind of technology.

It's an intermediate step. It's not to cut it off, but to add a step in the development process.

DR. MACKENZIE: I get the impression that you're saying, for example, near the beginning of your presentation, that there's a lot of basic research that has to be done. Isn't that the thrust of the -- all the gaps and holes that you see in trying to formulate policy?

DR. WHITE: That's right, and what I was saying generally was that I think that very frequently -- the research questions, as they are formulated, in a hard science disciplinary sense, are not the questions that need to be answered from the policy oriented perspective, and I was saying that we need a much better set of linkages between the policy-maker and those who are doing the research, so that the questions are formulated in ways which meet policy needs, and not necessarily disciplinary needs.

If you allow scientists in each academic discipline to set the research agenda they set it in terms of expanding knowledge in their respective disciplines. They don't do it in terms of what will be the incremental benefit to improve policy making by the acquisition of that kind of knowledge.

DR. GAGE: What types of mechanisms, then, do you think are needed in order to bring about this marriage of policy and research resource allocation at the Federal level, if not at other levels?

DR. WHITE: Well, as I said very generally in my prepared statement, I think what's needed is an iterative on-going program which is attempting to look out into the future, but at the same time upgrade the data base, improve the knowledge that people running current programs need to have on a day-to-day basis.

There seems to be a gap now between people who are dealing with current enforcement problems and people who are trying to look out into the future and anticipate problems and do research which would provide a basis for dealing with these problems.

And I think that it has to be in one continuous process, and that the way in which you enlist the people who are dealing with today's problems into thinking about future problems is to give them products on a continuing basis which they can use.

DR. GAGE: That still sounds fairly general. Do you have some specific recommendations for improving these interactions? I gather you are trying to speak to preparation of reports which feed the long-range perspective into the viewpoints of the research planners, but can you go beyond that at this time?

DR. WHITE: Well, part of what I was saying in my statement was that I don't think we know at the specific level yet, and I think we need to devote a great deal more attention to learning how to do that much more effectively than we can do it at the present time.

I identified it as a major gap in the decision or policy sciences at the present time, as they are used in policymaking in this area.

So I don't have an agenda set that I can lay out for you in a specific manner.

MRS. HARRISON: Your presentation, as you said, was very general because of limited time, so it makes it difficult then to ask you questions on general information, but one of the things you threw out was the public need to enter into the policymaking, and for them to enter up front on policies being made. On a general basis, I totally agree.

But I wonder, in the specific information that you will be giving us, if in fact you're going to tell us how to include the public up front in policymaking, and also, who will provide some technical data to them and technical assistance so that they can participate in some kind of meaningful way.

DR. WHITE: Well, let me just use an example that I have some detailed personal knowledge about. One of the kinds of research that I said we need more of is technology assessment, and one of the things that's characteristic of technology assessment, at least the approach that we use in our work, is to attempt to involve this broad range of interested parties in the research itself beginning with research definition and research design stage.

And to carry those people with you, then, through the process of acquiring the knowledge and identifying what the problems are that the research is intended to address, and the alternative ways of trying to deal with those problems.

In fact, this is something of a political process, because what it does is give the various interests an opportunity to participate in the learning process, and it leads them then to having a much better understanding about what the policy choices really are and what the implications of these policy choices are.

Now, in some of the early work that we did in off-shore oil and gas, for example, one of the things that we've gotten lots of feedback on is that the level of the debate significantly changed as a consequence of people having been involved in that study using the information which was a product of our study. That is, -- they now understood in a much better kind of way.

I think we need to do a lot more experimentation of that sort, to see if we can't get the up-front agreement, the accommodations, rather than pay the price after we make the decision and implement it.

DR. REZNEK: Thank you, Jack

DR. WHITE: Thank you.

DR. REZNEK: I think we have two witnesses next, Mr. Todd Caliguire and Elwood Holstein, both representing Congressman Andrew Maguire, who unfortunately couldn't be here today.

STATEMENT OF THE HONORABLE ANDREW MAGUIRE
MEMBER OF CONGRESS FROM NEW JERSEY
AS DELIVERED BY MR. TODD CALIGUIRE

MR. CALIGUIRE: My name is Todd Caliguire. I'm here on behalf of Representative Andrew Maguire from New Jersey.

I'd like to read a statement from the Congressman first, and then I'll be pleased to answer any questions you have afterwards.

I am very concerned about the problem of fine particulate pollution as it relates to the nation's commitment to double coal consumption by 1985. As you know, coal-burning power plants are a major source of these pollutants.

Although the National Energy Plan envisages a gradual reduction in total emissions of particulate matter, air quality may still decline because the concentration of particles in the submicron range may well increase.

Existing particle collection devices, although highly efficient for the removal of large particles and thus for the reduction of bulk emissions, preferentially allow the emission of the smallest, most toxic particles.

It is widely recognized that this equipment is least efficient in removing particles in the critical 0.1 to 1 micron size range.

A report prepared by the National Institute of Environmental Health Sciences, chaired by Dr. David P. Rall, on the effects of increased coal utilization states that, "Control measures which remove only the larger, non-respirable particulates may cosmetically lower the level of TSP," total suspended particulates, "without having any impact on health effects. In fact, it is conceivable that reliance on such control measures, e.g., electrostatic precipitation, could lead to an unrecognized increase in respirable particulates, and hence more of an adverse effect."

The threat to human health that is posed by fine particulate pollution has been well documented. Fine particulates, especially those which are less than one micron in equivalent aerodynamic diameter, are small enough to avoid the body's defense mechanisms in the upper respiratory system, and to penetrate deeply into the alveolar regions of the lung where natural fluids facilitate the dilution of the toxic elements they contain, and transport these chemicals into the blood stream.

In addition, researchers at the University of Illinois have determined that it is these very small particles which carry the greatest concentration of toxic chemicals.

Those fine particulates which result from the combustion of coal are especially hazardous. A group of researchers at the radiobiology laboratory at the University of California, Davis, have recently confirmed that the fly ash emitted by coal-fired power plants contain substances capable of causing mutations in bacteria.

There is a ninety percent correlation between the mutagenic activity in a bacterial test system and carcinogenicity of substances in animals and man.

The carcinogens contained in the fly ash apparently include inorganic compounds such as cadmium, cobalt, and nickel, as well as organics such as benzpyrene and other polycyclic aromatic hydrocarbons.

Such evidence suggests that the prospect of a large increase in the amount of coal burned for energy production presents a severe threat to human health in the absence of specific regulations limiting the amount of fine particulate emissions resulting from this increase.

The Rall Committee has concluded that, "The elevation of gases and aerosols, as a result of increased coal utilization, near or above current ambient levels may be associated with increased respiratory disease, acute and chronic, including lung cancer."

There are two other compelling reasons for acting swiftly to promulgate standards for small particulate emissions. The first is to allow utilities and industry to take into early consideration the need for control devices for this form of pollution. It would simply be more economical and fair to incorporate these technologies into plants for the conversion of existing facilities to coal use, and for the construction of new coal-burning plants, than to retrofit them in order to meet new fine particulate standards issued after these programs are under way.

Action must be taken very soon if this advantage is to be gained, since the switch to coal has already started and is expected to accelerate rapidly following passage of the National Energy Act.

The second reason concerns the implementation plans which were required of the states pursuant to the Clean Air Act Amendments of 1977.

The states are currently preparing plan revisions to meet the new requirements of the 1977 legislation, due January 1, 1979. If new fine particulate standards are promulgated after these revisions are submitted, they may render the states' work obsolete or incomplete, in that the new standards may be inconsistent with some of the control targets and strategies which the states will have established.

Concern over the effects of fine particulate pollution did not originate with the National Energy Plan. By 1973 it had become widely recognized that these smaller particles pose a far more serious threat to human health than the larger particles which national standards were designed to control.

In testimony before the Interstate and Foreign Commerce Committee EPA witnesses stated that, "Our Agency is moving toward controlling fine particulates, that we do have the authority to control fine particulates, and that the schedule calls for controlling fine particulates in the next year or so."

In its 1979 Guidelines Policy Statement for the development of 1973 to 1978 program plans, Administrator Ruckelshaus gave tacit recognition to the magnitude of the fine particulate problem by identifying the establishment of national energy and air quality standards for fine particulate matter as a national priority objective.

As a result, the Office of Research and Development committed $47 million to the study of fine particulate pollution over a six-year period beginning in 1974. This program was to include the study of health and welfare effects, particle formation and transport, monitoring and measuring, and control technology.

In 1975 Administrator Train reiterated this concern when he testified before the Interstate and Foreign Commerce Committee that, "The general conclusion at this time certainly is that fine particulates are in an order of magnitude more significant from a health standpoint than gross particulates."

In addition, in 1975 the National Academy of Sciences began its own review of total suspended particulate standards with an emphasis on the possible need to control fine particulate pollution. The status of these projects and the summary of the results obtained have never been made available to Congress.

In a 1975 letter submitted to the Commerce Committee the EPA gave a preliminary analysis of the fine particulate problem by emphasizing that the proper solution would be to combine the existing total suspended particulate standards with standards for certain classes of toxic fine particulate compounds, such as lead, sulfates, and nitrates.

In testimony to the Committee in 1973 Dr. Greenfield of EPA stated that sulfate and nitrate small particulate standards would be enacted within three years. To this date the Agency has failed to establish such standards, and none appear to be forthcoming.

The EPA has often blamed its inability or unwillingness to enact fine particulate standards on the non-existence or impracticability of control equipment. This excuse is entirely unsatisfactory. The state of New Mexico has already demonstrated the efficacy of current technology in inhibiting fine particulate emissions.

In 1974 New Mexico adopted a regulation for coal burning equipment which prohibits fine particulate emissions of less than two microns in equivalent aerodynamic diameter and unit density to the atmosphere in excess of .02 pounds per million British thermal units of heat input.

This regulation is being enforced at both electrical generation plants in the state, and several of the units of both plants are expected to be in compliance within a few months, using currently available control technology, yet no EPA representatives have even consulted with officials from the New Mexico Division of Air Quality concerning the methods they have utilized and the results obtained in this effort.

The history of EPA's effort to remedy the apparent inadequacy of existing particulate standards is one of broken commitments and circumlocutory scientific study. After spending large sums of money and undertaking numerous investigations there is every reason to expect that EPA is rapidly approaching the level of preparedness necessary to promulgate its national standard for fine particulate pollution. This is especially reasonable in light of the Agency's 1973 claim that it was prepared to promulgate such standards, and the subsequent five years that it has spent working on the problem.

The Clean Air Act Amendment of 1977 required that the EPA conduct an eighteen-months study of the fine particulate question. This work should now be well under way.

I'm interested in knowing the specific termination dates of these projects, the contracts which have been awarded for this work, and the amount of study which will be conducted within the Agency itself.

An interim report describing the exact nature of the work and the results obtained to date should be made available to Congress as soon as possible.

I believe that it is vital to the interests of public health that the EPA be prepared to promulgate an interim standard for fine particulate emissions immediately upon the completion of this eighteen-months study. It would be unnecessary and inappropriate to delay the beginning of the rule-making process until the completion in late 1980 of the Administrator's review of the National Air Quality Standard pursuant to Section 110 of the 1977 amendments.

These same amendments authorize the Administrator to revise existing ambient standards whenever available information justifies such action.

In view of the growing body of evidence relating to the harmful effects of fine particulate pollution, and the emerging national commitment to coal as an energy source, there is a clear need for the Administrator to establish the schedule for the rule-making for fine particulates which will assure that standards are in place by early 1980, or sooner.

The emphasis of the Agency's strategies in this regard should be on the prevention of adverse effects, not undertaking an endless series of studies which delay effective action at the expense of human health.

That concludes the Congressman's statements. I'd like to note that the same points will be reiterated in a letter to Administrator Costle, which will be sent in a few days.

I'd be happy to answer any questions.

QUESTIONS AND REMARKS

MRS. HARRISON: I'd really like to make a statement, rather than ask you a question. I wish I had more Congressmen's representatives telling us to go ahead and do something before all the data is in, because in my region I hear the opposite, "Don't do anything until all the health effects are tied down and you can prove it."

So I'd like to take you back to my region.

MR. CALIGUIRE: I'd be happy to go.

DR. MACKENZIE: Is it your judgment or the Congressman's judgment that there is available control and technology to control fine particles at a level that will protect the public health? Is that the statement that he's made?

MR. CALIGUIRE: I've spoken to some people in New Mexico personally, at the Division of Air Quality, and they've had this program in effect since 1974 using venturi scrubbers and horizontal scrubbers and they claim that they've had a fair degree of success.

As I said, a few of their units at the two plants will be in compliance in one month.

DR. MACKENZIE: In compliance with New Mexico's regulations?

MR. CALIGUIRE: With New Mexico's parameters.

DR. MACKENZIE: And in the Congressman's judgment, that's sufficient, so the technology's available. Is that what he's saying?

MR. CALIGUIRE: I believe that there is technology to control the fine particulates --

DR. MACKENZIE: Sufficiently?

MR. CALIGUIRE: -- pollution. Whether it's efficient or not certainly bears further investigation.

DR. MACKENZIE: Okay, the other question I had was: Does this opt for or favor a synthetic fuels policy, one that would, say, convert coal to gas, where particles might be more thoroughly removed, rather than direct combustion? Would that --

MR. CALIGUIRE: If that is the case, I think you're right. I think it would favor such a program.

MRS. HARRISON: Have you been speaking to Ken Hargis in New Mexico?

MR. CALIGUIRE: Yes, I have.

DR. REZNEK: As you know, New Source Performance Standards are based on best demonstrated technology. The question I would like to ask is: What constitutes a demonstration? This is a difficult question for a technology such as high Btu gasification, which is not commercially available. Experiments have been completed either abroad or at home on a small scale by the Department of Energy. Timely full-scale demonstrations of technologies with some environmental advantage, such as control of fine particulates, are needed both to encourage industry-wide conversion to them and to assure that regulatory requirements for them can be developed in a rational and timely fashion. Do you or the Congressman have any thoughts on how this nation might assure such timely full-scale demonstrations?

MR. CALIGUIRE: I think that there definitely is an advantage to be gained by incorporating that type of technology on a large scale. We're concerned that the switch to coal will occur before appropriate technology is put into place.

In other words, as I said, it certainly makes more sense to allow utilities to incorporate the technology as they switch to coal than to force them to retrofit after they've already begun utilizing coal as an energy source. Just in terms of economics it makes a heck of a lot more sense.

DR. REZNEK: Some highly stringent versions of the proposed standards for conventional coal combustion, when you look at the water pollution requirements and the air pollution requirements, could put the cost -- either annualized cost or capital cost -- at thirty percent of the cost of a new plant.

Do you feel that thirty percent of the cost of electricity generation is a reasonable figure for environmental protection?

MR. CALIGUIRE: Well, I'd be interested in knowing what the figure is now in terms of gross particulates. Frankly, I don't know. I would imagine that it's going to be more expensive to control fine particulates. The control technology has to be more complex and more sophisticated, but I think if we're talking about endangering a population, subjecting a population to a form of pollution which could possibly increase various forms of cancer, I don't think that thirty percent is an excessive amount to be spent.

MR. HOLSTEIN: I'm Elwood Holstein, and I've enjoyed your presentation, Todd, but I wanted to add a couple of things on these points that you're asking questions about.

Todd is our staff expert on the particulate question, but I think some of the questions that you're raising do pertain more directly to some of the general questions that Congress has been trying to address, not just this year, but in the last several years in terms of synthetic fuel development and some of the other energy technologies -- and the cost factor.

I think one of the things that Congress is attempting to deal with nowadays is the actual cost of discovering, developing, producing, and making available to the public the various types of energy sources, so that when we talk about the environmental cost versus the cost of implementing the best available control technology, we're really talking about taking some of those costs which were previously externalized and figuring them in to our total audit, if you will, of the true cost of providing energy.

So that on the one hand we may talk about the added cost to the rate payers of providing the best available control technology for various types of pollutants, but that must be measured against the cost to the general public of the health effects if those control technologies are not implemented.

Another cost that I think is raised in this discussion, another set of costs, are those associated with synthetic fuels. There is much speculation now about potential for coal gasification and coal liquefaction for example, in terms of the potential for reducing pollution of various kinds, yet there's an on-going debate in Congress that we've seen in the last three years over just how that's to be funded, and there's much disagreement as to whether or not those technologies will be economical within the next five or even ten years.

The costs of these alternative synthetic fuels have persistently managed to float just above the higher cost of world oil, regardless of whether that cost was $3.40 a barrel, $7.00 a barrel, $10.00 a barrel, or $12.40 a barrel, so that I think we're going to see an increasing trend -- it's not a definite answer to your question, but I think it must be viewed in terms of a growing trend to try to assess energy costs in terms of their total budget, if you will, in terms of externalized costs, costs of government subsidies, and so forth.

DR. GAGE: Could I ask a series of questions? Are you familiar with the fact that most of the new increment of coal will be burned in new power plants? And further, are you familiar with the fact that the Clean Air Act really provides for two different types of standards, National Ambient Air Quality Standards (I believe that you referred to these in your testimony), on the one hand, and New Source Performance Standards, which would set the degree of pollution abatement in new plants, on the other hand.

I gather you are concerned because you believe that new coal-burning plants are probably not that reachable under the National Ambient Air Quality Standard. Yet they are not only reachable, but they are very controllable under the New Source Performance Standards.

A new Source Performance Standard is now being prepared for new coal power plants for both sulfur dioxide and particulates. The stringency of the New Source Performance Standard for particulate control, which is in its early draft stages at this point, appears to be quite ample to provide as high a degree of control as possible under the present circumstances.

The Ambient Air Quality Standards and New Source Performance Standards are, of course, connected, but we have found that in protecting public health, we're able to go much, much farther by means of New Source Performance Standards.

MR. CALIGUIRE: I think another reason for concern, though, is the fact that many smaller scale plants will be using coal increasingly as a fuel. I think that it's obviously much more -- it's a much easier problem to solve when you're talking about large-scale utilities, because they are easily recognizable, and easily observable, but smaller scale plants, number one, tend to be in areas of densest population, and, secondly, are -- because they are so small and numerous -- difficult to observe and control.

I think that's where a major problem lies, and for that reason I think the National Standard is necessary.

MR. HOLSTEIN: Dr. Gage, if I can just redirect your own question back to you and ask -- I'd like some clarification on your point. Is it the basis of your judgment that the bulk of future coal use will come in new plants, based upon the predictions of expanded power plant construction in coming years?

And the reason I ask the question is simply that one of the difficulties that we've had with that, of course, is that the radical changes that have taken place in future energy demands have caused utilities, not only in New Jersey but throughout the nation, to totally revamp their estimates of future power plant need; have caused the local -- the state commissions, rather, to take a much closer look at the utility data with respect to future power plant needs; and have caused some drastic downward revision in the expectations, not only of the power plants, but of the coal that they may be expected to use.

DR. GAGE: I believe that your capsulization of the reaction of the utility sector within the last few years is a pretty accurate one. I think the fact still remains that the largest bulk of new coal capacity will probably be coming in the so-called Sun Belt, in our Region IV, and Region VI as represented by Mrs. Harrison here, and that the uncertainty associated with the increased use of coal in the industrial sector is probably the largest uncertainty that is still available in the National Energy Plan.

I think that we are all, of course, very concerned about conversions in urbanized, industrialized areas, but each one of those conversions have to be subjected to a health review, and we may in fact end up requiring essentially best available control technology on a number of those conversions in order to protect public health.

I might point out, the conversions cannot occur in areas which do exceed the National Ambient Standard now. I think that that in itself speaks to the necessity for moving ahead in a very accelerated way to revising, if the data shows that it's necessary, the National Ambient Standards for particulates, as well as for the other pollutants.

Adlene, did you want to comment at all about the situation in the southwest?

MRS. HARRISON: Well, I think we're expecting probably about eleven precent increase in the use of utilities using coal, and it's going to escalate very rapidly. And so, therefore, we're equally concerned that we have the proper regulations in place.

But you're not going to stop these conversions, because a lot of things are in place, and therefore we're going to monitor those conversions very closely.

As Steve said, if they can't meet the Ambient Air Quality Standards, they're not going to be able to do that at all.

Secondly, in my area we have a problem in that it's low sulfur content coal, therefore thay have to burn more of it. So in a way it really starts a whole other ball game.

We used to pride ourselves on the fact that we had low sulfur burning coal. Instead that's going to impact in some other way.

But the thing about -- one thing that interests me about what you said about retrofitting, and that really nothing should be built before all the facts are in, haunts me in a way that we talk about nuclear energy plants too. I don't think we know all the answers there either, and yet we've gone on and constructed some nuclear energy plants.

The country's not going to be able to stand still with energy development while all the facts come in. Philosophically, I would totally agree with you. I wish we could just stay in place until we know all the answers. But we're going to find that we're going to have some problems, because we don't know all the answers, as we retrofit -- or even the new sources.

I mean our standards for new sources might be strict, but we may find later that they're not the whole answer either. So we're going to be moving forward, and we're going to do it with as much expertise as we have available.

MR. CALIGUIRE: I'd like to answer a couple of your points.

First of all, it's not our intention to stop the conversions, merely to afford the maximum degree of protection to the population.

Secondly, I think that it's not a question of waiting for the facts to come in. I think we've done enough investigation. We've been carrying it on for upwards of five years and at a cost of nearly $40 million. I think it's time to consolidate the facts and move ahead in order to afford that protection to the population.

And as I said, let me reiterate, it's not our intention to stop the conversions at all.

MRS. HARRISON: Well, as you know that -- because you talk about studies, there are all kinds of studies going on, for instance, about health effects, and we can study it every day and we should continue to do it. So I'm not speaking against the studying of it.

But maybe ten years from now, when we put all of those studies together, we will still not know all of the effects, as the studies come in, and you are totally right, Mr. Holstein, when you say -- when we talk about the impact, the economic impact of development of techniques, and so forth, that we should not lose sight of the fact of all the economic impact from a public that is not healthy.

So you have to put all of those figures together, but I think that this panel and the Department of Energy and EPA and everyone certainly wants to hear any facts that they haven't uncovered to move us forward in a manner that we're not going to waste, and yet protect the public health.

I'm hoping after sitting here for eight hours today that I'm going to hear a lot of new things.

MR. HOLSTEIN: I think that one thing you'll probably conclude by the end of today's session, if you haven't already, is that there is such a wide range of opinion on these matters, that we all end up dealing in gray areas. I think our message here today is that -- at least one of our messages here today is that -- Congress has imposed upon you folks the job of sorting out those gray areas, and our difficulty in this instance is that we're dealing here with a program that, beginning with the Energy Supply and Environmental Health Coordination Act's Coal Conversion Authority, which unfortunately or fortunately has not seen much fruition in terms of actual orders for conversion, and continuing on through the National Energy Act that the conferees have now reached agreement on, at least in terms of the coal conversion section, we're dealing now with the very immediate, or at least in the near future, need on your part to come up with the best standards possible, balancing these various gray areas.

And if in fact there is a -- what you would feel is a substantial and compelling body of evidence to suggest that small fine particulate pollution is going to be quite possibly a real hazard, then I think perhaps the forthcoming procedures that you devise ought to take that into account.

I don't know whether it's applicable, but I was noting with some interest the other day that the National Highway Traffic Safety Administration published -- and I don't know whether it's for the first time, or not -- but they published in a recent Federal Register the product of their thinking for the next ten-year period of time in terms of the things that they are taking a look at.

I believe that it's an opportunity to give policy makers, automobile manufacturers, and so forth, an opportunity to begin to think far in advance about what types of safety modifications may become necessary in the future on the basis of on-going research in that department.

Perhaps a similar effort would be called for in this circumstance where an education effort launched by the Environmental Protection Agency to prepare the public, industry, utilities, and the Congress, for what may come on the basis of some on-going research, even if you were not prepared at this date to promulgate standards on the basis of your judgment of this balancing of interests.

MS. VAN SICKLE: Have you reviewed the proposed New Source Performance Standards? And do you feel that they will more adequately control the emission of fine particulates and toxics in the environment?

MR. CALIGUIRE: Frankly, I haven't reviewed them, but I've been led to believe that they're moving in the right direction. The question is: Are they going to be sufficient? And that's a question which frankly I can't answer at this time, but my feeling is that a national standard is going to be necessary, despite the New Source Performance Standards.

Basically, what we're trying to do here today is to encourage the EPA to move ahead in these areas. Mrs. Harrison said before that she was pleased to see someone coming forward urging the prevention of adverse effects.

I think that we've suffered too much in the past from shortsightedness to not move forward in these areas, and I think that prevention is the key. We've made too many mistakes in the past, and it's time now to have a little bit more perspicacity and farsightedness.

DR. REZNEK: Any further questions?

Thank you all very much for your remarks.

MR. CALIGUIRE: Thank you.

MR. HOLSTEIN: Thank you.

DR. REZNEK: We have a substitution next. Dr. Meyer Katzper of Systems Information Analysis is going to substitute for Mr. Clarke Watson.

STATEMENT OF DR. MEYER KATZPER
SYSTEMS AND INFORMATION ANALYSIS

DR. KATZPER: I will expound on one of the issues mentioned by the previous speakers, namely, the fact the Federal government has some difficulty in dealing with small-scale dispersed systems. If we are concerned about control technologies and have a lot of small installations all over, the question arises as to how to monitor them and how to keep them in line.

There are also the questions of the capital costs involved in installing effective pollution controls in many small plants.

In terms of our national needs for energy supplies certainly one of the options that has a lot of potential involves small-scale and intermediate energy technologies, and this is an area which -- again, partly due to the Federal government's problems with it -- has not been explored sufficiently. For instance, the Department of Energy has been critiqued for a lack of emphasis on small scale dispersed energy systems. A synthesis of these critiques may be found in the book, Soft Energy Paths: Toward a Durable Peace by Amory B. Lovins (Ballinger Pub. Co. 1977).

The two main points that I will focus on in my talk, therefore, are, A) what should be done with respect to small and dispersed energy technologies, and B) what does the government have available, so to speak, and what technologies can it help to advance? Energy technologies must not be considered in isolation but in terms of the infrastructure they fit into.

The synthetic fuels program, for instance, fits into a preformed network. Similarly, the many electrically oriented developments which involve high technology fit into a pre-formed network where the distribution is already available and the entire supply system is in place.

If we want to put into operaton some sort of a small scale energy utilization process, we have to worry about its discharges. But we also have to worry about the entire infrastructure, which means that we have to worry about starting from resources and going through the many steps of manufacturing, transporting and distributing all the way to the end where you get your discharges.

This is done in very large cases. If you're worried about a mine mouth power plant you're going to wonder how you're going to get everything from here and there, whereas if you're wondering about a local town's heating and cooling facility, no one worries much about the distributor and about the supply or about the manpower.

One of the examples given by Lovins of a technology that has achieved widespread use on its own is up in Vermont with the cold winters and lots of wood around. Apparently the increase in the number of Franklin stoves burning wood has been something like thirty or forty percent.

You can say, "Oh, isn't that great?" But there is a catch and the catch is, there already was in place a manufacturing industry, suppliers, distributors, and even repair services to fix the stove, if anything should happen to it.

This is the sort of analysis which has not been carried out in terms of the entire chain, even though every step of that chain also has environmental impact on energy implications. You not only have to worry about the end user creating soot from his stove, but you also have to consider the manufacturing. The stove may be manufactured in an antiquated plant.

We now will focus on an example of a technology which the government can help develop which can provide energy and solve problems of waste disposal.

One of EPA's major mandates has been to assist in clean disposal of solid waste. EPA has undertaken some interesting and innovative attempts at waste disposal which also will use the waste to generate energy in a relatively pollution-free approach.

Unfortunately, the experiment that was carried out and that's best known -- namely, the Baltimore pyrolysis plant -- collapsed, in a sense, in that enormous financial losses were incurred. Monsanto, the company that was involved, backed out at a great loss to themselves.

But if we look at the history of what happened, it's interesting to note that the bench scale prototype was developed and operational in 1968. It was rather small, 0.6 tons per day. By spring of 1969 they had a small-scale prototype in St. Louis, Missouri of 35 tons per day, and also in the spring of 1974 in Kobe City, Japan, there was a 35 tons per day pyrolysis plant. Late in 1974 Monsanto put into operation their full-scale prototype of 1,000 tons per day, and disaster after disaster occurred.

I suggest that while it is necessary to consider all of the integrating infrastructure factors previously mentioned, such as the support required to establish a small-scale plant, nevertheless if these small-scale plants had been fostered, had been spread, had been supported by EPA instead of scaling up, there could have been at least a half-a-dozen small-scale plants operating around the country by now. Those plants would have given us an enormous amount of knowledge that we need.

However, what has happened instead is there is one big plant and it's ten years since the bench pilot project was carried out.

I therefore suggest very strongly that EPA use some of its resources, at least, in looking at the smaller scale technologies and supporting their development. One of the approaches suggested is the use of coal for fluidized bed technology for cogeneration combining electric production with process team generation or district heating. These technologies are admittedly largely untested. They have not been implemented at full scale. Experimental prototypes will of necessity be expensive.

There are going to be overruns, but if we develop smaller scale technologies we can put them into action faster than large scale projects and we can find out whether they are operationally effective.

In the case of pyrolysis and fluidized bed technology, we have processes which possess similarities, and we can learn from one with respect to the other. We can possibly -- hopefully -- develop environmentally superior processes so that we don't have to put our major focus on best available technology for pollution control.

Scaled down and environmentally superior energy technologies are the two things which I feel have not been focussed on.

There is an interesting problem in the choice of focus. Administrators, given a choice between a multimillion dollar project or devoting some of their time for a smaller scale project, are going to pick the ultrabig project. After all, the large prestigious project can supply a large percent of our country's needs, and can be bolstered with many arguments and supporters. But it's not true, if the thing's going to flop.

Specifically, in the case of pyrolysis, I really think that it's something which should be revived on a smaller scale in spite of the large scale failure.

QUESTIONS AND REMARKS

DR. REZNEK: I enjoyed your comments. As you know, within the Federal government the basic responsibility for creating energy technologies, at whatever scale of operation, lies with DOE. EPA's responsibility is for environmental overview and assessment of these new energy technologies.

Your comments about the difficulties of bringing about a small technology, a technology for systems consuming a relatively small number of Btu's per day, and your comments about how the Federal government has difficulty in managing a program designed to create such a small-scale technology, are intriguing. I would like to hear a response to these comments from the panel, or perhaps you would care to discuss this matter further. I'd especially like to hear any suggestion for how to deal with this situation.

DR. MACKENZIE: Well, I think you're quite right. At the moment the Department of Energy does not have, for example, any office of small-scale technology. Senator Percy has submitted legislation to create it, and it looks like it's going to happen, but partly it's, I think, from my experience, a problem of staffing.

And this goes true with your argument about one big thing rather than a lot of small things. It takes a lot of people to manage a lot of different contracts, and one person can manage a big contract rather easily, and that's another institutional problem.

It strikes me, though, that it's not always true that small-scale things are necessarily cleaner than bigger ones.

DR. KATZPER: No. I don't make that claim. I understand.

DR. MACKENZIE: But I mean there is an environmental trade off. There's a total energy system that Harvard University is trying to build in the middle of downtown Brookline, Boston, in the middle of the Harvard Medical Center complex, and it's being fought bitterly because it's going to produce about one percent of all the NO_x in Massachusetts in the middle of this hospital complex.

And yet it's the sort of thing, you know, with high energy efficiency, supplying chilled water and electricity and the whole business, and so I think I agree with you. Things have to be approached, though, sort of separately and separably, and scrutinized carefully.

MS. VAN SICKLE: Perhaps a lot of this is happening more at the state level. In Louisiana we have about a million tons of bagasse produced each year, a sugar cane by-product, and a lot of the mills are already burning this to provide heat to refine the sugar.

So I don't know -- I'm sure as long as we stay within the water and air quality standards, that we'll be all right with that.

MRS. HARRISON: Well, having served on the Energy Task Force for the National League of Cities before I came to EPA, we studied some of the pyrolysis plants, and so forth, and I will admit that the big ones were flops, and therefore everyone ran away from going back to that kind of technology.

But in the meantime, there are some communities that are fairly viable that are trying some things on their own, and also some states, as you suggested.

It's not going to always be the Federal government to do some of these small-scale things. It's going to be certain regions, certain cities, certain counties that are going to go ahead on their own with some assistance from Federal government.

So I think if you will look around, there are, in fact, some small technology things going.

DR. KATZPER: May I interrupt for a second? I know they're going on, and what happens is not only the Federal government not helping in their development, as it should, but once they're going they are well hidden.

If we say that we have a need, at least one simple test that can be made is instead of doing academic type and policy studies, which decision makers like, one could say, "Here is what actually is there. Shouldn't we try convincing one or two other guys to try it?"

It's as simple as that.

DR. REZNEK: I am intrigued with the idea that rather than the Federal government establishing a Franklin stove repair industry, its proper role is to document that one, in fact, exists. I think that is an important role, a role which can't be done at any of the lower levels of government. Furthermore, I should say that the Federal government could probably accomplish this documentation a lot cheaper than other organizations.

Are there any further guestions?

DR. REZNEK: Thank you.

DR. KATZPER: Thank you.

DR. REZNEK: The next witness, actually the next two witnesses, are from the National Water Well Association: Jay Lehr, its Executive Director, and Tyler Gass.

STATEMENT OF THE NATIONAL WATER WELL ASSOCIATION
BY DR. JAY LEHR, EXECUTIVE DIRECTOR
AND TYLER GASS, DIRECTOR OF TECHNICAL SERVICES

DR. LEHR: Thank you, Dr. Reznek, and panel. The National Water Well Association greatly appreciates the opportunity to address this very important hearing.

Just a moment to introduce ourselves. The National Water Well Association started out as a professional society and trade association representing the ground water supply industry and geologists and hydrologists involved in ground water development.

We have evolved in recent years primarily to a research, education, and development group with a professional staff of fifty residing in Worthington, Ohio. Our primary responsibility is research and publishing and dissemination of information on ground water development, and, perhaps more importantly, ground water protection.

Our interest in non-nuclear energy development has a very long track record. During the past decade, as interest has focused on the development of oil shales, more extensive in recent years, on further development of coal, and as well, the continuing development of oil and gas, all of these energy activities have a significant impact on ground water utilization.

Now, we begin from a position where we recognize that our nation's ground water resources are between twenty and thirty times greater than our surface water resources. They have been underutilized, primarily due to lack of education, but as our surface waters become utilized to a greater degree, and also more and more polluted, in recent years the emphasis of ground water use has increased manyfold.

And while we have vast ground water resources, we cannot afford to pollute them. And we wish to charge this Agency with a very careful cost accounting in terms of oil shale development, coal development as well as marginal oil and gas, to recognize that the requirement for large quantities of ground water in the development of these non-nuclear fuels should be taken into account and recognized as a cost, that this water should not be thrown away unnecessarily, as the nation faces a significant water crisis.

So our first message here today is to ask that you guard carefully against the pollution of our underground waters in the development of non-nuclear fuels.

The second is to awaken you to the fact that we can in fact use ground water not just indirectly in the development of non-nuclear fuels, but we can use ground water as an energy source itself.

The aspects of ground water that make it cooler than air in the summer and warmer than air in the winter offer it as a great potential for energy utilization in extraction through heat pumps, and we'd like to direct a few minutes of our comments here on that subject, and for this purpose I would like to introduce to you Mr. Tyler Gass, who is the Director of Technical Services for the National Water Well Association, to speak more specifically on that part of our testimony.

MR. GASS: Perhaps the best way of working towards protecting our ground water resources, due to the development of fossil fuels, is by reduction of our need for fossil fuels. And this could be done by utilizing ground water as an energy source.

Ground water, regardless of its temperature, should be considered a form of geothermal energy. Temperatures as low as forty degrees Fahrenheit can be used with conjunction with a heat pump to heat or cool interior building space.

Perhaps I'd best begin with describing what a heat pump is.

A heat pump is a year-round air conditioning and cooling system that utilizes a medium such as air or water as a heat source or heat sink.

For heating, heat is extracted from the medium -- air or water --and it's transferred to a refrigerant. The refrigerant -- the heat energy in the refrigerant is pumped from that heat exchanger to another heat exchanger, which would be an air refrigerant heat exchanger, interior air space, passing through that heat exchanger, would absorb the heat and carry that through the building.

During the summer when cooling is needed the reverse would occur. Heat from inside the building would pass over the air-to-refrigerant heat exchanger transferring the heat from the air to the refrigerant. The refrigerant would then be pumped to the outside source, which would act as a heat sink, this time, whether it be air or water, and the heat is extracted and the refrigerant continues through the cycle.

If we have an abundance of air you may ask why use ground water? Well, there are a number of reasons for this.

First of all, let's look at some of the physical characteristics of water. Water has one of the highest specific heats of any compound commonly occuring substance on the face of the earth. It has a specific heat of one. Air has the specific heat of 0.18, or eighteen thousandths.

The specific heat is kind of a measure of a substance's capability to store heat energy or transfer heat energy. If we take a pound of water, and starting let's say at fifty degrees, and we lower it one degree Fahrenheit, we get one Btu out of the water.

If we take a pound of air and lower it one degree Fahrenheit we get eighteen thousandths of a Btu.

In other words, we're getting fifty times the amount of heat energy for a given temperature drop, for a given unit weight, of water than we would with air. Therefore, the ground water heat pump operates at a much greater efficiency than the air source heat pump.

But as many of you may know already, the air source heat pump has gained great popularity in the United States over the last few years.

In addition to being -- and literally the ground water heat pump is twice as efficient, producing twice as much heat or twice as much cooling capability as an air source heat pump.

In addition to this, it overcomes a number of other problems associated with the air source heat pump. Air source heat pumps rely on outside air temperature. It's a non-steady state situation. As the air temperature drops, let's say, during the winter when you need heating, the system becomes less and less efficient. During the summers when you want cooling, the air temperature outside is hot, and it acts as a less efficient heat sink.

Ground water has a constant temperature throughout the year. The temperature range of ground water in the United States is ideal for ground water heat pump operations.

In addition to this, utilization of ground water, with the heat pump, is a non-polluting source of energy. It's also a non-consumptive type of energy. We're returning the water back to the ground.

Now, in a wide band of the United States, where the heating and cooling loads are almost balanced, there is no chance of environmental damage whatsoever.

There are a few areas where either the heating load dominates the situation throughout the year, or the cooling load dominates the situation throughout the year, where there may be -- and I emphasize may, because preliminary investigation shows that it seems like it would be insignificant -- but there may be an environmental impact.

The factors which affect the impact have to do with heat pump -- the density of heat pump use, the rate of ground water movement, the heating and cooling load of the area, and the net change of the water temperature entering the system and leaving the system.

There are 13 million homes in the United States today being supplied by individual well water systems utilizing ground water. There is no reason in the world why these 13 million homes cannot be reducing their energy consumption for heating and cooling by one-half to two-thirds by utilizing ground water heat pumps.

There are over a million factories in the United States today that utilize ground water for a sanitary or a drinking water supply or for industrial use. There's no reason in the world why these one million factories shouldn't be using ground water for heating and cooling.

In addition to this -- and probably more important than the two groups I just mentioned -- there are half a million new homes going up each year that will be supplied by ground water. They will have individual water supply systems, well water, and they'll be using ground water, and in the planning stages they should be planning to develop or work with a ground water heat pump.

After all, in most areas they cannot get natural gas any more. There's a problem getting oil. Electrical costs have skyrocketed, so they should and they could be using ground water heat pumps today.

The National Water Well Association and the Water Well Contractors of the United States have gone a long way in promoting ground water heat pumps by explaining the availability and the occurrence of ground water in the United States.

Heat pump manufacturers are beginning to explain the utilization of ground water heat pumps. So slowly the country is recognizing that these systems exist.

However, there's a great need to educate the public on ground water heat pumps. The Federal government has gone a long way in promoting the utilization of solar energy, and in doing so the public has gained acceptance in the utilization of these systems.

The Federal government has a hand and should be actively educating the public to the availability of ground water heat pumps and the availability of ground water in the country. For in eighty-five percent of the United States there is enough underground water at shallow depths that these systems can be utilized.

I'll turn back to Dr. Lehr for some concluding comments.

DR. LEHR: Thank you, Mr. Gass.

Again, I'd just like to emphasize that we have a two-fold purpose here. One is to focus a great deal of attention or ask that attention be focused on the cost of utilizing underground water in the development of non-nuclear energy, the vast quantities of water utilized in the development of oil shale, the vast quantities of water that are polluted in coal development, acid mine drainage problems, and the like, the potential pollution problem of developing marginal oil and gas that deal with the fact that salt water is developed with the oil and gas and has to be disposed of, and the disposal problem is one that is very hazardous to the well-being of the potable ground water that exists in those areas, and simply that we -- we put a cost on these water supplies and do not develop them thinking that some water is lost but it doesn't have a cost to society. It does.

And then, focus attention on the turnaround and look at the water as being a direct energy source, something that's been totally overlooked. It seems today, in the non-nuclear area, if you get away from the shale and the gas, the oil, the coal, fossil fuels, solar is the magic word.

I suppose we could use solar -- we could say that it's solar energy that heats the earth and it's the heat in the earth that heats the water in the ground, and thus ground water heat pumps are a solar energy source. I suppose that's true, but that's hiding behind, today, a political catchword to make something very popular.

We have a sleeping giant in energy available tens of feet below the earth that can be utilized directly as a non-nuclear fuel that has not begun to be done so in this country, but I think the future of looking at that for the Environmental Protection Agency and looking at then the environmental impact of doing this, which is going to have to be done hand in hand, is the message that we wish to leave you with.

Thank you.

DR. REZNEK: Thank you. Panel?

QUESTIONS AND REMARKS

DR. MACKENZIE: First, I'd like to say I enjoyed your presentation.

You're probably aware that the Department of Energy has a division on energy storage, and in fact they are planning I think for next year to air condition JFK airport using underground water as seasonal storage.

What they'll do is all winter long they will bring up water from below, run it through their cooling towers, cool it further and further, put it down into the aquifer, and then during the summer draw it out for air conditioning purposes.

They expect to reduce their cooling demand for electricity by ninety percent using this.

And so there is a program.

But there are a couple of questions that arise in my mind. First of all, whether there's more information available. You said eighty percent of the country, I think it was, there exists enough water. I'd be interested in any documentation, for the record, if you have, or personally, or whatever.

DR. LEHR: Yes, we could supply that.

DR. MACKENZIE: Secondly, are there legal problems? Who owns the water? Is that going to become an issue, if people start using this either for seasonal storage or for a heat pump?

DR. LEHR: There are indeed legal problems. They vary from state to state. By and large, though, for non-consumptive use of ground water, and the small quantities that are consumed through this use, landowners for the most part can do as they please as long as they're not polluting.

Now, the states are going to have to look at this problem individually and decide under what regulatory scheme they can allow people to take water out of the ground and put it back in the ground, essentially chemically unchanged. They are going to have to also look at the ramifications of alteration in the thermal balance of the ground water.

And these are areas in which research is desperately needed. These are problems that will have to be solved, but they're not problems by any means that should turn us aside from utilizing it.

The JFK situation is an outstanding example of some research that is being done. As a mater of fact, the low temperature energy group at Oak Ridge, Tennessee is holding a symposium on it, Lawrence Berkeley lab, the second week in May, of which I am one of seven speakers that will form basically a state of the arts report on low temperature energy storage.

MRS. HARRISON: I think a couple of my questions have already been placed, but you mentioned the environmental impact, you know, and studies are needed for that. I agree.

I wonder, though, if the National Water Well Association has done any studies on environmental impact of constant movement of underground water, and if so, what do you suspect in that area?

DR. LEHR: I think I can answer that, Mrs. Harrison.

We have been working in this area for about three years. We started off with a very small seed grant from EPA to look at it. In the past year we have built our own test facility in a domestic home in Columbus. We've only scratched the surface.

We suspect, as Mr. Gass inferred, that the environmental impact will be very slight. That is to say in most areas the heating days and cooling days balance each other and the ground water moving so slowly that within a given aquifer, a small area, the net input of heat approximately equals the net extraction of heat, so that over a large area of the aquifer there is no net change in temperature.

There have been some studies done at the University of Wisconsin actually charting a plume, a thermal plume moving away from a storage area, looking at the dissipation of heat and the long-range alteration of the temperature of the ground water. It appeared to be virtually negligible. But this is only the beginning, so we suspect that the end result of research that is needed will be very positive, but there is no way that the government can really begin promoting the utilization of this type of energy without having much harder facts that we have today.

MRS. HARRISON: Also, although I know your facts are still scanty, what would you project as the use of underground water as far as giving us energy in this country? Would it be five percent of the energy needs, or ten percent? Or what? At one time I heard a ten percent figure that was thrown around for a long time, but I think that was probably taken out of somebody's imagination.

DR. LEHR: I think that's true, and the more I look at the various energy alternatives, that look very exciting, you always come down to what I say, single-digit numbers, and the more we recognize that there is not one answer to our energy problem, but we damn' well better have twenty, twenty times five, making a hundred, and I think we're in that range.

I think we're talking between four and eight percent of what we look at, and probably the most important figure to recognize, which is a very accurate one, and the one Mr. Gass gave, is that there are 13 million homes drawing their water supply from wells, and these very same wells, without even drilling an additional well, other than the disposal well, which is a much less costly factor, can be utilized in eighty percent of the cases. They could retrofit a ground water heat pump system that would probably -- again, by our preliminary estimates -- decrease the amount of fossil fuel that would be needed for heating and cooling these 13 million homes by about sixty percent.

That's a lot of millions of barrels of oil a day that could be saved. This again is something we need much harder numbers.

MS. VAN SICKLE: What are the current and projected costs for the installation of ground water heat pumps in individual homes?

DR. LEHR: Presently -- to give you an idea -- the sole national manufacturer of heat pumps, which are supplied in Florida area, the Frederich Group of Wylain

Corporation, which is a New York Stock Exchange company, makes a unit in the state of Florida working on a higher temperature water. It will work on fifty-five degrees, but they really only promote it for sixty degree water. It sells for $1200.

They have told us that within six to eight months they will have a unit that will work on forty degree water, which is the lower level of ground water within the United States, and they estimate that the cost will not exceed $1800.

Now this is not a lot more than the standard furnace, and of course it does both the air conditioning and the heating. Generally it can be retrofitted to your air duct work in a house with only minor alterations to what presently exists.

But it will be more expensive, but we're talking about reducing electrical energy costs or oil and gas quite dramatically. We're talking easily in terms of fifty percent.

DR. REZNEK: Any further questions? Thank you very much.

DR. LEHR: Thank you.

MRS. HARRISON: If you get a button for underground water, instead of Sun Day, I'll wear that too.

DR. LEHR: Thank you.

MR. GASS: Thank you.

DR. REZNEK. The next witness is Dr. Ronald Wishart. He is director of the Energy and Transportation Policy of the Energy Supply Service Group for Union Carbide.

STATEMENT OF RONALD WISHART
DIRECTOR OF ENERGY AND TRANSPORTATION POLICY
ENERGY SUPPLY SERVICE GROUP, UNION CARBIDE CORPORATION

MR. WISHART: Thank you. I appreciate the opportunity to be here with you.

I am Ronald Wishart, and I am Director of Energy Policy for Union Carbide. I strongly support your review of environmental and other impacts on non-nuclear energy research and development and of the role of the government in achieving necessary environmental and energy goals. I welcome the opportunity to participate in it.

I've chosen -- you have in front of you, I guess, a draft of my remarks. I've chosen, you'll find, to drop out a couple of things in my oral discourse here in the interests of time.

We in the chemical industry have a special interest in the development of all new energy technologies -- non-nuclear included -- that can supplement or replace the finite supplies of petroleum and natural gas that presently power our manufacturing processes and provide our basic raw materials, for hydrocarbons are to our industry what iron ore is to steel and electricity is as essential to us as it is to the manufacturers of aluminum.

For the chemical industry as a whole, fifteen cents of every sales dollar is spent for energy and feedstocks. That figure rises to thirty cents of each sales dollar for the pertrochemical companies. We are here, therefore, as a large energy consumer with great reason to care about how much we pay for energy, how efficiently we use it, and whether there will be an adequate supply available when we need it. Government, I'm afraid, will play a major role in determining the answers to all of these questions, and of course we hope they will be positive ones.

If anyone questions the need for development of new energy technologies, he should look at the fact that oil and gas -- with proven reserves of only a few decades -- supply 76 percent of the U.S. energy needs today. Coal, shale, and uranium -- with reserves large enough to meet our needs for hundreds of years -- provide only twenty percent. All other resources, including renewable ones, take care of about four percent.

There's an obvious need to encourage fuel switching in the stationary applications that utilize over sixty percent of our oil and gas to produce heat and power. And there is an immediate need to reduce the thirty percent of these scarce fuels now used for transportation, while we develop effective, economical ways to synthesize transportation fields from plentiful U.S. coal and shale resources.

And there is a special need to do these things so that we can preserve these finite supplies for their highest value added use as chemical feedstocks, because these hydrocarbons have unique properties as chemical building blocks that make them hard to replace in the near future.

In recognition of these needs we have for some time been switching our natural gas boilers to oil, and to coal. We have done so for three reasons:

the anticipated scarcity of natural gas, the rising cost of oil and gas and their greatly enhanced value as feedstocks. But neither we, nor the nation, can stop there.

We must develop alternative feedstocks with longer term potential than oil and gas. Therefore, we at Union Carbide -- and I'm sure others -- are exploring alternatives that range from the familiar -- making synthetic gas from coal -- to the exotic -- using biological synthesis to turn biomass and solid waste into chemicals.

The Department of Energy is proposing to have built, or to encourage the building of, a small number of commercial scale coal conversion plants which should be suitable to demonstrate the feasibility of various technologies at full scale.

Such plants will be few in number over the next decade, since their products will not be currently profitable substitutes for petroleum. Nonetheless, it is essential that they be put up and be in operation as soon as possible if we are to learn enough from them to support expansion of these technologies in the 1990's.

Hence, it seems to us that the role of the EPA should be to prevent delay of these plants by the environmental regulatory process. In the perspective of the national air loading, for example, these few plants can hardly be consequential, and time exists to develop and add an adequate environmental protection technology if a coal conversion process demonstrated, proves to be economic.

Coal-based technology leads our list of alternatives because of the abundance of coal and because of our long industrial experience in synthetic gas processes. Crude oil from shale, tar sands, and coal will eventually become more attractive as the price of crude oil from conventional sources goes up.

And finally, increasing oil and gas prices and improving biomass and solid waste utilization technologies will make these resources attractive, probably by the 1990's. It is possible that the alternatives we are now studying can provide ten to fifteen percent, but not more than 25 percent, of needed feedstocks by the year 2000.

Based on our current technological innovation and our own experience in commercializing new technologies, we see four phases of change in the chemical industry between now and the year 2000:

In Phase One, which is where the industry stands today and is likely to remain for the next six or seven years, research, development, and demonstration projects on alternative feedstocks are being conducted on a priority basis.

Perhaps the most important development in this phase is the commercialization of technologies to increase the efficiency of the use of crude oil as a feedstock. An important evidence of this is the demonstration of an Advanced Cracking Reactor which will be operating at Union Carbide's Seadrift, Texas plant in 1979. It will make ethylene, a key chemical building block, directly from atomized crude oil, and will provide a higher yield of ethylene from each barrel of crude.

Phase Two will be characterized by increasing production and use of synthetic gas from coal as a feedstock for such chemical products as ethylene glycol -- which I think you know as anti-freeze, and it's also important in polyester fibers -- and methanol, a widely-used solvent and intermediate. We expect these technologies to emerge in the late 1980's.

Depending on economic and technological factors, they could eventually displace natural gas and some petroleum feedstocks for as much as 25 to 30 percent of the U.S. petrochemical production. Syn-gas technology can utilize a wide range of feedstocks such as residual petroleum fractions, coal, municipal refuse, and biomass.

Phase Three will be characterized by the introduction of supplemental crude oil derived from shale oil and coal, both as fuels and possibly as feedstocks. But supplemental crude will not play an increasing role before the 1990's.

Phase Four will involve the production of chemicals from biomass or solid waste, both of which are renewable resources with great potential. Commercialization, however, is not expected until well in the century, for several reasons.

Biomass harvesting is expensive and not an efficient art today. It would, for example, take 100,000 acres of corn to produce enough starch to supply a commercial petrochemical plant. Biomass also has a lower specific carbon content than coal and a higher moisture content, and this means more expensive and less efficient conversion processes. Solid waste, on the other hand, is readily available, but the cost of collection, transporting, sorting, and converting it is high.

We see the chemical industry using biomass and solid waste in two ways: synthetic gas for the production of oxygenated chemicals and ammonia, or in the direct production of chemicals, such as alcohol, through fermentation and other biological means. Union Carbide's biomass research effort is going forward in anticipation that in 1990 this technology may be a viable alternative.

Development and commercialization of alternative feedstocks will take place slowly over a period of decades as we shift first to coal, next to shale, and then to biomass and other resources. But this timetable may be shortened -- or it may be lengthened -- according to the incentives for progress or impediments to it put in our way by government legislation and regulation.

Synthetic liquid fuels made from coal appear now to be unsuitable as feedstocks. Therefore, our principal interest in them is in their displacement of crude oil fractions from the fuel market. This displacement will make petroleum feedstocks more available. We believe, really, that if we take care of the fuel problem, the feedstock problem will be resolved.

We see opportunities for dramatic reductions in process fuel requirements in the chemical industry. For example, the 1980 olefins plants will use forty percent less process energy than the 1965 olefins plants. And in our chemical plants we have, in 1977, this is Carbide's plant, experienced an eighteen percent reduction in the Btu's required per unit of output, compared with 1972.

Feedstock energy improvements have been achieved, but the opportunities here are less likely, since feedstocks are converted into products, not consumed, as in the process fuel uses.

I've reviewed our scenario for development of alternative feedstocks for two reasons. First, it suggests my company's active commitment to develop alternatives to current oil and gas, but more importantly, it indicates that development, demonstration, and commercialization of new energy technologies does not take place overnight, and that the realistic time frame is measured in decades, not years.

For that reason, we obviously can't wait until the supply of traditional energy and feedstock resources is depleted to start development. We also can't wait until utilization of a specifc technology is economically feasible before the research and demonstration processes begin.

We need to have the new technologies waiting in the wings when the time comes that it makes economic sense to use them, when it is more economical to switch to renewable resources than to drill for finite ones.

Realistically, the decision to make commercial use of new technologies will be made on a solid economic determination that it is better to invest money in chemical processes adaptable to coal processing than in the drilling of deep, dry holes in well-perforated real estate.

Not surprisingly, positive government incentives can move forward the time when these new technologies do make sense economically.

As an example, current oil and gas pricing data demonstrates that it is not economically advantageous to invest in coal utilization and that additional incentives are required to reach parity. If, as proposed in current National Energy Plan negotiations, drilling incentives are allowed to increase four and one-half percent above inflation, it would take approximately fifteen years to double the gas-oil incentive. More than doubling seems to be needed to make investment in coal utilization attractive.

The economic decision is an important one, because energy development and environmental control, as well as chemical manufacturing, require major capital investments. Since money, like oil, gas, and clean air, is a finite resource, the size of these investments is a prime indicator of when it becomes logical to shift to other fuel and feedstock alternatives. Given the risk and uncertainty that seems to abound in current environmental laws and regulations, it's a natural reaction to minimize investment to conserve finite money resources.

In this current period of energy and environmental challenges we believe four things will determine how successful the nation -- and the chemical industry -- will be in developing, demonstrating, and utilizing new non-nuclear alternatives to the present fuels and feedstocks.

First, the kind of realistic economic signals and incentives from government that enable and encourage us to develop and use current energy resources as efficiently as possible, and that foster development of alternative resources. Most productive would be a change in the current carrot-and-stick approach to emphasize the carrot -- not the stick.

Two, a rational approach to environmental goals that won't stand in the way of needed development of new resource technologies. Let's not hold up development of badly-needed energy technologies until we have developed environmental protection technologies. After all, the best environmental protection equipment in the world is no good if there isn't an adequate energy supply to operate it.

We also need to ask ourselves if zero-impact-on-the-environment is a viable environmental goal, or an unrealistic roadblock to the development of new technologies.

Three, legislation and regulation that provide the kind of certainty needed to make required capital investments and economic decisions. This is essential if private decision makers -- like my company -- are to respond rationally to the nation's energy and environmental needs.

And fourthly, a commitment from government and industry to innovation and technology, and a realization that there are demonstration technologies that industry can afford, and some that only government can afford.

Innovation may be too ambiguous for some planners to use in their models, but recent history teaches us that resources provided through new technologies are the variable that confounds the arithmetic of depletion. At Union Carbide we're convinced that scientific and technological innovation is the driving force behind conservation, development of new energy resources, and environmental protection, for it involves using both our resources, and our resourcefulness.

We firmly believe that if either the chemical industry, or the nation it serves, fails to stay economically and socially healthy in this era of energy and environmental challenges, it will be from lack of faith that we can come closer to creating the kind of society we want -- not from lack of resources.

We don't have that lack of faith at Union Carbide.

Thank you.

DR. REZNEK: Thank you. Panel?

QUESTIONS AND REMARKS

DR. MACKENZIE: Yes. Do you have any idea what the chemical feedstock needs will be in say 1990 or 2000, any kind of an overall -- primary fuels in quads -- guess?

MR. WISHART: Well, there must be a study some place. Present feedstock and energy needs of the chemical industry are about eight percent of the oil and gas supplied in the United States.

DR. MACKENZIE: So it's about six quads, or something like that.

MR. WISHART: Yes, five, three, something like -- maybe six, right.

DR. MACKENZIE: You think maybe it will double by the end of the century? I mean do you have any sort of sense of that?

MR. WISHART: It's a good question. We have, for example, seen studies that project the GNP growth at its reduced rate and project the chemical industry growth at its reduced rates, and one is still double the other.

So the arithmetic suggests you would be looking at double, or more, maybe, in that time.

DR. MACKENZIE: Have you -- has the chemical industry, or Union Carbide, looked at the relative economics of say biofuels versus synthetics and coal? It seems to me that they are, you know, very close to being in the same technological state. People produced methane for a long time, and from there methanol is pretty straight forward.

MR. WISHART: Well, of course. In parts of the world biological processes are fundamental. In India, for many years we operated an ethylene plant on ethanol made by fermentation. That has not been economic for a number of years, but I don't know the present state. I think that it is considered sometimes.

Today -- I think it is being reconsidered today. That, of course, is a local decision.

The biomass problem -- I commented in my paper here, in the part I skipped over, a detail that it takes really an enormous amount of land and material to produce -- support a significant size plant.

I had a group some years ago. We studied all kinds of things, including making ethylene out of the waste from feed lots. You could do it, but it would take an awful lot of cows.

DR. MACKENZIE: It's being done commercially now in Chicago at about a dollar-and-a half for a million Btu's, producing gas from manure from feed lots, so it's --

MR. WISHART: Zero cost for the manure, huh?

DR. MACKENZIE: Well, that's a waste product. We're solving a problem there as well.

MR. WISHART: Yes. Yes. Yes, and there's that enormous spruce forest up in the middle of Maine that has been affected by the bugs, a very large acreage. It's -- I guess I equate this, you know, a little bit to the analyses we've done ad infinitum since the early sixties about making petrochemicals in Arab lands. If they gave us the raw material for free, we can't do it.

I think that will change as their economies advance, and they -- it doesn't -- it isn't so extraordinarily costly to build a plant and maintain a work force, the transportation, and so on. It's -- something like that happens with the pine forests. The manure was concentrated, but I think the feed lot -- the Chicago stockyards are shut down, aren't they?

It's a -- you know, it's the gathering business, developing the experience in the infrastructure.

DR. REZNEK: I'd like to explore the question of not having environmental goals which serve as a detriment to development of alternative feedstocks.

If the chemical company is going to grow at a rate which will double its size by the end of the century, and if our resources of clean air and clean water are finite, and if we're going to be using fuels which have a great potential to be dirty, as for example when you start using coal rather than natural gas to produce methanol, how do you strike a balance?

There's a need for economic growth and a need for environmental protection. You are considering using resources which produce a larger amount of pollution to be abated? How do you draw the bounds? Under what circumstances do you set a course which will degrade the environment? Or when do you try to hold the emissions inventory of your industry where it is now? How do you strike a balance?

MR. WISHART: Well, I left you with the wrong impression, I think, based on your first comment.

My point with respect to the alternative fuel sources was that in the next decade the construction of those plants is going to be very few, because they don't make economic sense, today. It's a de minimis problem.

I would not suggest that you should not have what are deemed to be adequate environmental protections associated with such plants when they proliferate. My point is, though, first build the plants, and see if the thing is going to work before you -- the alternative might be, you see, to delay the building until you were perfectly satisfied that you had adequate environmental protection, and you would be then stressing a technology which is unproven, losing time, and time is a valuable asset.

But I also said that it's appropriate in that decade to be concerned about the environmental things, but that comes second.

Is it worthwhile to develop a fancy apparatus to clean up the air when you don't know that you're going to use the thing at all? That was the point I was making.

Now, with respect to the other point, about the chemical industry, it indeed -- it's position has been, I think -- oh, ever since the generation of management changed in 1965 because of the environmental stress -- has been that it has to be a good citizen, and can't pollute the air.

The point of zero degradation, though, represents an absolute that is more a function of how good is the analytical technique than how much we pollute, and the analytical technique keeps advancing.

We found, for example, in the Coal Policy Project, in our discussions there with the environmentalists about clean air and other problems associated with coal -- and Jackson Browning will talk about that in a couple of days, before you -- we found that when we sat down together that everybody agreed that every time you build a plant you would have some effect on the environment. You would have some effect.

There is a balance between necessary economic development and impact on the environment, and you cannot say that one is so important you will not have the other, and we agreed on that.

So I think that really the point I'm making here is that we have to keep things in balance.

MRS. HARRISON: Mr Wishart, I think maybe all of us misunderstood, but it's pretty clear in writing on page five, page seven, in your closing remarks, that government regulations are very bad things to have, when you don't know exactly all the effects that you're going to get from pollution control equipment, and all.

The one thing -- I spoke to someone at the break and I said I liken it to what a doctor said to me, that when everyone starts talking about the problems of cholesterol, and said that he was going to put his patients on low cholesterol diets because if in ten years it was proven that they didn't need to be on those diets, they still would be fairly healthy anyway. It wouldn't hurt them. But if he found out that he waited for all the results, and in fact they should have been on low cholesterol diets, he couldn't retrieve the damage that was done.

I'm not saying that you need unreasonable controls, but who is going to decide what's unreasonable? It depends on whose ox is gored, sometimes, I think, and in my region I have to really look at the petrochemcial industry, because I have so much of it in my area.

And what I find missing in this text -- and I would like to ask you if it's part of your consideration -- is the fact that you're talking about the economics of environmental control being so tough that maybe it will cause people not to build plants anymore, or whatever, because of the economics of it, but do you explore the fact of what kind of productivity you get out of employees, for example, if there's more illness in the area of all the chemical plants, if there were no controls, by people not coming to work or being half as productive because they don't feel well?

What are the medical costs to Uniòn Carbide, for example, because they have policies on all these people -- I'm certain that they do.

MR. WISHART: Yes.

MRS. HARRISON: So that really also has to be figured in on costs, I think.

MR. WISHART: Well, I recognize your point, and the problem isn't arising from a general debate on that subject. It's not a question of whether we agree with you or not, but the question is quantification and what degree makes sense.

But that was not the object of my statement. The object of my statement was to try to bring a sense of perspective to what has seemed to me to be an incredibly difficult thing, and that is to develop the alternate fuel technologies.

I have on a number of occasions in public, predicted we'd never see, in my lifetime, anyhow, coal conversion plants, for a lot of reasons.

There's an abundance of oil in the world right now, right? We have a national defense security dollar problem. That's what that's all about, that question of the importation of oil, and indeed there is a lively concern in the government, and I think some concern in the countryside, about that.

The proposals with respect to alternate fuel development from coal it seems to me are coming into some sensible perspective. We're not talking about crash programs now. We're talking about proving out a few of them.

Mr. O'Leary has a B-17 analogy, which is a pretty good one. He says that in 1942 -- and I remember that -- there were twelve B-17's in the world. Not a very big bomber force for the United States, but they've been around for ten years. We knew how to fly them, we knew how to make them, we knew what their good points were and bad points, so that we could very promptly go ahead and replicate them in the thousands, and that was a significant factor in the outcome of the Great Conflict.

What he's saying here is -- my analogy -- it's wise to get these things up, even though we won't -- pretty sure we won't need them till the 1990's, and I agree with that. That makes sense. Let's find out if they work.

That's the only point I want to make.

MRS. HARRISON: I don't think anyone debates the fact we need to try certain technologies.

MR. WISHART: And that ought to be done quickly.

MRS. HARRISON: But at the same time, I think we also have to have some measure of control as we do it.

DR. REZNEK: It would be a shame if we understood the performance characteristics of coal conversion plants, for instance, to the same extent that we understood the performance characteristics of the B-17's before they were produced in large quantities, but did not simultaneously understand their environmental performance.

MR. WISHART: Well, I don't disagree with that at all, but I think the environmental technology we have today for power plants is not as good as that we'll have in several years, and it's not sufficient to achieve the environmental requirements.

And what are you going to do? Force it? If it doesn't work, it doesn't work. Spending a lot of money on it doesn't make any sense to me.

MRS. HARRISON: How would you ever get the technology if you never tried?

MR. WISHART: Well, we're getting the technology. It's coming ahead in terms of burning coal, for example. It'll get there. It's like all of this fuss here in Washington -- which I've been involved in for the last three years -- about a big national energy policy.

Without any laws at all the objectives of the national policy are being realized by the free market, somewhat held up by the government, but we're getting there.

[Audience Laughter]

MRS. HARRISON: I think you should put in the testimony that we should do away with all government.

DR. REZNEK: Any further questions?

Thank you.

MR. WISHART: Thank you.

DR. REZNEK: Our next witness will be Mr. Demmy. Mr. Demmy is Executive Vice-president of Roy F. Weston.

STATEMENT OF MR. RICHARD H. DEMMY
EXECUTIVE VICE-PRESIDENT
ROY F. WESTON, INC.

MR. DEMMY: My name is Richard H. Demmy; I am Vice President of Roy F. Weston, Inc., Environmental Consultants and Designers. The operation is a consulting engineering firm specializing in environmental consulting services for industry, municipalities and government. Our studies are directed toward problems of air, water, land, wastewater, solid waste, marine pollution control, energy conservation and management, environmental and occupational healths, resources development and recovery. Our professional staff of over 270 include 125 registered Professional Engineers, Planners, Architects, and Geologists, and 35 Diplomates of the American Academy of Environmental Engineers. Augmenting and supporting the professional staff are approximately 300 technical and administrative personnel.

I am pleased to discuss the subject of future energy patterns and coal use with you this morning. First, because Roy F. Weston, Inc. has been deeply involved in the subject of environmental protection and energy conservation as a corporation. Secondly, because I have personally chaired the Coal Utilization Subcommittee of the Commerce Technical Advisory Board Panel on Project Independence Blueprint and have recently been Chairman of the Coal Gasification and Liquefaction Subcommittee for the National Coal Policy Project.

In the past, energy use has been determined by the economics and availability of the fuels. Coal replaced wood in the latter part of the 19th century; and in the early part of this century, oil and gas have displaced coal. The future energy problems of the United States, and as a matter of fact of the world, will not be totally determined by economics and availability as has been the case in the past but will be determined by political decisions reached in the capitals of the world. Witness the National Energy Plan developed to deal with the "eventual and inevitable shift from oil and natural gas to a new mix of fuels". The political decision has been made: "a national goal of an annual coal production (and consumption) of one billion tons by 1985".

Even before the Arab Oil Embargo it was obvious the domestic oil and natural gas resources could not satisfy the burgeoning national demand for fuel much longer. Petroleum -- or more specifically, cheap petroleum -- had become a dominant force in the economy but supplies were limited. The implied energy policy of the United States was to rely on cheap oil imports. However, the days of cheap oil imports are gone, and whereas in the near term, world oil supplies are plentiful, we cannot assume lower oil prices. Indeed we must prepare for the ever present potential of another oil embargo with its impact on national security and on the economy of our country.

The National Energy Plan demands greater use of coal and rightfully so. Coal is, after all, our most abundant domestic energy source. The National Energy Program has assumed that the only way to use coal is for industrial steam raising or for converting it into electrical energy.

Inadequate attention has been given to the emerging technologies of coal gasification. Coal gasification -- compared to conversion to electricity -- will cause significantly less air pollution, generate less solid waste and use far less water to produce the same amount of energy. The environmental impact of two equivalent energy projects is shown in Table 1.

TABLE 1. ENVIRONMENTAL IMPACT OF TWO EQUIVALENT ENERGY PROJECTS(1)

	COAL GAS(2)	COAL ELECTRICITY(3,4)
Unit Plant	250 million cu ft/day	3000 Mwe
Discharge to Atmosphere (lb/hr)		
Particulates	180	870
Sulfur Dioxide	450	2,300
Nitrogen Oxides	1,780	20,830
Water Requirements (Acre Ft/yr)	6,300	41,400
Solid Wastes (Tons/day)	1,400	5,100

(1) Table 1 is from "The Gas Option" by Henry R. Linden and J. Glenn Seay, Institute of Gas Technology, for the New England Gas Association Annual Business Conference, 16 March 1978, Boston, Massachusetts.

(2) Radian Corporation, A Western Regional Energy Development Study: Primary Environmental Impacts, Vol. II, Council on Environmental Quality and Federal Energy Administration, Contract No. EQ4AC037, August 1975.

(3) Final Environmental Impact Statement on the Proposed Kaiparowits Project, U.S. Department of the Interior, March, 1976.

(4) Atmospheric discharges based on use of average quality coal.

The technology to build low, medium, and high Btu coal gasification plants now exists. Many improvements are under way and "second generation" technology is being developed.

If the future energy patterns of the United States are to guarantee the best environment, we simply must make sure that our nation's vast resources of coal are channelled into a system that will contribute the most energy for our nation at the lowest cost economically and environmentally. That system is coal gasification.

Gasification projects can utilize high sulfur bituminous coal from coal reserves adjacent to the industrialized east. These projects would be in a competitive position with alternate low sulfur coal projects located farther west. Also, it is technically possible to utilize some of the anthracite and bituminous refuse banks that scar the landscape as a result of earlier coal preparation.

An example of the utilization of high sulfur coal would be the Pennsylvania Coal Reserves where 43 billion tons out of 58 billion tons contain sulfur in excess of present environmental standards. If a utility chooses to use this fuel, and particularly in light of the new air pollution laws demanding best available control technology, it will mean costly expenditures for stack gas cleanup. The economic incentives for using eastern coal gasified for eastern industry are substantial.

Although interest in new coal gasification technology virtually disappeared in the United States with the shift to natural gas, interest continued high in petroleum-short Europe where coal remained the chief energy source. Mixtures of carbon monoxide and hydrogen -- synthesis gas -- also became increasingly important as the basic raw material for ammonia and a whole range of organic chemicals needed for plastics. As a result the United States is looking to Europe for the initial technology in coal gasification. At the present time, research and development support is being given to at least three basically different coal gasification approaches: synthetic, natural gas and coal liquefaction.

I stated earlier that coal gasification will contribute energy to our nation at the lowest economic cost. Let me quantify that statement:

Let's assume that we are going to use coal to add 1.5 quads, about 2 percent of our energy, per year to the nation's energy supply. One quad is equal to ten to the 15th power of Btu's.

To convert that coal to electricity it will take 50 - 2,000 megawatt plants for the capacity of 100,000 megawatts. At the going rate of $800 per kilowatt, these plants will require a capital outlay of $80 billion.

If we convert the coal to substitute natural gas (SNG) we are going to need 20 plants capable of producing 250 million cubic feet of gas per day. These plants, based on latest figures, will cost approximately $1.2 billion each or a total cost of $24 billion.

Another approach would be the conversion of coal to a low Btu gas. This gas would be made available for industrial usage in a limited area. While there is no particular virtue in making a fuel with low heat value, the cost of producing such gas is lower because upgrading steps are eliminated and the overall process is more efficient.

Let's compare low Btu gas production with an electric plant producing an equivalent amount of electricity. A plant with a 1,000 megawatt capacity, again at the $800 per kilowatt cost, will require an investment of $800 million to produce a like amount of gas -- 10 billion Btu per day -- will require five gasification plants at $28 million each or a total cost of $140 million. Again, this is low Btu gas for industrial use. The plants would have to be located near their customers to make them economically worthwhile. Table 2 (High Btu Gas Versus Electric) and Table 3 (Low Btu Gas Versus Electric) reveal that the effective fuel costs to the consumer are significantly less by converting coal to gas: 65 percent of the cost of electricity for high Btu gas and 35 percent for low Btu gas.

An additional area which is not being sufficiently addressed at the present time is the fluidized bed combustion of coal. If the coal industry is to participate in the industrial and electric utility energy market(1), a modification in the method of burning fuel is indicated. Witness the intense opposition to fluid gas desulfurization scrubber systems. It is my belief that the atmospheric fluidized bed is the only method of fuel combustion available today in sizes which can be utilized by industry and upgraded to large steam production requirements of the electric utility industry in the United States. This method is available in commercial sizes today. Two atmospheric fluidized bed boilers are supplying steam to a 60,000 kilowatt generating station in Casablanca, Morocco. I fear that the delays inherent in developing commercial pressurized fluidized beds will prohibit the commercial development in the United States. However, if the atmospheric fluidized bed process is introduced into the United States, we will have fuel technologists knowledgeable in fluidized combustion capable of guiding the development of the next step forward in this technology; namely, pressurized fluidized beds. The atmospheric fluidized bed needs research and development funds to further the art of limestone sorbents in the active bed.

(1)"Ignifluid Boilers for an Electric Utility" by Richard H. Demmy, P.E., presented at the 69th National Meeting of the American Institute of Chemical Engineers, Cincinnati, Ohio, 16-19 May 1971.

TABLE 2. HIGH BTU GAS VS. ELECTRIC

USE OF COAL TO ADD 1.5 x 10^{15} BTU/YEAR

COAL TO ELECTRICITY		COAL TO SNG
0.5	Capacity Factor[2]	0.8
100,000 MW	Plant Capacity	20 plants @ 250 MMCFD
$800/KW	Cost	$1.2 Billion each
$80 Billion	Capital	$24 Billion
	UNIT COSTS IN $/MMBTU	
$10.66	Annual Capital Unit Cost (20% Capital/yr)	$3.20
$ 3.20	Effective Fuel Cost	$1.78
(36% eff.)		(56% eff.)
$13.86	Total Production Cost	$4.98
3.20	Transmission & Distribution	$1.75
$17.06	Total Cost	$6.73
100%	End Use Efficiency	60%
$17.06	Effective Fuel Cost	$11.22

(1) Table 2 is from "A Utility View of Coal Gasification" by Richard H. Demmy, Roy F. Weston, Inc., Symposium on Pennsylvania Coal sponsored by Air Products and Chemicals, Inc., College of Engineering and Physical Sciences, Lehigh University, Pennsylvania Power and Light Company, Bethlehem, Pennsylvania, 25 March 1977.

(2) Capacity factor is based on plant usage and is modified by plant availability. For example, gas can be stored underground while electricity must be generated to meet daily loads.

TABLE 3. LOW BTU GAS VS. ELECTRIC

USE OF COAL TO ADD 1.5 x 10^{13} BTU/YR

COAL TO ELECTRICITY		COAL TO 300 BTU GAS
0.5	Capacity Factor[2]	0.8
1,000 MW	Plant Capacity	5 plants @ 10^{10} Btu/day
$800/KW	Cost	$28 million each
$800 million	Capital	$140 million
	UNIT COSTS IN $/MMBTU	
$10.66	Annual Capital Unit Cost (20% Capital/yr)	$1.86
$ 3.20	Effective Fuel Cost	$2.38
(36% eff.)		(75% eff.)
$13.86	Total Production Cost	$4.24
3.20	Transmission & Distribution	0
$17.06		$4.24
100%	End Use Efficiency	70%
$17.06	Effective Fuel Cost	$6.06

(1) Table 3 is from "A Utility View of Coal Gasification" by Richard H. Demmy, Roy F. Weston, Inc., Symposium on Pennsylvania Coal sponsored by Air Products and Chemicals, Inc., College of Engineering and Physical Sciences, Lehigh University, Pennsylvania Power and Light Company, Bethlehem, Pennsylvania, 25 March 1977.

(2) Capacity factor is based on plant usage and is modified by plant availability. For example, gas can be stored underground while electricity must be generated to meet daily loads.

An environmental concern of the energy projects I have discussed today is to properly identify and control the hydrocarbon releases in gaseous emissions wastewater and solids discharges. Although the basic technology is available to treat and control such releases, the specific application of available technology is not proven. This is particularly so relative to the monitoring and control of leachate from the land disposal of process solids. Adequate R&D funding should be supplied to answer these concerns immediately.

In summary, coal must be used in the near and medium term to satisfy the energy requirements of the United States economy. Fluidized bed combustion and coal gasification (low, medium and high Btu) are the most economical and environmentally acceptable solutions.

Thank you.

DR. REZNEK: Any questions?

QUESTIONS AND ANSWERS

MRS. HARRISON: Can I ask -- on page three, at the top of the page, where you say that coal gasification will cause significantly less air pollution.

MR. DEMMY: Yes.

MRS. HARRISON: And then I think in the summary you say that coal gasification is more environmentally sound than other methods.

As of about a year ago I was involved in some studies of a coal gasification plant in the Midwest. A municipality was thinking of putting a coal gasification plant in, and they did not seem to have any of the facts on the environmental impact.

MR. DEMMY: Well, the facts are available. As a matter of fact, the MOPPS study had a very good report on just that, and if you'll turn to Table 1 of my paper I can give you a comparison of the reduction of the particulate emissions defined for a high Btu coal gasification project, which were 180 pounds per hour of particulates, 450 of sulfur dioxide, and 1780 of nitrogen oxide.

That sounds high until you compare it with a coal electric plant of the same energy capacity, delivered to the consumer.

The water consumption is much less, as well as the solid wastes, as you can see by that table.

This table is developed from the work that was done on the MOPPS study recently. So we do have it.

Yes?

DR. MACKENZIE: You've got particulates and oxides and nitric oxides, but my understanding is there are -- there's much less known about things like polycyclica, you know, hydrocarbons in gasification plants, both in terms of occupational exposures and in terms of contaminants in the actual gas as it leaves, so that when you get to the consumer you're not quite sure what's coming out of that pipe in terms of trace metals, or what have you.

MR. DEMMY: You'll notice at page 6, I mention at the bottom of that, in the last paragraph, our concern to identify and control the hydrocarbon releases in the gaseous emissions wastewater and solid discharges.

DR. MACKENZIE: Yes, so --

MR. DEMMY: So we recognize -- I recognize that, and it must be identified, but it has not been addressed sufficiently at this point. That's why I brought it out in my testimony. I agree with you.

DR. MACKENZIE: Yes. There's one other comment I had, and that is on your comparison between using coal for electricity, or gas, it strikes me, you know, in a gross sense you're right, but you really have to see what the energy's being used for.

You could, for example, take coal, gasify it, and then burn it in a combined cycle power plant and then run a heat pump, and that might be far more efficient and less polluting than making natural gas and just burning it in a home.

MR. DEMMY: I would take issue with you on that. No. I don't agree with you.

DR. MACKENZIE: Well --

MR. DEMMY: One -- the reason behind it is this: that the -- I have shown you the environmental impact, and the cost impact on Table 2, of high Btu gas where the delivery system is available in the United States for the gas system to be delivered into the home.

If you use that system you will use less total material of coal in the beginning including using the heat pump. Actually, if you utilize the heat pump, and that will only be for the energy to heat the air, you'll end up with about 28 units of energy for every 100 units of energy you start with in coal, whether you go the gas route or whether you go the coal route, and that's including the heat pump.

But the units of heat, for heating water, and for cooking, the units of coal will then rise on the electric side, compared to the gas side.

I can supply studies for you, should you desire to have them. I have them available.

DR. REZNEK: I think that the economics of pollution should be expressed in terms of a market-basket of mixed end products, although I realize it's very hard to do this and that it wouldn't be universally appropriate to use those terms.

One of the things that I've always been interested in but never see mentioned is this: You can power a heat pump with gas, can't you?

MR. DEMMY: Very definitely, and the only reason they have not developed it is because economics -- which the former speaker talked about -- have not driven the heat pump. The cost of gas has been too low to justify the capital costs.

The capital costs will be higher for a gas heat pump. As a matter of fact, if you go back five to six years ago, the gas refrigerator went out of business, and that is a gas heat pump.

So the technology is there, but costs are higher, but the capital cost denied the savings of the low cost of gas, which has been inordinately held down by price regulations in the national market for the domestic consumer.

Therefore, there's been no push for it. If you look at the cost of electric energy, where I live in the Philadelphia area today it's about $15.00 a million Btu. Gas is still selling for $3.50 a million Btu.

If you can get a coefficient of performance of two on those two units, your dollars saved in electricity justify the heat pump. They do not justify it at this point in the gas, but they will as our costs of gas rise.

Coal gasification will be $5.00 per million Btu, whereas gas out of the ground today in the Texas area is approximately $2.00 and even a little bit less, because the competitive market has come back into play there.

In Pennsylvania the price -- minimum price for typical gas is about $1.85, much lower than coal gasification at this point.

But the point is, that if we're going to protect our environment we should be pushing toward gasification because it has less impact upon the environment and actually does use our resources up at a slower rate, since there is a better efficiency.

DR. REZNEK: Any further questions?

Thank you very much.

MR. DEMMY: Thank you.

DR. REZNEK: The next witness is Earle C. Miller, Vice-President of Charles T. Main, Incorporated.

STATEMENT OF MR. EARLE C. MILLER
VICE-PRESIDENT
CHAS. T. MAIN, INC.

MR. MILLER: Dr. Reznek, panel, my name is Earle Miller and I'm Vice-President of Chas. T. Main engineers of Boston, Massachusetts.

I'm President of the Engineering Society's Commission on Energy, Chairman of the Technical Committee on Energy of the Pan-American Association of Engineering Societies, and past President of the American Society of Mechanical Engineers.

I'm presenting my own personal views.

It's a privilege to participate in this hearing. I am interested and have been for many years in expanding the use of coal to help to assure continuing reliable supply of electrical energy, at least until such additional sources, new sources of electrical energy, become available.

Now, we hear of many proposals for saving of energy, saving of gas, saving of oil, conservation, improving efficiency, but many of these will require additional electric capability. And this is what I'm most interested in.

The need for utilization of vast quantities of coal will certainly extend well into the next century. We must now look to the near term, and also the long term in R and D.

Research and development must be considered for both the near term and the long term. The near term must rely on improvement of developed or nearly-developed technologies if the results are to be a substantial help in the next few decades.

This phase of the work should stress demonstration plants capable of proving and improving performance, reliability, economics of the most promising of the processes.

Concurrently with this phase the work on advanced research should proceed to provide improved options for the next century.

The current mix of projects in the Department of Energy program is, in the main, commendable. Unfortunately, the success of the project is not likely to impact coal utilization as quickly as the nation would wish.

There are a number of reasons why successful research takes time to become commercial, and not the least of these is the inertia of people resisting change until that change has been fully proven. This takes time, and rightly so, and in electric energy supply, reliability has to be a consuming goal. There is an economic need to get on quickly with the expanded use of coal, to keep our industrial machine and our national fiscal position healthy enough to carry the heavy R and D loads for the future.

I believe the present Department of Energy program for coal is well-balanced to achieve such a goal.

I do perceive two unattended areas that need early attention, that is sulfur emission control processes and a more accurate determination of acceptable levels of sulfur emission.

Our present regulations on sulfur emission are based more on the lack of information than on knowledge. For this reason, very straight, stringent regulations were promulgated. These regulations are far more restrictive than those of the highly industrialized nations of Germany and Japan.

The U.S. regulations preclude satisfactory operating parameters for present sulfur removal equipment.

Mandating performance and accomplishing that performance are not synonymous. Less stringent regulations would result in a marked gain in equipment usage. Increased usage is a fast way to get the improvement needed.

There is highly developed equipment for the utilization of coal for power generaton, equipment that has been proven and is available. This technology is handicapped only by the lack of reliable sulfur removal equipment. Attention to this handicap would be productive.

I suggest that the Department of Energy additonally be charged to develop reliable data on acceptable performance, or achievable performance, of sulfur removal equipment. Concurrent with the determination of achievable performance an aggressive research and development of the most promising processes of sulfur removal should be pursued, and this includes waste disposal.

There is within the Department of Energy the capability of assessing the potential of various systems of sulfur removal, and the most serious problems in those systems. In addition, knowledgeable advisory committees could be assembled to assist in the evaluation of a productive program.

In conclusion, I believe that we have penalized our progress by making our goals unachievable. Whenever a mandate is handed down that simply can't be executed, we lose time, and accomplish very little.

I would hope that we would change from an adversary position to one of cooperation. I believe that EPA, the Department of Energy, and industry should study the problems, come up with reasonable solutions, and proceed.

Thank you.

DR. REZNEK: Thank you. Does the panel have any questions?

QUESTIONS AND REMARKS

MS. VAN SICKLE: You said that you think the sulfur standards should be re-evaluated based on available technology. What magnitude of down-grading do you think is necessary, if that's what you're getting at?

MR. MILLER: Well, the way I would approach it -- I wouldn't give you a number, because I don't think we have a number. We don't have a number because we set a goal so high that we couldn't attain it.

It's like the fellow trying to pole vault. If you set it at eighteen feet, you may never know how high the fellow can vault. You start out at a level that he can attain and you build up to a maximum. You simply don't set a goal that's unattainable and stay back and say, "Let's keep on trying to get across that pole." You'll never get across the pole.

So I don't think we should try to establish a number at this point. I think we should determine what we can do and move from there.

DR. MACKENZIE: I'd like to ask you on sulfur, I reviewed the standards and the criteria and so forth, you know, when they were set in the early seventies, and I think there's been some recognition that SO_2 as a pollutant is perhaps less of a problem than what it gets turned into -- the sulfates, for example.

And indeed, the more evidence -- as research goes on we see that sulfates and the acid rain that results from it, is indeed a much more seriously problem.

For example, in New England there are streams in New Hampshire which have no life left in them because of acid rain. There's a lot of damage there that's being done due to acid -- masonry and copper and so forth -- things that are eroded, and it seems to me that it's likely that even in the face of SO_2 reductions the consequent damage is still significant and that I see a further reduction, based on not SO_2 emissions, but basically the damage that seems to be more and more, as we look at it, from the sulfates that result from it.

I'd like to hear your comments on that.

MR. MILLER: Well, you've pointed out specific areas. I think I know the areas you're talking about. I think one of our problems, one of our problems nationally, is that we pick a Los Angeles basin and we say the oxides of nitrogen are so high they are creating smog in the Los Angeles basin.

We then set the same regulation for the plains of Texas.

In response to yours, I think that we do have to treat all of these problems on a regional basis, and not try to impose the same regulation across the country, because the conditions are different. We're a large country. Maybe in a small country you have the same uniform condition. That's not so here.

So in answer to yours, yes, I agree on several courses. One, I think that we have put a tremendous effort into elimination of oxide of sulfur, and that is what I'm saying. We worked with too little information and became too rigid in our conclusions.

I'd back off from that and take a look at some other items.

Now, as I suspect -- this I don't know either -- I suspect that better control of solids emissions, in combination with reduced sulfur emission, not at the present level, but an attainable level, would gain us more than setting the sulfur level so extremely stringent as to be unattainable.

Our regulations are becoming self defeating because the plants that can't meet the code have the new equipment shut down, and they revert back to plants that have no solution for either solids or the sulfur.

So you've got to take a broader view.

DR. REZNEK: I'd like to explore one point. Your suggestion that there be an advisory panel for a Federal program in developing sulfur control technology is an interesting one and it has received a lot of consideration. For instance, such a program was in the first version of the National Energy Plan.

Could you comment briefly on the composition of such a review panel, how it might work, what groups might be represented on it?

MR. MILLER: That answer is going to depend on what chair you're sitting in.

I realize that there is in the government tremendous talent, tremendous talent, in different areas. And starting from that position, a few years ago I got involved at the request of a department of the government to try to encourage cooperation and that was to get the other party to understand that they were really trying to be reasonable and accomplish a standard goal.

Well, in that particular case what I suggested was that since two different agencies of the government were in conflict, and both of those were taking adversary positions with respect to industry, the agencies should jointly sit with industry to develop an acceptable program.

I think, then, that possibly a part of that type of conflict could be resolved simply by advisory committees within government itself.

I was one of the group that offered to various government agencies to put together from the various engineering societies consulting groups, and to put them together in the same manner in which we put our own code committees together.

As a member of ASME I worked on code committees, and although that was financed by ASME, we put on those code committees people from the government, from industry, and from the public in order to get a balance in our codes and standards.

And if I were setting up the programs that is the way I'd go about it. I'd put government, industry, and the public into it.

DR. REZNEK: Any further questions?

Thank you.

MR. MILLER: Thank you.

DR. REZNEK: We'll adjourn now for one hour and five minutes, by my watch, and reconvene at 1:15.

Thank you.

AFTERNOON SESSION

DR. REZNEK: Let's start the afternoon session.

Once again, if there are questions from the audience you can turn in a three-by-five card and they'll come up -- either questions for panel members or for witnesses, if they're still available.

Our first witness is Bill Chandler from the Nature Conservancy. Bill?

STATEMENT OF MR. WILLIAM CHANDLER
NATURE CONSERVANCY

MR. CHANDLER: One aspect of coal use which I would like to address today is its impact on the nation's overall natural ecological diversity, a subject area with which the Nature Conservancy has been long involved in trying to protect.

Coal development, of course, is only one part of a larger problem, and that is landscape alteration in general, which has gone on this country in an unplanned fashion for about 200 years.

As a result, we have literally been throwing away our diversity of ecological resources in haphazard fashion, and eventually we may pay the price for that.

A lot of people ask the question, out of ignorance, as to the value of maintaining natural diversity, and you often see the argument raised, "What does it really matter if you lose half of the species on this earth as long as Man continues to dominate natural systems and maintains his own species?"

I think it should be pointed out that every time we throw away one of these unique genetic resources we are in fact eliminating a resource option on which our society can depend in the future, perhaps for a source of medicine, agriculture -- an agricultural product, a forest product, or what-have-you, and it's just sheer fool-hardiness in terms of resource management to be throwing these things away in an unplanned fashion.

The Conservancy has long thought and tried to do something, or figure out what needed to be done, to protect natural ecological diversity in the United States, and in order to maintain that full range of diversity you basically have to decide what it is you're trying to maintain, where it is, what its status is, and then you have to take intelligent actions to go out and specifically protect examples of each one of these resources.

The key to doing that is classifying the landscape into the individual elements which compose that diversity, doing an inventory on a continuing basis to find out where these things are, what their status is, et cetera, setting up a data management system that allows people who need this information in facility siting decisions, and so forth, to utilize it and to access it very quickly; and going out and actually taking protective action to make sure that as many examples as possible or as practicable of these resources are preserved.

This is a job that's never been done before in this country, and it's a little strange, or it's interesting to me, that we've had a Geological Survey in the United States for a hundred years, but we've never had a biological survey to do the same thing on the biological front; and there's just simply been no holistic, systematic, comprehensive effort to do this on a national scale.

I would like to point out that this job is now being done in ten states and in the TVA power service region. Seven of those states, by the way, have substantial coal deposits.

The states that have a natural diversity inventory and maintenance program going on right now are West Virginia, Ohio, Washington, Oklahoma, New Mexico, Mississippi, and Tennessee. They need more resources to do a better job, but at least they've started.

I would like to briefly state how these programs work and then try to tie this in with coal use and development.

First of all, the program staff sits down with the scientific community in the state and they draw up a classification system of the state's elements of diversity, which include all of the plant community types known to exist and be native to that state, the aquatic community types, all plant and animal species which are liable to disappear from the state without deliberate efforts to protect them, the different types of geological features found within the state, and then they have a category called miscellaneous -- sort of a flexibility category where they can throw in other types of ecological resources which the state feels are important to maintain.

Then what they do next is to actually go out and search the landscape for examples of where all of these different elements can be found, and they actually plot these locations on quad maps. Each one of these states has a comprehensive set of USGS quad maps on which they locate every example of each element of diversity that they can find and verify.

They set up a state data bank to manage this information and to analyze it, and then they actually set up a protection program to go out and make sure that insofar as possible the best examples of all of these elements that they can find are protected, whether they're on private lands, Federal lands, or state lands.

In addition to identifying important elements of natural diversity which need to be saved before they're irretrievably lost, this data bank that these states have now established has tremendous utility in the EIS process.

For example, in West Virginia, they have evaluated 245 surface mining permit applications, since August of '77, for the State Department of Natural Resources. They're also providing information to consultants who work for EPA trying to do an EIS on coal development in West Virginia.

In Mississippi, the state has passed the strip mining law down there which basically requires areas unsuitable to strip mining to be identified, and an area unsuitable to strip mining happens to mean a unique natural area, among other things, so that the state natural diversity program in Mississippi is actually helping implement that state law by providing information, specific concrete information, on where all of these elements are found and how these overlap potential coal mining sites.

To cite another type of energy development, the New Mexico program is doing work on evaluating the impact of geothermal leasing sites for BLM; and to give you an idea of how much data one of these state systems can manage as they're now set up, the state of Tennessee last year with one-half person for the entire year screened 1800 Federal projects for their impact on the elements of natural diversity in Tennessee.

In other words, the NEPA process is being made to work for the first time in these states that have these data management systems with respect to the specific genetic resources with which the Nature Conservancy is concerned.

And of course this all ties in to siting decisions, trade-offs, where do you put development, where do you not allow development to occur, and so forth, and this is how it relates then to the coal problem.

Theoretically we could go out and dig up every acre of coal in the United States and be done with it. On the other hand, we know that to do that there will be certain environmental consequences that need not nor should not occur.

We would suggest that one of the consequences that should not occur is that this process of energy development should not be allowed to wipe out unique ecological resources on which our society is going to depend in the future. We just do not have that right to throw those things away on a short-term basis, so the alternative is to get out and actually find these things, so they aren't eliminated in ignorance, and to take specific actions to protect them.

And the only way that you're going to do that is to get one of these state inventory programs going and to keep it running, and it's going to take us a long time. We're way behind. The energy forces are moving rapidly, and we have to start moving equally rapidly on the ecological data collection and management process so that we can identify these sites, and provide this information to people making these decisions.

We very strongly feel that the basic role of the Federal government in this whole process is to get the financial and the technical assistance down to the state level where we think the job can best be done. It can't be done from Washington, it should be given to the states because they're closest to the problem. They have the authorities and most of the tools necessary to do the job in terms of protecting lands that have natural diversity value. They also have a sufficient breadth of scope in terms of geography that they can compare the trade-offs of siting a coal mine here versus there, in terms of the state's overall natural diversity resources.

In closing I would like to point out that although there are seven state -- or excuse me, ten state programs that are trying to do this inventory now, as I pointed out earlier, they do not have sufficient resources. They could use more help. There is a piece of legislation pending in the Congress which we hope will provide that Federal financial and technical assistance, and if it passes we will be very happy.

We have our fingers crossed, and hopefully the Congress will recognize the importance of these state data banks and get the money out to the states to do the job.

Thank you.

DR. REZNEK: Thank you, Mr. Chandler. Are there questions?

QUESTIONS AND REMARKS

MS. VAN SICKLE: Are you familiar with the basic monitoring network that each state has implemented?

MR. CHANDLER: The basic monitoring network?

MS. VAN SICKLE: Right. It was required by EPA, and we have -- each state was required to set up a network of sections across the state to inventory the different types of communities, and benthos, nekton, plankton, and also run sediment and all these types of --

MR. CHANDLER: You're talking about water quality data.

MS. VAN SICKLE: Yes sir. This is just in water quality area. This is one of the first things that we've done, like this.

MR. CHANDLER: Right.

MS. VAN SICKLE: And each state has implemented this program and it was funded through EPA. I guess we started ours last month.

MR. CHANDLER: Those kinds of programs, to the extent that they would provide information relevant to, you know, the actual location of aquatic types, or aquatic species of plants or animals, would be helpful to us. To the extent that they don't, they would not be helpful, because we're actually trying to pinpoint habitats and locations on the map where, you either find a species, or you find an ecosystem type that you can identify as being native to that state.

These programs, by the way, these state programs build on a lot of different inventory efforts that are on-going. In fact, that's one of their great benefits. They can take information gathered by the Fish and Wildlife Service; they can take information gathered by the Parks Service, or by state agencies, and then they transform that, if they can use that data, into a comprehensive picture of the entire state landscape, which nobody else has ever done before.

DR. REZNEK: Presumably, Federal action is not needed to allow mining of coal resources on privately owned land. At any rate, how does this ecosystem inventory affect the situation where a unique biological resource is on land which is privately owned and mineable?

MR. CHANDLER: Well, first of all, the first thing we have to know is that there is a unique resource on private land, and again, that ties back into the inventory system. We may find, for example, that there are forty different locations of an oak-hickory forest in the state of Tennessee, some of which may be on private land, some on Federal land, some on state land. To the extent that that type of ecosystem is not protected, the job then would be to go out and get several examples of each -- of that ecosystem that we could definitely insure were protected for the future.

We realize that we don't have the resources to do everything. You know, we can't protect every example of every element.

In the case of the private landowner who has a resource that we would like to protect, we've got to go out and argue with the guy, try to get him to understand what the value of that resource is, and we basically go about that now by trying to buy the land from him -- give him an option as to what he's going to do with that land, or try to get some sort of a conservation easement, or what have you.

But we basically work with positive techniques to try to get him to dedicate that resource to long-term conservation. There's no condemnation applied to that particular site.

It's basically an argumentative process.

Let me cite a good example of something that happened, although it didn't pertain to coal lands, just to make this more clear. There is a heron rookery down on the Potomac River, about sixty miles south of here. The owner basically had an option to sell for second home development and subdivision. Somebody came out and told him what was on his land. He said, "Hey, that's really neat, you know, give me another option," so we're in the process now of trying to raise the money to buy that site.

So you know, when you can come in and tell people that they have something unique on their land, we've found that in ninety percent of the cases they're more than willing to listen to a conservation option, if you can help them achieve that and protect them financially.

MS. VAN SICKLE: The ten states that are involved now, what type of funding are they working on? Is it Federal funding, or just from the states?

MR. CHANDLER: The ten state programs that are running were started with a mix of private and Federal resources, in most cases. The Federal government usually bows out after a couple of years. They are being funded through the old Bureau of Outdoor Recreation as part of their state recreation planning process.

And then eventually, within two years, the states take these programs over and run them totally on state funds.

DR. REZNEK: Any further questions?

Thank you. Our next witness is Mr. Sheldon Kinsall of the National Wildlife Federation.

STATEMENT OF MR. SHELDON KINSALL
ASSISTANT CONSERVATION DIRECTOR
NATIONAL WILDLIFE FEDERATION

MR. KINSALL: My name is Sheldon Kinsall. I'm Assistant Conservation Director of the National Wildlife Federation, which is the nation's largest conservation organization, with three and a half million members.

We appreciate the opportunity to present our views on the nation's R D and D energy policy. We'll focus on the policy process by which the --we believe the nation's future energy pattern should be drawn.

We'll take a somewhat broad brush approach in this short statement. We'd also like to make some general comments on several problems we see in the actual process.

The Federation, like most environmental and conservation groups, has had a long interest in energy. A very significant portion of the environmental issues which are of concern to us are in some way related to the impact of energy extraction, transportation, conversion, or use.

As the demand for energy increases, living space shrinks, reserves of conventional fuels dwindle, and environmental concern grows, these areas of conflict will just get worse, at least for awhile.

It is not surprising that energy is such a major source of environmental problems when one considers the central role of energy in our society. We realize, as I believe all environmental and conservation groups do, that enough energy to fuel our society is essential, but environmentalists and, clearly, a growing number of people here and abroad recognize that a decent environment is also essential to our economic as well as individual health and well-being.

While many believe or at least proclaim, because it suits their personal ends -- that achieving the twin goals of a decent environment and sufficient energy for society are mutually exclusive, we do not accept that.

The Federation realizes that some trade-offs between energy production and environmental quality are inevitable. We can control, however, the significance of the trade-offs, especially the further we get into the future.

The future energy supply pattern of the country can be drawn in a number of ways with differing impact on the environment. Just as there are a number of alternative energy futures, there are a number of alternative and environmental futures, some more survivable than others.

While energy can be supplied by a number of sources, we obviously have only one environment. The only prudent course is to protect it, because when we degrade it we pay the price, inevitably.

We cannot avoid payment by adjusting interest rates, providing subsidies, or legislating that less than the full amount will be collected. We can, however, manipulate these human institutions to adjust to our energy supply problem.

Such manipulation, of course, is the stuff of the policy process, and as far as the environmental impacts of policy are concerned, we would like to suggest some areas for policy makers to consider in trying to provide energy and still maintain environmental quality.

The most obvious and important consideration is that environmental questions be given full consideration at every stage of the policy process. This means thoroughly reviewing existing environmental data and, if that is insufficient, aggressively generating as much new data as possible before deciding on how to proceed with energy-related or other projects.

It means fully incorporating the environmental factors as givens which must be dealt with to at least the same extent as making a profit, or the role of the project in maintaining the national security.

In the Federal government, the review process envisioned in the National Environmental Policy Act is the kind which should be incorporated in all policy processes involving the environment. Unfortunately, even in government, the spirit -- if not the letter -- of NEPA is subverted.

A second policy consideration dictated by our increasing understanding of environmental dynamics is the need to give the environment the benefit of the doubt.

Often the understanding is lacking to prove conclusively that adopting a policy option will result in what most people consider unacceptable environmental costs.

At the same time, what evidence and understanding is available suggests that significant damage will occur. In such a case that option should not be chosen unless there is some overriding national interest involved and there is no other way to attain it.

The known short-term benefit must always be carefully weighed against long-term environmental costs.

As the growing concern with environmental quality has encouraged increased environmental research, we have found that pollution standards --such as in the Clean Air Act -- which we once thought were comfortably safe, do not give us such a comfortable margin after all.

This research is also uncovering problems about which we were ignorant even a few years ago -- PCB pollution is a good example.

A third policy consideration is one which should be easily embraced by policy makers interested in serving the public interest. It is one which provides a fair mechanism, the marketplace, to help determine what the nation's energy mix will be.

Simply put, the costs of protecting the environment should be internalized by the energy producer. Presently the costs of not protecting the environment too often are borne by society at large.

Simple justice dictates that the segment of society which utilizes an energy source should pay the total cost of its production. Since the costs of environmental protection will be passed on to the consumer by the energy producer, the consumer cost of that energy will reflect the total cost of its production if adequate environmental standards are set and enforced.

The market mechanism, then, will encourage some energy sources and discourage others. Similarly, competition within an energy production sector will encourage the most efficient producers.

Coal strip mining is a good example of an energy source in which the total costs of production are -- hopefully -- only just beginning to be internalized. It is probably not possible to figure the true costs of strip mining in Appalachia, for example, with complete accuracy, but included would have to be such things as the loss of tourism revenue, loss of recreational opportunities because of stream pollution, elimination of timberlands, health effects from ground water contamination, cost of increased water treatment, damage to downstream reservoirs from flooding due to increased siltation, the social, economic, and human costs of forcing people into already overburdened urban areas and onto welfare rolls, and so on.

This does not take into account such things as the aesthetic impacts, loss of wildlife habitat, dangers from landslides, and so on.

Compare these costs with the 50 to 75 cents a ton that it is currently estimated is the maximum incremental cost in most cases of doing the mining properly in the first place. This incremental cost per ton is a one-time cost. The much higher costs of irreversible stripping, however, must be paid year after year after year.

Clearly, society as a whole has not benefitted in the long run from the apparently lower costs of stripped coal.

A similar case could be made for cleaning up air and water pollution, protecting coastal marshes, and a number of others.

To restate the point, we do not avoid paying for environmental damage. It may not be noticeable; it may not seem to affect us personally; but nature will balance the books, nonetheless.

The fourth major policy consideration involves the overall goal of energy policy. By knowing what the desired objective is, the day to day decisions and trade-offs can be placed in proper perspective.

Losing sight of the goal can result in narrow, unwise decisions which may satisfy short-term needs, but at an unacceptable cost of long-range values, such as the quality of the environment we will hand down to our grandchildren and to their grandchildren.

Unfortunately, the government too frequently loses sight of the long-range goal, or does not seem to have one clearly fixed. The question, which is important, is too often, "How much energy will it produce by 1985?" and not often enough, "What are the consequences of starting down this path, or what other options do we have?"

The fifth consideration is where on the "worst case-best case" continuum should future policy planning be anchored. No responsible policy maker can base policy decisions on the premise that the best case will apply, but no realistic policy maker should base decisions -- especially in the energy area -- on the assumption that the worst case will apply.

This is particularly true when the environmental implications of accepting a worst-case scenario are considered. The hope for the future is clearly with energy research and development.

We have, fortunately, some sources for providing energy, primarily those in the solar area, which have either minimal environmental impacts or -- when compared to conventional sources -- much less adverse impacts.

I will not go into the advantages of solar energy. Most of us, I think, are familiar with that. In fact, over the past few years Americans have grown increasingly aware of the potential and progress in harnessing the sun's energy.

It seems that the only people who remain largely ignorant are those who propose and approve the Federal budget.

Again this year, as always before, the budget is unrealistically low and the public must again turn to Congress to provide a realistic level of funding.

As you know, this process has already begun, and I am confident that the Congress, at least, will adopt a realistic level of funding for solar research, development, and demonstration.

This year's budget is another result of the clear bias against solar energy, which has existed within the various Federal agencies which have had or now have solar R and D responsibilities.

The country simply cannot afford this kind of narrow minded approach to such an important issue of providing environmentally acceptable energy resources for the nation.

In addition to -- or perhaps because of -- the bias towards sources of energy with currently greater economic and political impact, there is -- from the outside at least -- a lack of coordination in public policy designed to deal with solving the overall energy problem.

Too much emphasis is being placed on a few energy supply efforts, and too little on developing new ways of using energy more efficiently.

In areas from agriculture to architecture there are many things which could be accelerated to reduce demand and still maintain our standard of living. We are told, often condescendingly, that conservation of energy is all well and good, but that we still need to produce energy. We agree, but we hasten to add that the problem facing the United States, at least, is not one of insufficient energy. Rather, it is one of tapping enough energy sources soon enough at acceptable economic, social, and environmental costs.

Conservation buys the time to permit this, if we will, to develop the options that we have available now, or which we can see just over the horizon.

The Federation firmly believes that we can provide sufficient energy for the nation and still maintain the quality of the environment. We do not feel, however, that as a nation we are making a particularly good start towards that goal.

We see a serious lack of sensitivity to environmental issues in the Department of Energy, a bias against some of what appear to us to be the best options, and too narrow a perspective on the scope of the problem and the range of solutions.

Unless some fairly significant changes are made our environmental future is far bleaker than we believe it should be.

I'll be happy to answer any questions or discuss any of these points further.

QUESTIONS AND REMARKS

MRS. HARRISON: Mr. Kinsall, since I think you said you have three and a half million members, so obviously you all are pretty active in public awareness programs. When you're out there in the field do you find that more people are becoming knowledgeable on these problems, or do you find there's less interest? You might be able to give us some handle on how the people out there perceive what's going on -- with government or with you, whatever -- with energy policy, development of energy, and the impact on the environment.

MR. KINSALL: We've -- there's obviously a number of aspects to that question. Let me just mention a couple.

We've just recently taken a poll of our -- a portion, a large portion of our membership, and among other things asked them which energy sources they felt should be given primary emphasis, and the energy sources that are usually grouped under the rubric "appropriate technologies or alternative technologies" were far and away the most popular.

Some of the more conventional sources came in quite a ways down in the list of those that the public -- at least that segment of the public which is included in our membership -- sees as desirable, and solar energy was clearly far and away the most popular.

Again, there seems to be a feeling which is part hope, but part an understanding, I think, on the part of a number of opinion leaders across the country, as to just what this potential is, and it seems to us that in part it reflects the lack of concern, to a certain extent, on the part of the public with where the energy comes from to turn on the light when they flip the switch, just so it's there and just so it's not provided in unacceptably high economic or environmental costs.

That does not, obviously, hold for some of the people who have careers invested in a particular technology, or who stand to benefit financially from one or another technology being accelerated.

In a somewhat broader answer to your question, opinion polls -- as you're probably aware -- have shown consistently that public concern with cleaning up pollution is one of the top three or four or five problems that people have identified for a long time, for -- certainly ever since Earth Day -- and while there was some small dip during the energy crunch, it's now -- and recent polls back up -- it hovers between 55 and 60 percent of the American people who feel that this is a very serious problem, one which needs to be corrected.

So obviously there are other aspects, but to take a couple of specific examples, we feel that as the population becomes more aware and as the education level goes up, the sensitivity, as more people grow up with interest and concern in the environment, that we will have increased desire on the part of the public to make sure that environmental quality is maintained and, if possible, enhanced.

MRS. HARRISON: Thank you.

DR. REZNEK: Certain people feel that some energy alternatives or options, particularly the softer technologies, are being overlooked, and that not enough consideration of what is practically achievable in that area is occurring.

They feel that once the full potential of soft technologies is realized, the enormous expenditures to develop the hard technologies will be unnecessary.

Others feel that we'd better begin developing hard technology quickly, that we know what is achievable with them, and that equivocating for a protracted period now will cost us an enormous amount later, both environmentally and economically. These people feel that we must commit ourselves now to a course of action which will at least open up options as time goes on.

Would you like to comment on this issue? Should we keep on talking, or should we shut off the debate and devote all of our energies to action? Or specifically, should we examine soft technologies further to see to what extent they preclude the need for hard technologies, or should we get on with the business of developing hard technologies so that they will be ready when needed, since their lead time is so protracted?

MR. KINSALL: If I understand your question, part of our answer would have to be that our best immediate source of energy -- if we can look at it in some kind of broad perspective -- is conservation or greater efficiency of use, and another part of it would have to be that we have not really thoroughly explored all that we can get in the same time frame as some of the so-called hard technologies, some of the technologies which are currently most of the emphasis by the Department of Energy -- that is synthetic fuel production, for example, oil, shale, that kind of thing.

A number of interesting studies have been done, but one in particular -- if we're talking about the period from now to the year 2000, which is the mid-term period, one interesting study done in California recently suggested that if California now began to make a conscious effort to become relatively independent as a state for its enery production, based on its own resources and those that were already do-able -- not those that required considerable extensive research and development yet -- that it could sustain doubling the population growth by I think it was 2030, and the economy could increase four times, and by using things which under conservative estimates were going to be available in that time period, could become independent of nuclear power and of imported oil.

Now obviously we are talking there a somewhat longer time frame, but the point is that we have options available. These are things which don't require ten years of reserach and development.

The people who did this study -- Energy Laboratories in California, Lawrence Livermore and Berkeley, a couple of other universities I believe are involved -- took fairly conservative assumptions and they did not allow for breakthroughs.

We have certainly -- the one thing we can be sure of is that there are things which we're going to find out next year and the next year and five years down the road which are going to change the picture. And what we would like to see is a somewhat more flexible approach, something that would allow us to buy the time, and we could go into a number of examples of -- there's a report recently of a new tertiary recovery technique which might release some 70 percent of oil which is left in the average well after -- for all intents and purposes -- the well is dry.

Now there are things which if we focused on the problem and looked at the potential for conservation and increased efficiency we think we can buy the time to put off for a short while -- five to ten years, perhaps -- having to make the kinds of decisions which would pretty much lock us in.

And if we look at the amount of capital which we're talking about in a government program to subsidize or sponsor even demonstration of synthetic fuel, and we look at the payoff which is the late 1980's before these plants will even be in production for a long enough period of time to get an idea of the economics and the environmental impacts and so on. We feel that there are much more economic and efficient ways of spending that money in the short term, at much less environmental cost, which will give us the flexibility to make these choices.

So we would agree that something has to be done, certainly, but we would not agree that we're confronted right now with having to make major choices on which path to take.

DR. MACKENZIE: Just one quick question. Certainly conservation is affected by the price of energy. Has the National Wildlife Federation taken a position on either the deregulation of gas or the deregulation of oil prices?

MR. KINSALL: No, not specifically, but we have generally taken the position that energy should reflect the total environmental costs of clean-up, which --

DR. MACKENZIE: But not --

MR. KINSALL: -- in most cases would raise the price, and we unofficially believe that it ought to reflect the cost of replacement, but we have no official policy or national resolution on that question.

DR. REZNEK: I have one question from the audience. You mentioned insensitivity on the part of DOE to the environmental concerns, and yet quoted Lawrence Livermore and Lawrence Berkeley, which I believe are funded by DOE. Would you care to elaborate on the manifestations of --

MR. KINSALL: Yes, I would. There are two interesting aspects to that observation. One is that this particular study -- the exact title slips me right now, it's Distributive Energy Systems for California, or something like that -- was done about a year ago, and was somewhat surprising to many of the people, from very prominent Californians, technically competent people who were involved in that study, who were not particularly strong alternative energy advocates, but they were surprised as they worked through the pay-offs from various energy sources as to exactly the amount of energy that could be provided.

That study is currently back in the Department of Energy, and there has been some criticism -- there was criticism earlier on that the Department was trying to suppress that study.

That appears not to be the case, but what they clearly are doing is not making any effort to publicize that study and there are a number of things -- the NET-2 plan, which is underway right now within the Department, which could have benefitted from the kinds of data that these people came up with, and which was available to the Department at the beginning of this process, and yet there is not indication -- until it was raised through some leaked documents -- that energy conservation was even considered in this supply strategy, which is now the current ninety-day wonder going on within the Department.

So that's one interesting aspect of it, that while it hasn't been suppressed, it hasn't been publicized either.

But as a more specific kind of example of the insensitivity of the Department, we just within the last 48 hours finally have gotten an individual selected to be the Assistant Secretary of Energy for Environment. It is the last major -- I'd be happy to tell you afterwards, but this was related related to us on good authority, and we've checked with the person, but we were asked not to publicize it, but it's somewhat ironic, when you look at this from several perspectives. It almost is the six-month anniversary of the creation, the formal creation of the Department, and it's almost the one-year anniversary of the first letter sent by the heads of the National Wildlife Federation, and all of the major environmental groups in the country, to the President urging him, one, to -- suggesting the kinds of characteristics that the ideal Assistant Secretary for the Environment should have, but two, urging the President and, indirectly, Schlesinger and others, to make this one of the very early appointments so that in the creation of this Department this particular individual could be on the ground floor, so that his operating procedures were established and while the situation was in a state of flux everyone would -- hopefully -- get used to having someone responsible raise the environmental questions and ask the kinds of things which we think needed to be asked.

It is indicative, I think, of the dedication of some of the people in the Department that we are just now getting that person, and we are getting a good person -- it's a person we're enthusiastic about and the Department's enthusiastic about -- but I can tell you that it is only the result of very protracted struggle on the part of the environmental community to head off some of the people the Department wanted which we found unacceptable.

And we are not encouraged by our experience in helping find candidates for this position that there is that kind of sensitivity.

To expand on the question just a little further, we still do not have confirmation hearings scheduled for another key Assistant Secretary, who fortunately has been named, but is not in place and not functioning, the Assistant Secretary for Solar and Conservation.

That is held up somewhere within the Administration, and I think that it's probably very indicative -- I could mention the budget total for this particular sector, I could mention some of the transfers of programs within the Department that are going on, but I think it's indicative, a number of these things, of the kinds of priorities put on environmental concerns by the new Department.

DR. REZNEK: Are you aware of the environmental development plan process, and does your organization review the development plans?

MR. KINSALL: Some of them. We don't have the personnel to do as much as we would like to.

MRS. HARRISON: Could I go one step further? When you mention there will be an Assistant Secretary that you're pleased with, in fact, do you know whether that person will have staff?

MR. KINSALL: That's another -- we understand that there is a personal secretary allocated there.

MRS. HARRISON: His secretary?

MR. KINSALL: We understand that there were assurances that there would be the maximum amount of flexibility available to this person in staffing that Assistant Secretariat and in choosing people to head up the various--- in fact, even in terms of suggesting reorganizations of the organization, which is only a few months old, they felt that was desirable or necessary.

We will have to see, though, whether that is carried out.

DR. REZNEK: Any further questions? Thank you very much.

MR. KINSALL: Thank you.

DR. REZNEK: Our next witness is Dr. Roger Caldwell

STATEMENT OF DR. ROGER CALDWELL
COUNCIL FOR ENVIRONMENTAL STUDIES
COLLEGE OF AGRICULTURE, UNIVERSITY OF ARIZONA

DR. CALDWELL: My name is Roger Caldwell. I'm the Director of the Council for Environmental Studies, the College of Agriculture at the University of Arizona.

I'm going to speak in terms of energy, environment, and toxic materials and their role in the R, D, and D activities of the Federal government. I'm going to try to highlight areas I think are important to the process of Federal R, D, and D, as well as providing some specific recommendations.

Initially, I will discuss the relevant problems as I see them, and then review some of the Federal R, D, and D programs and finally list some areas of needed action. My oral comments will be about half that of my written comments so I can stay within the ten-minute limit.

The first problem area is the changing times. Due to these changing times, we've had some new interactions develop among previously isolated economic sectors, and the complexity of the world has become more obvious. These factors have raised questions relating to 1) new types of long-range planning where previous experiences cannot be simply extrapolated, 2) economic systems where externalities are internalized and the cost/benefit analysis is broadened to include long-term impacts, and 3) solutions of problems which involve more than social/institutional questions, rather than the technological components.

Therefore, any analysis of a program such as energy/environment must be conceptually understood to be a futures responsive question and open to new and untried solutions, rather than a simple continuation of past trends. This is particularly important when evaluating the type of R, D, and D to be pursued.

Another problem is the energy supply and demand. Historically, energy supplies have increased to satisfy the demand, and there was essentially no questioning of the cause and effect relationship. As a result of the changing energy situation it is no longer a simple matter to plan for future energy needs or to estimate the relative mix of the various energy sources.

It is becoming increasingly clear to those with broad understanding, however, that the growth rate of energy use will be less than that of the past, and probably significantly so, and that energy sources may significantly consist of "new technologies" that will most likely be different than the "new technologies" as viewed a few years ago. The concept of a substantially reduced energy growth rate and the idea of "new technologies" bears directly on the type of R, D, and D which should be addressed.

Another area is technology assessment. In recent years technology assessment has become a common topic of conversation, and it is a powerful tool if used appropriately. Reports have been developed to evaluate new technologies, their positive and negative impacts, the areas of uncertainty, and the limitations of the technique. The knowledge base and innovations relating to the specific technologies are enormous, though still limited, compared to the knowledge base of public understanding, behavioral characteristics, institutional constraints, and interactions among the specific technologies.

New technologies seem to be implemented more easily if they are well developed and understood prior to commercialization, if user groups are involved in the development, and if the risk of new technologies is distributed over several groups; otherwise, the effect is to reduce innovation.

In addition, to place new technology in proper perspective, scientific and technical personnel need to be committed to the public good, rather than simple allegiance to a specific technical idea. In some cases, scientists do not adequately understand the need for research directed at decision making operations, including those of a regulatory nature.

Since technology assessment must be evaluated with a future orientation, the outlook of Federal agencies regarding long-range analysis is related to their concept of the R, D, and D effort. In a 1976 study of seven Federal agencies by the General Accounting Office it was found that the Energy Research and Development Administration had a good long-range planning program, and the Federal Energy Administration did not, and the Environmental Protection Agency was intermediate in its approach.

New and innovative thinking, risk taking in terms of research, and long-range understanding are all necessary in part of a good R, D, and D program.

Public involvement is another problem area. Public involvement is just as important in the R, D, and D decision-making process as in any other agency activity, but is frequently ignored by agencies -- although not by Congress. In recent years the public has become more educated and sophisticated, as well as more interested in the activities which impact on their lives. As a result of earlier improvements in the communication process, the public is faced with too much information in some cases, insufficient data in others, and an increasing amount of conflicting opinion on technical questions.

These conflicting opinions to a large degree are due to the R, D and D process as we are now using it, and to the popular news media. Frequently, R, D and D efforts are contracted on a specific technical question, some questions which really cannot be fully answered until other studies are done.

However, when the contract -- whether it's internal to the agency or external -- is complete, it appears to stand alone, thus giving the impression that the study is complete and the answer is known.

When this process is combined with a number of variables involved even within the same research topic, legitimate and non-legitimate conclusions can be drawn from the selected use of available data. This piecemeal approach to R, D, and D is a major problem. As the news media publicizes such piecemeal reports, additional confusion results; this confusion is intensified by the apparent need for some of the news media to stress controversy and extreme viewpoints, as opposed to careful and full analysis.

The role of toxins is another problem area. Our level of knowledge on toxins is primarily on the analysis side, rather than on the effect side. New toxins are discovered or manufactured, analyzed, and publicized more rapidly than we can understand their effects.

Toxicity data are limited, but they are often referred to as "The Truth." This leads to reports such as, "carcinogen of the week," to reversing earlier decisions which were based on incomplete data, and to the setting of regulations based on limited data which may not be representative of the real situation.

We frequently give great credibility to a statistical analysis of some apparent cause and effect relationship, and use this analysis to make a regulatory or an R, D, and D decision. However, a proper statistical study can only be done when all the pieces of the relationship are known.

Rather than attempting first to understand the system and then evaluate the interactions, we guess at the interactions and forget to further evaluate the system. A great deal of R, D, and D resources can be expended in efforts, and sometimes are counterproductive.

Another major problem is risk analysis. Generally speaking, society and some regulatory decisions are oriented to a no-risk situation. But there are no no-risk situations, whether it's automobile travel, medical operations, or environmental impacts of energy development.

Until more effort is expended on probability or risk analysis, including public awareness efforts, many existing research efforts may add to the confusion, rather than to the solution, or worse yet, may result in incorrect assessments of an original good R, D, and D question.

In the area of research and development, current R, D, and D efforts can be placed into two broad categories: 1) those which significantly address key needs and may result in major new concepts or programs being advanced, and 2) those which are duplicative, irrelevant, and unnecessary.

In the first case, the research may be difficult to do or difficult to convince the agency it is necessary, it may be risky if the potential payoff is unknown, and it may not be compatible with prevailing political attitudes. Perhaps an example of this phenomenon is the omission of nuclear energy from environmental assessment under PL 93-577.

In the second case, the research may be easy to do, easy to fund, and provide only limited risk of not having a "product" at the end of the contract period. It is hard to say how much research effort would fall in each category, but I would guess the second one would be significant.

Research funded by mission-oriented agencies can be both long-term as well as short-term, and basic as well as applied -- and there needs to be an appropriate mix of all types. All that is necessary is that it be the appropriate subject of the agency or combinations of relevant agencies.

Regulatory agencies, understandably, need to direct research efforts to the regulatory process; whereas Cabinet agencies can be much broader.

It seems that much of the R, D, and D effort still tends to be oriented to a pre-embargo thinking, although changes have been made to a greater degree each year to reflect new needs. There is an apparent reluctance to write off "bad investments" in areas which no longer are technically/ economically a high priority but may be politically popular.

As more is known of the role of toxic materials in specific technologies, there does not seem to be a corresponding assessment of that technology and its role in the overall energy program. Included in the increase in knowledge of energy/toxic materials is the realization that we may increasingly know less about an entire system, thus putting that particular technology in a relatively greater risk area.

One of the major reporting problems of R, D, and D activities is the piecemeal approach referred to earlier. Years ago a scientist would perform many experiments, develop hypotheses, do more experiments, and develop conclusions based on a variety of events. Now, there is a tendency to publish each component as it is completed, and this allows for misleading conclusions to get into the information system. This problem may become more severe as Federal R, D, and D becomes more contract-oriented with a major incentive being making the contract deadline, rather than answering the question.

The need for more "risk taking" in research topics is important, and there is a need to focus research efforts to fill in gaps, as opposed to refining or duplicating already known facts.

There's also a great need to increase research in the behavioral sciences, in information use -- or studies of people's perceptions versus reliance on facts -- and how trade-offs are made when cost/benefit analyses and risk assessments are diffucult or impossible. While all these aspects do not fall completely to mission or Cabinet agencies, a considerable portion does.

Some of the current activities -- within the last three to five years there appears to be significant increase in real coordination among federal agencies dealing with environment and energy. While the day-to-day operations have been complex because of the state of flux of the involved organizations --particularly DOE, recently -- positive results are evident.

In addition, the environment/energy interactions appear to be significantly internalized within the appropriate divisions of agencies, rather than being treated as independent subjects. The major problem appears to be related more to developing a smooth working relationship, rather than the need for problem recognition.

One of the more important examples of coordinated energy/environment R, D, and D is the Federal Interagency Energy/Environment Research and Development Program. The seventeen-agency group -- coordinated through EPA -- was begun in 1975 and has published a number of relevent documents in the R and D Decision Series.

Important examples include "Environmental Considerations of Selected Energy Conserving Manufacturing Process Options" -- 1976 -- and "Accidents and Unscheduled Events Associated with Non-nuclear Energy Resources and Technology" --1977. In addition, the series provides important information relative to project abstracts, bibliographies, and budget analysis.

The National Science Foundation is currently analyzing for the Toxic Substances Strategy Committee the first agency-wide survey of toxic substances research in the Federal government -- "Research Activity of Federal Agencies on Toxic Chemicals."

Since the concern over toxic substances is growing rapidly, this should provide additional insight to their role in the energy/environment R, D, and D process.

There have been a number of significant NSF studies in recent years dealing with environment/energy and how to deal with future needs and coordination. Some of the broader -- multiagency -- research needs are being addressed, such as the inadvertent weather modification, environmental risk management, environmental effects of energy, and chemical threats to man and environment.

The National Academy of Sciences since 1973 has played an increasingly important role in this area. They have reviewed -- at the request of Congress --the entire R, D, and D program procedures at EPA. They've performed energy futures studies, and have published several books on procedures for evaluating chemicals in the environment.

The Department of Energy Environmental Development Plans and the Office of Technology Impacts appear to increase the integration of environment into specific technology programs at DOE.

The Council on Environmental Quality is presently developing regulations for the EIS process, and the agencies involved with EIS have largely accepted the idea now of EIS, and this should result in better use of existing R, D, and D information in evaluating future energy/environment programs.

Reports through the Congressional Office of Technology Assessment, the Congressional Clearinghouse on the Future, the NTIS, Smithsonian Science Information Exchange, and specific journals and documents of agencies all indicate the results of energy/environment R, D, and D activities being published.

Some problems still remain, however, even though major improvements have been made in recent years. Most research is directed at technical issues, whereas many problems are behavioral/institutional. Most research information is published in technical form and is not properly evaluated -- and I underscore "not properly evaluated" -- after contractors submit their final reports.

The results are generally not packaged for the appropriate audiences and there is a reluctance to research the most relevant topics, even though results of workshops and studies have been published on future agendas of research.

With such an increasing number of unanswered questions in areas which have not been researched, and the observation of significant data gaps in previously researched topics, the limited R, D, and D resources must be well directed and not duplicated.

There are a number of specific areas that one could specify for new R, D, and D directions, but I'm going to make only general remarks which I think are the most critical, and I've listed twelve points.

Number one, R, D, and D cannot provide all the answers and should not propose to do so; the major solutions in many cases are economic and institutional and may not be solved by further study.

Number two, there is a need for projects which analyze and tie together previous specific projects; this would provide a more comprehensive analysis and identify data gaps.

Number three, R, D, and D should be more innovative and should risk some resources to evaluate new options. Now there is too great a reliance on "accepted ideas" of what new technology should be.

Number four, there needs to be a greater broad public involvement in the initial process of R, D, and D decision making and a greater communication to the various publics after the projects are completed, and I should indicate, in a form which they can understand.

There need to be specific research projects directed at assessing the techniques of existing research activities. This should also include procedures to validate the data and to standardize the techniques where appropriate.

Number six, multiple R, D, and D contracts from the same project area should be given to a variety of researchers to provide diversity of viewpoint and to keep each group honest, but specific duplication of effort should be avoided.

Number seven, there should be a greater use of "expert agencies" when appropriate. For example, the National Institutes of Health should play a key role in evaluating toxic materials and human health.

Eight, there should be a greater use of groups such as the National Academy of Sciences as a "third party check" on R, D, and D assumptions, directions, results, and procedures.

Number nine, it should be recognized that the perception of people may override the facts, even if the perception is counter to the facts. The role of information science in R, D, and D efforts is probably seriously underestimated.

Number ten, there needs to be a greater technology assessment of R, D, and D needs by groups of varied viewpoint and experience; included would be the assistance in agency R, D, and D priority setting by outside groups.

Number eleven, there is a need for joint awarding of projects to groups of varied interest -- for example, environmentalists and industry -- such that the advocacy positions and differences in data validity are resolved within the project, rather than highlighted in the popular press.

Finally, number twelve, R, D, and D efforts should be directed at a fundamental understanding of the problem, and not simply an itemization of apparent cause and effect relationships or statistical summaries of processes which are not understood.

In summary, within the last ten years we have entered a new era and we can no longer depend on extrapolations of past experience. We have much new knowledge, but the complex interactions have created a greater lack of understanding even with this new knowledge. For example, acceptable estimates of energy use in the year 2020 range from several times that of today to less than that currently used.

R, D, and D efforts are moving in new directions as a result of these changing conditions. There is increased coordination among agencies working on related activities, and there is a greater understanding of the need for energy/environment interactions to be addressed early in program activities. However, there are active areas of R, D, and D support which appear less important than other areas which have been neglected, and there seems to be a bias toward technologies which were considered new several years ago, but may no longer be worth pursuing as much as other "new" technologies.

At this point, it seems more important to evaluate the R, D, and D procedure, rather than to suggest areas of research need. By assessing future technologies and energy needs from the new perspectives gained only in the last three to five years, it is more likely that the R, D, and D effort will satisfactorily address key energy/environment questions and also be more compatible with public and agency needs.

Thank you.

DR. REZNEK: Thank you. I find your remarks very interesting and stimulating. Does anyone have any questions?

QUESTIONS AND REMARKS

DR. REZNEK: As a research manager, I am intrigued by your suggestion that we save our facts until we get them all together. There are surely good reasons for doing this. The information may be in error, or it may be misleading. Still, this policy leads to charges of hiding things from the public.

DR. CALDWELL: Hiding the data?

DR. REZNEK: Hiding the data, or telling the public only what you want them to hear, and other interesting phrases like that.

Would you care to comment? How do you deal with the problem of not putting out preliminary information. Granted preliminary information may be misleading, but almost all Federal agencies operate in a goldfish bowl where all information has to be made immediately available for public scrutiny.

DR. CALDWELL: My background is in chemistry, but I'm serving primarily as an information and research coordinator within the University now, and I've switched from on-the-bench techniques to getting into more of the public eye.

My impression is that the major problem we've got is information science, and not the specific technologies of energy development, and the question you asked me would be a nice research topic, I think.

I don't want to avoid it by saying that, but I think it's a real problem.

As a contract study goes out there's a statement on the front page that says that this is published by whatever agency is publishing it and it does not necessarily reflect the agency, it's a contractor study, and somewhere on there it has the name of the contractor -- sometimes, but not always -- so you're not always aware of who did the study, sometimes, although it comes out under agency aegises.

So I think that there's some need for the agency, maybe, to evaluate the project. Maybe it's a two or three page summary saying that this is an assessment of this particular project, something that gives it a degree of is it good, bad, or indifferent, or just is it an initial summary that we can't evaluate yet, but I think there needs to be some indication of a group on how good the data are.

DR. REZNEK: Thank you. I'm sure you realize that your proposal is fraught with difficulties. In my own agency, we have a procedure for denying publication to contractor reports we're not satisfied with, although we make the list of the unpublished reports available, and anyone who wants to can obtain a copy. We just don't publish them.

DR. CALDWELL: One of the problems is just finding out the reports that are available, in the field. Of course in Washington, if one knows how the bureaucracy works, you're one up on anything else, and if you have access to information it largely depends on that you know the system, although there's -- no one is suppressing the information, you just don't realize that it's available.

There needs to be something done, I think, in just making available studies -- or knowledge of studies that are available.

DR. REZNEK: Any further questions?

Thank you.

DR. CALDWELL: Thank you.

DR. REZNEK: Our next witness is Boyd Riley.

STATEMENT OF DR. BOYD RILEY
CONSULTANT

DR. RILEY: Well, in listening to the auspicious affiliations that the previous speakers have mentioned, I'd like to start off by saying I represent the world's smallest consulting firm, and I'd also like to start by apologizing in reading this speech. It begins with an error, it says, "Good afternoon, gentlemen." And just stops. So I'd like to correct that and say good afternoon ladies and gentlemen.

It's a pleasure to have an opportunity to present several subjects for your consideration in this hearing. I plan to briefly address three topics, each of which is integral to the concept of fossil energy conservation.

By conservation I do not mean pointless depression of lifestyle, but rather the judicious use of energy in the most efficient manner possible.

As we are all aware, conservation via increased efficiency pays large dividends. These dividends are direct in that the cost of conserving energy is almost always less than the cost of replacing the saved energy with energy exclusively drawn from conventional new energy sources.

Important secondary benefits are derived by using fewer pounds of fuel to accomplish a specific task. Proportionately, fewer pollutants are released into the environment and fewer non-renewable resources must be extracted with attendant adverse environmental effects.

The three subjects I will address today are: the potential for biomass as a significant domestically produced, renewable energy resource; the need for a new initiative to accomplish direct firing of high-temperature gas turbines with high ash fuels; and the importance of maintaining effective tools for the accomplishment of a selected task.

The last subject may sound unusual, but it impacts directly on the legal framework required to develop energy conservation programs which will be of great benefit to the nation.

The first topic, the potential for biomass as a significant renewable energy resource, must be opened with a definition of biomass. Many definitions of biomass as a fuel resource have been offered. Mine includes anything that burns, is or has grown, and has not been fossilized.

This definition of biomass is extremely important because it emphasizes the ubiquitous nature of biomass and implies a multitude of potential sources for any selected region or facility. Thus, it dictates an approach which is not presently being pursued and which promises significant short and long-term benefits to the U.S. energy economy.

To achieve maximum benefit, we must organize a management system which allows us to harvest the equivalent of twenty percent of the land adjacent to and east of the Mississippi River at a rate of thirty dry tons per acre per year for fuel purposes.

Such a program will yield about thirty quads per year of an energy resource which is permanently renewable by solar infusion.

Because of its ubiquitous nature it is highly unlikely that any individual or organization will ever dominate the production of biomass fuel resources; however, a biomass production organization could be established, just as a modern corporation is formed. That is, small contributions by many individuals. In other words, a middleman is required who is capable of buying when biomass materials are available, processing these into a storable form, and then selling as market requirements dictate.

One configuration for the fuel which appears compatible with the requirements for preparing and storing biomass fuels is the high density pellet. Although little is known about the most desired formulation of such a pellet, there seems to be no technical reason why it could not be prepared to meet any requirements, including water resistant coatings to facilitate outdoor storage of the fuel.

Once a sufficient collection and processing system is established, then any number of applications may be developed for this material. It may be used as a direct boiler fuel, it may be gasified for a fuel, or used to create chemical precursors.

None of these applications may be developed, however, if an adequate, dependable collection system is not developed first. The concept of many small contributors has many parallel systems to follow -- e.g., grain, -- and will provide a meaningful supplement to farm income, just as grain crops and what have you, are collected.

The DOE biomass program is only faintly comparable to the program suggested herein. DOE has organized itself in such a way as to treat biomass as a series of special materials, such as forest waste or fuel crops, which must be segmented and not intermingled. Hence, there is no effort at DOE to develop a regional biomass resource based on multiple inputs.

The environmental implications of improved and expanded use of biomass are promising. For example, because biomass is renewable by solar infusion, the coal, oil, and gas which are displaced by biomass will never be mined. Hence, all of the secondary and primary pollutants produced both by the mining and by the utilization of these fossil fuels will not be incurred.

In addition, biomass-based fuels appear to contain fewer pollutants than fossil fuels -- sulfur, heavy metals, that sort of thing. A further potential benefit of increased biomass utilization is the dedication of sewage as an irrigation and fertilizing medium, rather than as a disposal problem.

Biomass production will require significant land resources, and the irrigation of these lands will significantly enhance the growth rate of the biomass resource. Thus, generous land areas for sewage disposal via drip irrigation or what have you could be created and achieve zero discharge.

New technologies offer the promise of low cost sterilization of raw sewage without significant conventional treatment, thus precluding the transmission of disease through combined food and energy crops.

To develop biomass as a resource contingent on contributions by numerous producers of raw material, several steps are required.

First, one or two demonstration areas must be selected for the testing of the feasibility of the concept of reliably producing significant quantities of biomass from small contributors of varying types of biomass materials.

Second, a macro-environmental impact study must be carried out which compares the impacts of maximizing the use of biomass with the coal, oil, or nuclear power which would be displaced by this energy resource.

Third, the feasibility of using municipal sewage as an irrigation and fertilizing medium for biomass on a large scale should be examined in greater detail than any studies heretofore directed at this subject.

The next area I will address is the all-important area of the development of high temperature, high pressure gas turbines which can be fired with ash-containing fuels for the generation of electric power. I will not bore you with the legions of numbers that indicate the significant improvement in overall thermal efficiency of this type of approach versus conventional steam electric generating plants. Suffice to say that perhaps as much as one-third more energy could be produced at the bussbar if such a turbine could be successfully applied on any type of fuel.

DOE has several programs directed at one approach to high temperature turbines and combined cycles. These programs all plan to use fuels produced by gasifying coal, a process which is fraught with technical, economic, and energy efficiency difficulties. Hence, in the long run any efficiency gain created by improved gas turbine technology will be offset by the cost of fuel preparation.

A need unmet by DOE is the creation of the ability to fire fuels with modest to high ash contents directly through gas turbines. In order to accomplish this, new technology is required for the removal of particles from hot, high pressure gas streams without significantly changing these streams.

Historically, the Combustion Power Company, under EPA sponsorship, has attempted to burn mixed urban waste in a fluid bed and exhaust the gases through a gas turbine. Many difficulties were encountered in the project, principal of which was particulate removal from the gases to a level which would allow adequate conventional turbine life.

Prior to the CPU 400 experience, the Office of Coal Research committed several years of effort in the late 1950's to the development of a coal-fired gas turbine without success. Again, the principal problem was the control of particulate in the gas stream.

DOE has elected to circumvent this problem by first producing a clean fuel and then firing it in a gas turbine. Fuel production is accomplished at significant energy cost and at significant intensification of the capital investment required for each facility. Thus, another major benefit of the high efficiency gas turbine is cancelled; that is, the incremental addition to the electric power generating systems of high efficiency modules.

Two areas which are missing from the DOE program and should be added are: first, the establishment of an information matrix for the examination of the potential of direct firing gas turbines with high ash fuels. Such a matrix would allow one to compare all of the possible combinations of technologies, and to assess their potential for successfully removing particulate pollutants prior to the admission of the hot gas stream into the turbine.

Second, the application of high speed centrifugal particle accelerators to the gas stream has not been explored. The technique of centrifugally collecting particles with a high speed particle accelerator as a first stage for the turbine, or as a flywheel type cleaning stage, offers significant hope that the turbine could be protected from all particles over one micron in size.

The remaining particles could be controlled by utilizing a cooled blade turbine which would enhance the efficiency of the system while providing protection from those very small particles which tend to act like gases instead of particles during their passage through the rotor and stator stages of the turbine.

The technical feasibility of this concept needs additional exploration. However, it offers several benefits over the DOE approach. That is, it maintains the high efficiency and incrementality of the gas turbine and thus reduces the planning and construction time to increase electric generating capabilities.

It also allows one to combust a variety of fuels in the system, none of which may be classed as premium or imported. The environmental benefits of such a program, again, are obvious in that fuel conservation reduces the impact both from primary production of the fuel and from the production of secondary pollutants.

Finally, the subject of maintaining appropriate tools must be addressed. For DOE and EPA the principal tools are the contracting mechanisms, which allow you to acquire the ideas and knowledge of the public at large and focus these towards the purposes the goals of your programs.

It has been my experience, both inside and outside the Federal establishment, that these tools have progressively deteriorated to a state wherein they scarcely work at all.

While there appears to be an adequate mechanism for launching massive undertakings or buying a zillion pens, there is no mechanism for dealing with the special problems of the small business or the creative individual. This is extremely regrettable, since large organizations are psychologically incompatible with many creative people. That is to say, those that create are not likely to be found within the structured organizational confines of a large organization.

If your agencies fail to reach these individuals, then it is likely that you will fail to reach many of the most creative ideas available in American society. Hence, your rate of progress will be retarded.

The problems of doing business with the Federal agencies have become so great as to cause a number of my clients to simply say, "We won't try any more." Contract award times of eight months to a year, after a twelve-month planning period, are not uncommon. To initiate an unsolicited program is almost impossible, and I've even been told that certain programs were simply too small to be worth doing the paperwork on. Obviously, none of these impasses are pertinent to the energy and environmental problems which need solutions.

I realize this subject is an uncomfortable one and, to a certain extent, beyond the purview of the technical professional personnel within the agencies, but I feel it has reached the critical point and someone must call attention to it.

Thank you for your attention. If you have any questions I'd like to try to answer them.

DR. REZNEK: Thank you. Do we have some questions?

QUESTIONS AND REMARKS

DR. MACKENZIE: Yes, I'd like to ask you two questions on your biomass estimate. Here's something I've been looking at recently in our -- we have ourselves. You cite thirty quads per year. Is that finished fuel, or is that raw input?

DR. RILEY: That's about thirty quads per year.

DR. MACKENZIE: Of what?

DR. RILEY: That was based on dry weights, you could call it finished fuel.

DR. MACKENZIE: I mean that's -- if you convert that into methanol is it fifteen quads, or is it thirty quads of methanol, for example? If you wanted, say, a liquid fuel.

DR. RILEY: Well now, the thirty quads would be as a solid fuel, let's say comparable to coal.

DR. MACKENZIE: Okay, so probably get -- if you converted it to liquid fuel you would probably lose forty percent of it, or something like that.

DR. RILEY: Or more.

DR. MACKENZIE: Okay. Your productivity at thirty tons per acre a year as far as I can see is about at least ten times sort of what ordinary crops are, and is comparable to the most highly cultivated sugarcane in the most favorable regions and it strikes me as being somewhat optimistic to think that you could grow that on twenty percent of the area east of the Mississippi. I'm wondering what you're growing, secondly, and -- let me finish it -- secondly, the sewage -- I am somewhat -- in addition to sewage -- most of the sewage, let's face it, is in the cities where there's a lot more than organic stuff being thrown in -- God knows what else. You know, mercury and chemicals and heavy metals.

Unless you have a sewage separation system, that's going to pose a problem, and in fact, of course, at that type of growing, you know, you're mining the soil of nutrients, and so forth, which is another kind of major problem, all of which I'd like to see overcome, but I'm just wondering how you comment on that.

DR. RILEY: Well, let's talk about the thirty tons per acre. That is a very high number. It is achievable with some crops today. It apparently can be achieved by more specialized breeds that are grown specifically to produce mass, as opposed to let's say soybeans or wheat or what have you.

In fact, much of the work that's been done agriculturally has been to reduce the mass produced in order to increase the yield of beans.

I picked that number as a maximum. I doubt that we would ever go much beyond thirty quads a year.

On the other hand, we're not exactly limited to only twenty percent of the land for this purpose, either. We may get much lower yields over a much larger land area.

DR. MACKENZIE: This is comparable -- in fact, it's larger on a percentage basis than what we devote to agriculture in the country, which is seventeen percent of all our lands.

DR. RILEY: Right.

DR. MACKENZIE: This must be prime agricultural land that you're devoting here, in which case it's probably a good part of it. Have you considered what that means?

DR. RILEY: Not necessarily. The things that could go into biomass don't really require prime land.

DR. MACKENZIE: At these growth rates --

DR. RILEY: The national flower may turn out to be the almighty weed.

DR. MACKENZIE: Okay, do you have any documentation or -- I mean for the thirty quads? I'd be interested if you have any of that.

DR. RILEY: It's developed in a report that I did some years ago for EPA. Basically it's a rough estimate. I wouldn't nail my heart to it at this stage.

On the other hand, if you added up everything that could conceivably be put into it, I don't think it's that far off, either.

It could be fifty percent off. Could you live with fifteen quads? It's still a much bigger --

DR. MACKENZIE: That's getting close to where we thought.

DR. RILEY: Okay.

DR. MACKENZIE: I mean we talked with many experts and everyone said well, ten seems like it's do-able. Thirty, you know, sounds like quite a bit.

MS. VAN SICKLE: Do you have any data on using aquatic plants like water hyacinths and things like that as forms for the high density pellets?

DR. RILEY: No data specifically. It seems to me that that increases difficulties in processing the material by one more step in that the moisture content is extremely high in acquatic plants.

There's no reason why you couldn't do it, but it seems to me that with a lot of green things already growing out there, maybe we'd best devote some attention to learning how to use those before we start trying to develop other things.

MS. VAN SICKLE: Well that's what I'm getting at. We have tons and tons of water hyacinths that we have to get rid of, and there are all kinds of harvesters, but you also have the problem of disposal, so you could have twin benefits if you could do something like that.

DR. RILEY: Well, I believe DOE has a program on the water hyacinth specifically, but it's ninety-plus percent moisture, or something like that. You're harvesting an awful lot of water.

MRS. HARRISON: Did I understand you to say that coal gasification or fluidized bed combustion of coal is not an environmentally sound technique?

DR. RILEY: No, I didn't say that at all. All I said was that if you had to process the coal into a clean fuel form there's no way you're going to get a 99 percent yield. Seventy percent is perhaps your most optimistic, and when you compare that with a thirty percent increase in efficiency that gas turbines might offer for generating power, you've just lost it -- by processing the coal.

DR. REZNEK: I was intrigued by your last comment about the clumsiness of the research support mechanism in government. I must admit that while I blanched at the number for the yields on biomass, I didn't blanch at your times to get contracts out, since we live with that.

When NASA was being put together as a major Federal experiment in fostering and developing technology, unique Federal contract funding arrangements were developed and instituted. These funding arrangements are the basis for our contractural procedures today. I have not heard this type of comment in all of my discussions of energy and environment and the needs to take action. But it's true. We're operating in a different kind of situation and the funding mechanisms available to the government are 25 years old and need some rethinking if, in fact, we are going to get to the new or tap existing fundamental understanding and ideas.

It's an interesting comment, and I'd like to underscore it.

DR. RILEY: So would I. We're on the other side.

DR. REZNEK: I had some comments about your turbine remarks also. DOE and EPA had a conference at the end of last calendar year on high-temperature and high pressure particulate control. This constitutes a difficult physical regime under which to perform experiments. You do not want to expose an expensive piece of high-technology equipment like a turbine to the basic substances that are in coal.

A lot of money is going into research on the problem, but, like fusion, it's going to take an awful lot of development money to make progress.

DR. RILEY: Well, I agree. There's a lot of money going into the problem. I'm not sure it's going into this particular aspect of the problem. I think people are getting discouraged with coming up with a solution.

On the other hand, the work that I was most familiar with, there really wasn't that much attention paid to solving that particular aspect of the problem, that was de-entraining particles in a hot gas chamber, starting necessarily at the bench, so to speak, and working up from there.

It doesn't seem to me that that's an unsolvable problem. Difficult, yes, and economically perhaps even more difficult, but at this point I don't even know of a listing of technical approaches where people say it can be done.

DR. REZNEK: Any further questions?

Thank you.

DR. RILEY: Thank you.

DR. REZNEK: Our next witness is Dr. Richard Merritt, who is a consultant representing the state of Nebraska.

STATEMENT OF MR. RICHARD MERRITT
CONSULTANT
REPRESENTING THE STATE OF NEBRASKA

MR. MERRITT: I'm not Dr. Merritt yet. Hopefully some day.

I'm Richard Merritt, and I'm here representing Charles R. Fricke, the Administrator of the Nebraska Agricultural Products Industrial Utilization Committee, commonly known as the Gasohol Committee. I'm a consultant to the Committee. I'm a consultant to the Committee and their representative here in Washington.

I'm going to read his statement, and then if I might take the liberty of adding a few small comments of my own at the end.

Charles R. Fricke has been the Administrator of the Nebraska Agricultural Products Industrial Utilization Committee -- better known as the Nebraska Gasohol Committee -- for the last three and one-half years. The Committee was created as a state agency in 1971 by the Nebraska Legislature to research and to cooperate with private industry in the development of new or alternative markets for Nebraska agricultural products.

Chief among the Committee's research and development projects is the Gasohol program. Presently, this is the only state agency in the United States researching and developing ethyl alcohol blended fuel on an extensive basis.

The Nebraska Gasohol Committee is recognized as the national leader in the research, development, and marketing of gasohol. Gasohol, properly defined, is a motor fuel consisting of a blend of ten percent agriculturally derived, anhydrous, 200 proof, ethyl alcohol and ninety percent unleaded gasoline.

Nebraska has tremendous supplies of grain and other agricultural crops each year which can easily be converted into alcohol fuels. This is now true historically of other states in this agricultural region.

Agricultural representatives from fifteen states have now indicated interest in developing gasohol programs of their own. This is becoming a reality with the creation of a National Gasohol Commission.

The interest in gasohol has been so strong over the past year that the National Gasohol Commission was officially formed on January 24, 1978 in Lincoln, Nebraska. The Commission would: 1) coordinate and disseminate information on ethyl alcohol fuels among the member states, 2) coordinate and develop uniform gasohol legislation among the member states, and 3) apply political pressure on the national level for pro-gasohol legislation.

Initially, this organization will advocate regional development and distribution of gasohol only. I wanted to lay out this information as a preface to my remarks to follow regarding the U.S. Department of Energy Research and Development program.

Gasohol is relevant for testimony at this hearing today due to its connection with coal. Coal would be used as the conversion fuel for the production of renewable sources of liquid energy from agricultural products.

Gasohol would be relevent to testimony on solar energy and energy conservation programs as well.

Gasohol could fit into several DOE research and development programs. Currently, gasohol -- or any ethyl alcohol fuels from agricultural crops -- is considered under the Solar Energy Division's Biomass Department.

Since ERDA was created very little attention has been directed toward Nebraska's dynamic gasohol research program until just last year. Only trivial funds have been directly channeled toward gasohol by DOE. This amounted to only $30,000 for an economic feasibility study in 1977 to the University of Nebraska at Lincoln Energy Research and Development Center.

If there have been other grants, I have never heard about them, or they were very small.

I would like to emphasize here that gasohol is beyond the study stage. Gasohol is actually being sold at a profit -- not inconsequential -- in Illinois, is being sold in Nebraska and Illinois today, but only at four or five service stations that we are aware of.

So, gasohol is technically and economically feasible today.

However, only a small amount of agriculturally derived anhydrous ethanol is available from only one supplier in the nation, currently. It is very expensive to transport it from its current site, which I believe is in Bellingham, Washington.

What I'm saying is that DOE needs to develop a loan guarantee program providing loan guarantees for the construction of agricultural anhydrous ethanol plants. Such plants would create supplies that would be close to the areas where they are demanded and consumed. Then the price of gasohol could be even more cost competitive. Urgency is essential.

If this country ever expects to be less dependent upon foreign oil, gasohol is the fastest, least expensive, and cleanest way to do it.

If gasohol could be developed on a regional or a national level, it would provide positive and constructive means to lessen the balance of payments deficit and help resolve historical farm problems of this country.

International tension in the Mid-east countries is another reason for the large-scale program on gasohol being urged. I would hate to think what another oil embargo could do to this country.

A loan guarantee program needs to be implemented immediately for the 1979 or 1980 budget. A reasonable monetary figure for this loan guarantee program would perhaps be in the $500 million to $1 billion range.

This is appropriate, compared to the millions of dollars that have been poured into the research development programs for the development of methanol and other synthetics from coal.

I am distressed that ethyl alcohol as a fuel or fuel extender has been greatly and unjustly discriminated against by key DOE officials. However, recently there are indications that this attitude may be more favorable, due perhaps to Congressional pressures.

Ethanol is an excellent product for near-term energy conserving fuels. Ethanol is a clean-burning and an environmentally safe fuel. Ethanol is not toxic, compared to methanol, which is highly toxic and poisonous.

Possibly these problems with methanol can be overcome. I might say personally that I think that the best use for methanol is to slurry coal with into what's called metha-coal.

So, environmentally speaking, ethanol should be acceptable to the U.S. Environmental Protection Agency as a liquid fuel, either by itself or as a blend in unleaded gasoline. Several official emission tests show that gasohol emits less pollutants than regular unleaded gasoline.

Ethyl alcohol -- in fact, even methanol -- are octane improvers, and this means we can get the lead out of gasoline completely and raise the octane in gasoline without the use of lead, and I commend the EPA for their efforts to get the lead out of gasoline.

Gasohol should be a major permanent part of the Department of Energy R and D programs. A special department in DOE should be created, solely devoted to ethyl alcohol fuel.

Why all of these recommendations and criticisms? The year 1978 will be recognized as the year that gasohol, the first fuel of the future, gained a foothold -- hopefully -- in the United States. Also, it will be recognized that gasohol struggled to reality without much -- if any -- help from the Federal government. Gasohol has arrived, on a small scale, in this country.

Hopefully it is here to stay and grow, but it needs the assistance and promotion of agencies such as the EPA.

I would like to list significant facts on gasohol as a motor fuel.

One, improved gasoline mileage and higher octane; two, less polluting; three, no mechanical adjustments are required on any vehicles operating on ten percent ethyl alcohol, known as gasohol; four, can be burned in any internal combustion engine, including diesels and gas turbines.

If gasohol is developed on a regional or national basis it would reduce the importation and dependence upon foreign oil. Thus, the development of gasohol could reduce the chances of the oil spills in the oceans that are so disastrous to the environment.

I would like to end my testimony by directing the hearing panel's attention to a copy of a letter, two reports, and a gasohol brochure that we have attached to a copy of the oral presentation, which provides additional support on gasohol and further information regarding DOE activities with regard to gasohol.

Thank you for the opportunity to present an oral statement on Nebraska's gasohol program as it relates to environmental and energy programs. I sincerely hope that EPA officials will promote the development of gasohol during the deliberations on the energy bill in the next few months.

I would like to personally add that EPA can do a number of things, I think, in relation to gasohol. One is to consider the topic that President Carter mentioned in a press conference a few weeks ago wherein he said that he was aware that farmers in Georgia had been particularly hurt by the aflatoxin problem, and as I understand, aflatoxin is a cancer agent that infects corn; I believe in some states in the south fifty percent of the corn crop has this agent which is a very -- which I believe the FDA has said is the most powerful natural carcinogen known.

When a corn crop has this in it, it is a total loss to the farmer and supposedly, I believe, has to be buried in the ground, in which case I wonder if the toxin gets into our ground water. But toxin corn is a very good raw material, and indeed has been and is being used in Alabama right now, in Selma, Alabama, as a raw material to produce alcohol.

So therefore, if you take the alcohol out of the corn you do get some return to the farmer from the crop, and it should be possible to kill the toxin agent during the distillation process. That needs further research.

If you did do this, then you could recoup the value of the corn, which as it is now is a total loss to the farmer.

The second is that biomass fuels, such as alcohol, would have a major beneficial effect on the greenhouse problem. When you use biomass fuels you do not add any new carbon dioxide to the atmosphere, which I think in the long term will be a severe problem and I would hope the EPA would consider the beneficial effect that alcohol fuels from renewable sources could have on that.

Thirdly, thermal pollution from nuclear power plants is something that people worry about, and distillation is a heat consumptive process and to site a distillery next to a nuclear power plant would absorb perhaps a rather substantial amount of this heat, which essentially is wasted and creates a problem now.

Distillation is a low-temperature, low-pressure process and should be an ideal candidate for siting next to nuclear plants or existing power plants for co-generation.

Fourth, urban wastes are good candidates for conversion into alcohol, and we see this as a distinct possibility. I am intrigued by the idea that garbage trucks will run on alcohol made from the garbage that they pick up, perhaps in a municipal power plant.

Lastly, new car emissions testing today is done on gasoline specified by EPA. We would like to urge -- and I think there will be Congressional action on this -- that new vehicles be tested not only on the standardized fuel, but on gasohol, and we're quite sure that the emissions in new cars would be reduced from the testing we have seen. But if EPA would specify either as an alternative or as an additional fuel that all new cars must be certified on gasohol, this would be a real step in the right direction.

Thirdly, I believe it's EPA that handles the annual rating of vehicle mileage standards. We would like to see the mileage standards defined as to exclude the alcohol content, thereby -- if a car is running ten percent alcohol -- it should have a latitude of ten percent in the mileage standard, because after all, mileage standards are to reduce the consumption of gasoline -- a non-renewable synthetic fuel of which much is imported today -- and to the extent that we can get vehicles onto alcohol, which is a clean-burning renewable fuel, that should be exempt, the alcohol content should be exempt in the Federal mileage standards.

And Detroit engineers have told me that they would welcome this as a definite benefit to them. Furthermore, it's well recognized in automotive circles that high efficiency vehicles need a high octane fuel. You can't have high mileage, high efficiency motor vehicles on low compression engines with low octane fuel, and alcohol is the only environmentally acceptable octane improver we have today.

I'd be pleased to answer any questions as best I can.

DR. REZNEK: Thank you.

QUESTIONS AND REMARKS

MRS. HARRISON: If someone put forth a billion dollars for further development of gasohol, then what would that mean in the course of energy development? What could we count on at the end of a certain time period of that kind of development to reduce consumption of other kinds of energies -- and this would be replacement.

MR. MERRITT: I would urge that money that would be available -- and a billion dollars would be a nice figure --

MRS. HARRISON: Well you used it. I'm not -- you said 500 --

MR. MERRITT: All right.

MRS. HARRISON: -- million to a billion, and I'm saying what if you got a billion?

MR. MERRITT: Well incidentally, that's miniscule compared to the strategic petroleum reserve. We would like to see the money that's being expended this year, which I believe is $3.6 billion -- next year $4.2 billion. We'd like to see that go into distilleries, good old-fashioned distilleries, vodka and gin, and we look upon alcohol as a strategic energy reserve that would be far better than putting your crude oil underground in Louisiana.

So I would have to say that we need a whole new energy industry to convert a multitude of materials -- not just grain. We need sugar beets, sugar cane, timber, urban waste. We need new crops, we need plant hybrids that would produce a lot of alcohol -- the Jerusalem artichoke is such a thing. It will produce a lot of alcohol.

We need -- basically we need the plants. The product works. It's been sold all over the world for fifty or sixty years by the oil companies themselves, incidentally. It's beyond research. Ethyl alcohol works today. You can dump it in your car. I've done it, and as soon as I get the next drum of alcohol in I'd be happy to make some available to the panel. You can see if your own car doesn't run.

MRS. HARRISON: I don't think you're answering my question.

MR. MERRITT: I would say the billion dollars should go into distillery construction.

MRS. HARRISON: I know what you want it to go into. I'm saying what if that happened. Then what do you think you would produce in terms of reducing the use of other kinds of --

MR. MERRITT: Well, we would reduce gasoline consumption by ten percent, depending on the output of the distillery. $20 million -- $20 to $25 million would give you a distillery big enough to put out twenty million gallons annually of ethyl alcohol, which would replace that much gasoline.

Yes?

DR. MACKENZIE: You stated that gasohol -- or alcohol for use in gasoline, with gasoline, is now being sold competitively.

MR. MERRITT: It is.

DR. MACKENZIE: What is its cost in gasoline gallon equivalents?

MR. MERRITT: It's sold in Illinois without any tax exemption at all today at 72.9 per gallon.

DR. MACKENZIE: That's gasohol.

MR. MERRITT: That's gasohol, which is two cents under Amoco premium, which is the only other premium unleaded fuel you can buy. So it is competitive with Amoco premium. I paid 74.9 here for Amoco premium.

DR. MACKENZIE: Well my understanding of the cost of ethanol is that it's on the order of three times the cost of petroleum for a car.

MR. MERRITT: This is true, but it's an octane improver, and we're only adding ten percent to a gallon of gasoline.

DR. MACKENZIE: But can you -- all right, so you're saying that although it is more expensive, that because of the special function it's therefore --

MR. MERRITT: It's an octane enhanced product, and we've always paid four to five cents more for octane improvement.

DR. MACKENZIE: That's a good answer.

MR. MERRITT: And I might say that if we blend the ethanol half and half with methanol -- which is substantially cheaper, gasohol could be sold if it was five percent methanol, five percent ethanol, and ninety percent no lead, it can be sold at four to five cents a gallon over the unleaded fuel, which is exactly what we've always paid for an octane enhanced product, and this works very well with catalytic converters. You know, they seem to work better with -- we have a newspaper in New York City, the New York Daily News is running a test now in one of their own cars at the New York City Clean Air Lab and it looks very, very good, and they hope to have a series of articles soon on that.

DR. MACKENZIE: Have you estimated the cost -- I mean the volume of gas -- of gasoline that you could effect in some sort of reasonable way with this?

MR. MERRITT: Well I think gasohol could be a national program. That would be ten billion gallons of gasoline, if we took in all the raw material bases that are available to us, including sugarcane and timber, and perhaps a supplement from methanol.

DR. MACKENZIE: Would that significantly affect food crops, and so forth?

MR. MERRITT: No. Our agricultural excess capacity is somewhere in the area of thirty to fifty percent of our output today, and we see gasohol as a means of absorbing surplus crops, which the American farmer has the curse of excess production today, and we fail to see how exporting grain at $2 a bushel that costs the farmer $3 to grow so we can buy Arab crude oil at $15 a barrel is good for the farmer and good for the country.

We say let's keep the surplus grain here, which will perhaps bring up prices a little bit -- certainly bring up domestic prices -- and I for one would rather give the farmer more money for energy than more money for food.

We feel that if we have to help American agriculture -- and I think it's rather obvious American agriculture needs help -- let's not escalate dramatically food prices, let's get the farmer into the energy business, because he is an energy producer, he produces food energy. Let's let him diversify into liquid energy to give us an octane improver that we desperately need for our gasoline.

DR. MACKENZIE: One last question. American agriculture is very energy intensive and of course if you take these crops and convert them you lose something. Have you looked at the net energy -- in other words, of a hundred units of energy that you go out, how much energy had to go in to grow that?

MR. MERRITT: Very definitely, and I have numbers on that and would be pleased -- in fact, I would like very much to sit down with CEQ or anybody and go over these numbers, but we're also quite intrigued by the idea of actual on-farm production, where the farmer produces his own motor fuel right on the farm from his own raw materials.

And if a farmer can dedicate ten acres, it's entirely possible he can get at least 5,000 gallons of alcohol off of ten acres annually, using high sugar crops such as the Jerusalem artichoke, things like that.

And if that can be processed in the farm co-op or on the farm then the energy that he uses to grow his crops was actually provided by the farm, and this is the happy thing that the farmer had with the horse. The horse was fueled by the farm and farmers were essentially energy-independent, at one time.

DR. MACKENZIE: Yes, but it did take something like a third of our agricultural --

MR. MERRITT: A fourth, yes, third to a fourth. Right.

DR. MACKENZIE: A fourth, to run all those mules.

MR. MERRITT: Yes. I have documents with me published back in the forties on this concept, and they said the farmer will be cursed with overproduction when the horse is gone, and that this is the net reason that we have the situation we do.

DR REZNEK: I suggest -- there's a topic which I received questions from the audience on the environmental impacts of biomass and biomass systems. We'll explore that with the panel, and I'd like the panel to explore it when we get to the end of the witnesses.

Any further questions?

DR. REZNEK: Thank you.

MR. MERRITT: Thank you.

DR. REZNEK: Our next witness is Don Kash.

STATEMENT OF DR. DON KASH, DIRECTOR
SCIENCE AND PUBLIC POLICY PROGRAM
UNIVERSITY OF OKLAHOMA

DR. KASH: I appreciate this opportunity to testify. I should begin by noting that when I was asked to testify I sat down and prepared 22 pages of testimony. On the way in on the plane, I read the text and decided that I would submit it and make some extemporaneous comments.

The following is my prepared statement.

Mr. Chairman, members of the panel, I appreciate this opportunity to appear as a part of the Public Hearings on the environmental protection and energy conservation aspects of the Federal Non-nuclear Research and Development Program. My testimony today will do two things. First, it will discuss the general goals of energy-oriented research, development, and demonstration (RD & D) activities. Second, it will propose several organizational and procedural modifications which I believe would enhance the value of energy RD&D activities.

My testimony is taken in a major part from a study, funded by the National Science Foundation, which my colleagues and I completed a year ago. The results of that study are reported in a book entitled, "Our Energy Future."

When one examines the various efforts which the Federal government has sought to take to deal with the energy crisis over the last five years, the only consistently successful one has been the ability to steadily increase

RD&D expenditures. This RD&D response parallels a now well established pattern in our society, a pattern of opting for what Alvin Weinberg has called "technological fixes" for social problems -- Weinberg, 1972: 27-35.

The "technological fix" approach recognizes that the resolution of national problems by more traditional methods -- that is by motivating people to behave differently -- is a heartbreaking, frustrating business. Our society has repeatedly hoped for technological fixes, because they offer the opportunity to solve problems without having to face the difficult social and political choices implicit in strategies that require changing human attitudes and behavior.

Weinberg uses Ralph Nader's campaign for auto safety as an illustration of the technological fix. He notes that the traditional approach had been to use inducements and sanctions to improve driver safety. Nader's technological fix approach, by comparison, is to design safer cars. This strategy does not get at the root social problems involved in auto safety. In fact, it might even create other problems such as resistance by automobile manufacturers to bearing the primary responsibility for driver safety. But it does have the potential to reduce auto fatalities.

The nation's approach to the energy crisis parallels this example. It is politically more desirable to use technology to produce energy from new domestic sources than it is to require the adoption of less energy-consumptive life styles.

BARRIERS TO RD&D PAYOFF

The political attractiveness, then, of energy RD&D is not a question. Rather, the key issues are what contributions RD&D can make and what constitutes a successful RD&D program. Society supports RD&D programs in the hope that they will produce technologies or other innovations that can be utilized. But of course utilization is the last of a several stage process. It is preceded by the four RD&D phases: basic research, applied research, development, and demonstration.

In cases where technological fixes have been effective -- the most frequently cited examples being military and space programs -- RD&D usually has been defined as complete upon demonstration of technological feasibility. At that point, the production or user segment of the system took over and applied the technology. That is, a technological fix required only the demonstration of feasibility, since utilization was already built into the system.

Energy RD&D, however, differs from these previous efforts in both the processes by which utilization decisions will be made and the circumstances surrounding those decisions.

Four factors can be identified which explain the success of the technological-fix approach for military and space RD&D programs, as contrasted to energy programs. Very briefly, these are:

1. Developer versus User: In the case of military and space RD&D, the organizations that funded the activities were also, in some sense, their purchaser or user. By comparison, the Department of Energy will not use the products of its RD&D work, but must rely on private companies and individuals to adopt the technologies developed.

2. Decision making: In the pre-energy cases, decision-making was relatively centralized and generally limited to a well-defined user community. Energy utilization decisions, by comparison, will be made in a highly fragmented decision-making system which includes a variety of interest groups. For instance, the adoption of new electric power technologies will be the prerogative of hundreds of electric utilities, both public and private. Perhaps more importantly, standards of performance and acceptability will be set by interests ranging from bankers through the Environmental Protection Agency to local farmers.

3. Variety of Options: In the case of military and space RD&D, the number of technological options available for development at any given time tended to be fairly limited. Nuclear weapons or space capsules are relatively unique responses to national problems. On the other hand, the potential variety of alternative energy options is extensive. For example, electricity can be generated from every energy resource, and for each resource system there are usually several competing technologies.

4. Goals: The goals toward which these earlier technologies were aimed generally have been well defined: deliver a given ordnance, or beat the Soviets to the moon, for example. Unfortunately, the goals of energy RD&D are not so easy to define, given the pluralistic character of our society and the many participants in energy-related decisions.

The role of energy RD&D, then, must be viewed more broadly than has been the case with previous national efforts. In addition to serving its traditional purpose of producing new technologies, it must also address other non-technological solutions to the problems, and it must explicitly recognize that many of the decisions will be made in the political realm. The purpose of energy RD&D then might be defined as identifying, investigating, and implementing innovations in the energy system.

With this broader purpose in mind, the goal of RD&D can no longer be regarded simply as the production of new technology, but rather the production of information useful for energy-related decision-making. This expanded role requires that RD&D be used to reduce four types of uncertainty: institutional uncertainty, performance uncertainty, demand uncertainty, and impact uncertainty.

This contrasts with past efforts where the primary focus was the reduction of performance uncertainty. In essence, the need to use RD&D to reduce the other three types of uncertainty results from the fact that RD&D must serve the process of political accommodation, which is central to resolving the nation's energy crisis.

RELIABLE AND CREDIBLE INFORMATION

If RD&D is to be successful in reducing the four types of uncertainty mentioned above, and therefore contribute to the process of political accommodation, the information produced must have two qualities: reliability and credibility.

Reliability implies the scientifically estimated range of error included in any set of data or body of information. Stated in lay terms, reliability is a measure of confidence a scientist or engineer has in the data or information.

Credibility is a measure of the confidence interested parties have in information. Credibility is a synonym for believability. In general, information tends to have maximum credibility if it: 1) is responsive to the concerns of the parties-at-interest, 2) is produced by people or institutions who are perceived as being professionally competent, and 3) is produced by people or institutions without a vested interest in decisions to be based on the information.

A point which deserves emphasis is that the particular characteristics of credible information vary as much as a reflection of the mix of interested parties as the characteristics of the researchers. For example, if the range of parties interested in a decision includes only scientists and engineers, reliability may be synonymous with credibility. Introduce parties who have broader social or environmental concerns, and credibility requires more than a professional judgment of reliability.

To paraphrase a more general analysis by Don Price, the technologist may only want to know the level of reliability of the data, but the politician will want to know who provided the information and why it was provided -- Price, 1965: 132-62.

An illustration of the credibility issue can be seen in the controversy over natural gas reserves. The procedures for estimating reserves are thought to produce highly reliable information, yet the Federal Power Commission -- FPC -- estimates of gas reserves were a source of continuing controversy. The basis for the challenge of the estimates is that the data are provided by the gas industry. Critics argue that the data are collected and reported in ways that will benefit the economic interests of the industry. Thus, to certain parties, FPC data were not credible.

Lack of credibility may also be a serious problem when data are not collected on issues or questions of concern to some parties-at-interest. Normally, professionals design research to provide information on questions they consider to be of scientific or technical importance. When such research fails to provide information on questions of concern to parties-at-interest, credibility becomes an issue.

The most frequent examples of this tend to be associated with research funded to support preparation of environmental impact statements --EIS. At a minimum, failure to collect data on questions of concern to some parties-at-interest is interpreted as evidence of a lack of concern with those questions. At the maximum, such failure can be perceived as reflecting conscious choices not to collect such data because they will not support the interests of those paying for the RD&D.

It should be noted that since credibility is a reflection of the confidence that parties-at-interest have in information, credibility is not logically dependent on reliability. That is, information with little reliability may be widely believed. I would emphasize, however, that RD&D has the highest likelihood of contributing to wise decisions when it has both qualities. An RD&D program, then, should seek to maximize both reliability and credibility.

I believe it is useful to divide RD&D into three categories, if the two objectives of energy RD&D are to produce the broad base of information necessary to respond to the four types of uncertainty, and to assure that the information produced has maximum reliability and credibility. These categories are hardware, nonhardware, and demonstration.

As shown in Figure 1, I visualize hardware and nonhardware activities as two separate streams that converge at the point of demonstration. The hardware and nonhardware categories are distinguished by the different types of information they produce. Hardware RD&D produces information aimed at reducing uncertainty about the performance of technologies. Nonhardware RD&D aims at reducing uncertainty about institutional, demand, and impact characteristics.

The basic research through demonstration phases shown from left to right on Figure 1 reflect increasing information reliability and credibility, or, alternatively, decreasing uncertainty. Demonstrations, then, are conceived as providing both hardware and nonhardware information in the most credible and reliable form.

In my following written testimony I discuss the characteristics of hardware, nonhardware, and demonstration activities that have a high likelihood of providing reliable and credible information. I make a number of general recommendations for organizational and procedural changes that would enhance the utility of energy RD&D. Those recommendations focus specifically on nonhardware and demonstration activities which appear to me to be the areas needing most attention.

HARDWARE RD&D

Hardware RD&D generally includes physical science/engineering activities, and it seeks to provide technical information about energy processes or hardware. As I view it, hardware RD&D produces two categories of information. The first is design information; that is, information that would be used by engineers or scientists to design a process or piece of hardware -- e.g., heat-transfer coefficients, chemical-reaction equations, steel-tubing requirements, and so on.

The second is performance information on the economic costs, energy efficiencies, materials and manpower requirements, and residual outputs -- i.e., all outputs other than the fuel produced -- of an energy process or technology.

In general, it is performance information that is needed to inform the policy process.

Traditionally, hardware work has been defined as falling into three phases: basic research, applied research, and development. These phases are distinguished by their different goals. Basic research seeks knowledge for its own sake, while applied research is directed toward practical applications. Development activities are directed toward the production of useful materials, devices, systems, and methods; such work includes the design, testing, and improvement of prototypes and processes.

In terms of its utility for decisionmaking, basic research is usually viewed as providing a theoretical basis for judging whether, for example, energy can be produced from a given resource using a certain concept. Generally, applied research tests deductions drawn from these theories. The development phase then provides information on the process as it is scaled up in size.

As an energy technology evolves across the RD&D spectrum, increasingly reliable and credible performance information should be produced, resulting in a reduction of decisionmaking uncertainty. Each phase in the spectrum should produce data which can be used to make informed decisions about whether to move on to the next RD&D phase.

Thus, the reliability and credibility of the information on which these decisions are based is a very important consideration. Nothing is more impressive, however, than the frequency with which performance data on emerging and existing energy technologies are challenged. There appear to be at least four bases for hardware data lacking reliability and/or credibility: 1) the data are out of date -- this is a regular problem regarding economic costs; 2) the data are extrapolations to commercial-scale plants from small-scale work carried out in the early phases of the RD&D spectrum; 3) the data have been collected by the developers of the process, and they may present a biased or overly favorable picture; and 4) the data are not comparable -- e.g., economic costs of electricity from wind cannot be directly compared with those from steam plants becuase of the intermittency of wind power.

NONHARDWARE RD&D

Nonhardware RD&D generally includes life science, social science, and interdisciplinary problem-oriented activities. It seeks to provide descriptions and/or conceptual understanding of the social, economic, and physical environment in which energy technologies will be utilized and assessments of their impacts on the environment. In essence, nonhardware RD&D reduces institutional, demand, and impact uncertainty.

Nonhardware work is also traditionally divided into the three phases of basic research, applied research, and development. Both because the information produced by nonhardware RD&D is of concern to a much broader range of parties-at-interest, and because of the difference in level of theoretical development in the the disciplines involved, achieving reliability and credibility is more difficult than is the case with hardware RD&D. Although, as was discussed above, hardware RD&D can have credibility problems, they generally stem more from the misuse of data than from disagreement on how to measure such things as, for example, sulfur dioxide emissions from a commercial-scale plant.

In general, challenges to the credibility of nonhardware RD&D reflect the lower level of agreement on how to measure impacts. This lack of agreement reflects the less developed theoretical underpinnings of nonhardware RD&D. Most of the disciplines included in the hardware category would fall into what are jargonistically called "hard" sciences, while our nonhardware category generally includes those disciplines referred to as the "soft" sciences. While the distinction implied by "hard" and "soft" is overdrawn, it is clear that the findings of policy, socioeconomic, and environmental studies are more likely to be subjected to criticism based on reliability considerations than are hardware analyses.

Both hardware and nonhardware RD&D suffer from similar credibility problems resulting from perceptions of bias, but because of the higher level of reliability, credibility is not as serious a problem for hardware research as it is for nonhardware activities. The highest credibility for energy-related nonhardware RD&D appears to require, as a starting point, that the characteristics of some set physical, biological, or social phenomena be described and measured over a priod of time in advance of the development of an energy facility.

In environmental research, this is termed collecting "baseline information." More broadly stated, nonhardware research has credibility when a full range of the parties-at-interest have been allowed to include those phenomena in the baseline study with which they are concerned. The next step is to describe and measure the impacts of hardware inputs and outputs on the baseline phenomena. For the purpose of energy policymaking, these kinds of measurements appear to have the most credibility of any nonhardware research.

In general, then, nonhardware RD&D appears to require three elements if it is to have credibility for decisionmakers in the energy supply system: 1) the social and environmental phenomena monitored or studied must reflect the concerns of the whole spectrum of interested parties, and not just those of a specialized research community; 2) these data and impact assessments must be organized around the regional or local environment of social systems most likely to be affected by energy supply facilities; and 3) they must be funded and carried out by parties who do not have a vested interest in the outcome of the decisions to be informed by the RD&D.

DEMONSTRATIONS

As defined in this study, demonstrations of energy technologies have the purpose of providing hardware and nonhardware information with sufficient reliability and credibility to inform commercial utilization decisions. Commercial-scale demonstrations represent the final stage in a scaling-up process which begins in the laboratory and progresses through various development phases. Demonstrations normally take place only after a technology is thought to be well understood.

From the point of view of hardware RD&D, the main purpose of commercial demonstrations is to determine what the performance characteristics of a technology will be with scale-up. Since engineering experience indicates that the operational characteristics of a process may behave unpredictably with a major increase in the size of a facility, demonstrations serve as a final test of the reliability of hardware information.

In the energy context, however, the more important role of demonstrations is to produce credible nonhardware information.

In fact, a RAND Corporation study has stated that demonstrations should have as a primary focus "market demand, institutional impact, and other nontechnological factors, the goal being to provide the basis for well-informed decisions on whether to adopt the technology," -- Baer, Johnson, and Merrow, 1976: 1. Reliable and credible nonhardware information from demonstrations is thus a key to commercial utilization of new energy supply technologies.

Credibility can be built into a nonhardware information program only by designing it to serve the needs of the diverse group of participants who will be a part of the utilization decision. An accommodation among these interested parties is usually a prerequisite for full-scale commercialization. Looking at the post-1973 energy policy system, it must be recognized that government nearly always plays some role in the utilization decision, and through government the various interests nearly always have access to the decisionmakers -- see Holloman, et al., 1975: 11-40.

Unless a demonstration facilitates accommodation, it may represent a very expensive dead end. For example, a commercial-scale oil shale demonstration plant which provides little more than performance information may improve the reliability of the relevant data base, but it may also result in a low level of credibility and a reluctance to act decisively. But a demonstration which deals with the credibility issue by involving interested parties in a nonhardware information program may contribute to the creation of a consensus which will support a firm decision.

CONCLUSION

The three categories of RD&D defined above comprise the framework around which the following recommendations are organized. Use of these three categories can help insure that RD&D produces credible and reliable information responsive to the four types of uncertainty: performance, institutional, demand, and impact.

ORGANIZATIONAL AND PROCEDURAL RECOMMENDATIONS FOR ENERGY RD&D

GENERATING RELIABLE AND CREDIBLE INFORMATION

My recommendations address changes in both institutions and procedures. They emphasize the use of technology assessments and commercial-scale demonstrations as an integral part of an RD&D program, with general recommendations amplified by more specific proposals for implementing them. And they address the problem of the limited technical and financial resources of some of the groups who need to verify the resulting information.

TECHNOLOGY ASSESSMENTS

For every step in the development phase of an RD&D program, there should be a parallel technology assessment by a group without a vested institutional interest.

A useful assessment program will require: a source of funds for the assessments, an independent organization to allocate the funds, an assortment of research groups capable of performing credible assessments, and competent personnel to staff these groups.

A technology assessment is a form of policy study that identifies the capabilities and impacts of a facility or process. It is motivated by a recognition that the introduction, extension, and/or modification of technologies lead to a variety of economic, social, environmental, and institutional consequences. An assessment is a policy study which: 1) anticipates and systematically identifies, defines, and analyzes consequences; 2) identifies, defines, and analyzes alternatives which will either mitigate undesirable consequences or enhance beneficial consequences; and 3) identifies, defines, and evaluates implementation strategies for feasible policy options.

The purposes of a technology assessment are: 1) to provide an early alert regarding impacts that may enhance or constrain utilization; and 2) to assist in the creation of a cadre of professionals who have expertise about the hardware item and its potential impacts, but who do not have a vested interest in its promotion or demise -- that is, a professional group with credibility to a broad range of interested parties.

INDEPENDENT FUNDING AGENCY

An independent agency for supporting nonhardware RD&D should be established to fund and monitor technology assessments for energy technologies in the development phase of the RD&D spectrum.

I recommend that an amount equal to five percent of mission-oriented hardware expenditures be allocated for nonhardware research. I propose that half of that amount be channeled to a new Federal agency which has neither a promotional nor a regulatory role in energy policy. The agency would be analogous to the National Science Foundation in its relation to other parts of the Federal government.

This research agency would identify needs for independent technology assessments, select the groups to do the studies, fund them, and assure that each assessment is conducted so that the results are reliable and credible. Reliability and credibility require that the research group be professionally competent, but they also require that representatives of the range of interested parties be involved as consultants and reviewers -- industry, government, consumer interests, and universities -- representing the natural and social sciences as well as engineering specialties. Because some of the interested parties lack the financial and manpower resources to participate fully in such an effort, each assessment grant should provide for the payment of the costs of involvement.

Also see the following separate recommendation under the section, "Technical Support for Participants."

In addition to informing the interested parties about the impacts of new technologies, this participation procedure will add significantly to the credibility of the results of the assessment. Participation is the only dependable way to assure that the impacts of concern to all interested parties are addressed, and it is the only dependable way to screen preliminary reports by the research team for possible bias or misinformation.

Furthermore, such participation prepares the way for disseminating the information from the assessment, because it alerts interested parties to the fact that the data will be forthcoming and it gives them confidence that the work is comprehensive and unbiased. This is esential for assuring that the information will be utilized.

CREDIBLE NONHARDWARED RD&D INSTITUTIONS

Institutions should be created that have the capability for conducting credible nonhardware RD&D.

Most existing research organizations are viewed, at least by some of the parties interested in energy decisions, as having bias because of their ties with funding sources that have promotional or regulatory interests. For example, the National Laboratories are charged by the Department of Energy -- DOE -- with carrying out much of its nonhardware-type R, D, and D, but there is a widely held view that research findings that run counter to agency policy are unlikely from these captive institutions.

The credibility of various profit and nonprofit private research organizations is also regularly questioned, because it is believed that the continuing need for new research contracts imbues them with a sense of caution -- that, in practice, they become the kept organizations of those who fund them. Although these organizations often point out that they do research for both regulatory and promotional agencies, critics argue that controversial findings are skirted or diluted or, alternatively, that they are provided to the funding agency but not to the public at large. The normal Federal R, D, & D contract, which requires agency approval before research results can be released, compounds this credibility problem.

University research groups are often more credible, because their job security is somewhat more removed from continuing success in generating contracts, but they are hampered by organizational traditions. Technology assessments are interdisciplinary efforts, relying heavily on secondary data and external reviews. As such, they fit poorly with reward systems accustomed to academic disciplines and traditional basic academic research. In addition, technology assessments of the kind proposed here need to be produced on time, according to a schedule that responds to the needs of information users outside the university; and this runs counter to an academic viewpoint that truly creative activity cannot be rigidly scheduled.

Consequently, we believe that a network of new organizations needs to be built, organizations that depend for their livelihood on support from the independent agency proposed above. For this purpose the agency should allocate half of its funds to institutional support for organizations that can perform credible technology assessments.

A model for such institutional support is the U.S. Air Force relationship with the RAND Corporation. A fixed yearly support level allows the building and maintenance of a research staff. Based on that support level, the organization is obligated to do research in problem areas identified by the funding agency, but the research staff is also expected to carry out independent research of their own choosing.

I would like to emphasize that credibility requires openness. Publication of research results should not be constrained by contractual arrangements which require prior agency approval.

One of the reasons that I recommend institutional support is to develop an adequate pool of personnel for non-hardware research. At present, the personnel base is insufficient -- especially in the availability of social scientists with experience in interdisciplinary assessments. Because such integrative research lacks demonstrated methodologies and is characteristically focused on specific substantive issues, we believe that competence must be developed in the process of doing interdisciplinary assessment projects. The current practice of project support, rather than institutional support, has meant that few people have so far been able to stay involved long enough to become really skilled in doing interdisciplinary studies. With sustained institutional involvement, it should be possible to build the necessary personnel base.

DEMONSTRATIONS

As a general rule, every new energy technology or new technology application should be demonstrated at commercial scale before a decision is made on commercial utilization.

I propose a series of related procedures for making demonstrations the cornerstone of utilization decisions: broadly conceived baseline studies before a demonstration, a suspension of the preconstruction environmental impact statement -- EIS -- requirement, a comprehensive post-demonstration impact assessment, a "self-destruct mechanism" to assure that undesirable activities are terminated, and a program to provide financial and technical support to interested parties that lack the necessary resources to participate fully in the demonstration effort.

Confidence in performance and impact data is highest when they come from an actual commercial-scale facility in a given location. Even with a full program of technology assessments at the development stage, the data remain unreliable until a technology has been operated and observed at full scale. At this stage, the interested parties can verify information for themselves, resolving many disputes about technology characteristics and impacts by observing a demonstration facility together. Recommended procedures for gaining full benefit from demonstrations follow.

BASELINE STUDIES

Baseline studies should be initiated for each demonstration facility at the time possible sites are first identified.

The purpose of a baseline study is to describe the physical, biological, and socioeconomic environment of a proposed site before construction and operation of an energy facility. Later, monitoring and assessment activities seek to identify changes in the environments that are the result of the facility.

In order to have a record of baseline data over a period of several years, the studies need to be undertaken at the earliest possible time. For instance, fish populations normally fluctuate from year to year, as well as season to season. Without a data base to document the normal variations, new energy facilities may be considered the cause of fluctuations that would have occurred in any case.

If the baseline studies are to be credible and useful, it is essential that the entire range of interested parties be consulted about the phenomena and processes to be included. Broad participation, similar to the involvement previously proposed for technology assessments, will reduce the likelihood that baseline studies will overlook important impact categories. It will broaden the selection criteria and the discussion of measurements and interpretations. And it will serve as the beginning of a wide-ranging process of participation in the demonstration from start to finish.

SUSPENSION OF EIS REQUIREMENT FOR DEMONSTRATION FACILITY

The requirement for a preconstruction and environmental impact statement should be suspended for energy demonstration facilities.

The primary purpose of a demonstration facility is to generate information about its impacts. Consequently, a pre-demonstration impact statement is, by definition, hypothetical and uncertain. It tends to create opposition because extrapolations of performance data derived from the development stages are viewed by some interested parties as unsatisfactory. In order to speed the gathering of reliable and credible information, we recommend that the EIS requirement for a commercial-scale demonstration activity be dropped.

It is important to emphasize, however, that this step only makes sense if it is coupled with the other recommendations in this chapter: technology assessments during the development phase, convenient access to data, a post-demonstration impact assessment, and a procedure for terminating undesirable facilities. In addition to these assurances, the proposed site of a demonstration must be assured of full Federal responsibility for adverse impacts, including guaranteed financial compensation by the Federal government for any environmental deterioration that may result from the activity.

It is the post-demonstration steps that justify suspending the EIS requirement. They are especially important because they provide the means whereby demonstrations can inform the environmental and social controls on commercial operations. With these and the other recommendations, we believe that the purposes of the EIS requirement can be met and the generation of reliable and credible energy supply information can be accelerated.

POST-DEMONSTRATION ASSESSMENT

A comprehensive post-demonstration assessment should be prepared for each commercial-scale energy demonstration facility.

After a meaningful period of operating a demonstration facility -- probably one to two years -- the characteristics and impacts of the facility should be assessed. The assessment should serve as the basis for decisions on commercial utilization of the technology. This assessment should be the responsibility of the independent agency proposed above, and the funds to support it should be a required line item in the appropriation for the demonstration.

The post-demonstration assessment is the key step: the final stage before the diffusion of a new technology, the point of transfer from public-private cooperation to private commercial decisionmaking, and the time when the interest of all participants in the evaluation will be the highest. Assessing the impacts of such a demonstration should be a process involving broad participation. It is the culmination of a sequence of monitoring and evaluation activities that began with the baseline studies. As such, it should include all of the interested parties as consultants, reviewers, and discussants. It must be conducted by a research group that has the kind of credibility discussed earlier in connection with technology assessments, but it should be characterized by a continuous flow of information between the research team and the interested parties.

SELF-DESTRUCT MECHANISM

The decision to undertake commercial utilization of a technology should not be made until the post-demonstration assessment has been published. A negative assessment of the demonstration facility should result in both shutting down the demonstration and blocking commercial development.

A major obstacle to public support for demonstration activities is the fear that the first commercial-scale facility is an irreversible beginning for a much larger commitment. If a demonstration activity is to be accepted as a basis for a utilization decision, there must be confidence that the program will "self-destruct" unless the demonstration leads to broad social and political acceptance of utilization. In particular, a demonstration plant that is constructed without an EIS must be shut down automatically after the post-demonstration assessment unless its impacts are judged to be acceptable. Unless interested parties at potential sites believe that this will be done, the entire set of information-gathering procedures is less valuable.

I believe that, in the context of a pluralistic energy system, a broad-based assessment process will provide such confidence because of the ammunition it would provide opponents of development. Alternatively, a positive assessment should provide powerful support for rapid development.

TECHNICAL SUPPORT FOR PARTICIPANTS

A program should be established to provide financial support for the development of technically competent staffs for the parties involved in demonstrations and technology assessments.

It is so important to link interested parties to on-going demonstrations and other assessment activities that funds should be available to support broad participation. State or local governments, private interest groups, and other participants with limited financial or technical resources often find it difficult to enter into discussions of technologies with industry and Federal agencies, because technical details are inaccessible to them. Professional staff representation would allow the positions of all the different parties to be related to the best technical information, and it would assist in the design of a data-gathering program that is responsive to the interests of all parties. One of the obligations of a group receiving such funding would be to provide critiques of assessment reports on the demonstrations for which they receive funding. I suggest that the support program be administered by the agency responsible for independent nonhardware RD&D.

DISSEMINATING RELIABLE AND CREDIBLE HARDWARE INFORMATION

Dissemination has been an integral concern in formulating the previously recommended procedures for collecting, comparing, and analyzing energy information. In addition to the dissemination modes that are a part of the previous procedures, we have identified another major need. The following discussion outlines problems associated with improving public access to hardware performance and reserve-resource information.

The absence of any national system for coordinating the dissemination of performance -- input-output -- data for energy technologies has been cited by a number of studies -- see Senate Interior Committee, 1973: 21-23; Doub, 1974: 17, 21 -- and has resulted in the introduction of legislation to create a variety of energy-information access mechanisms.

Examples range from a narrowly defined Bureau of Energy Information in the Commerce Department to a more comprehensive, independent Energy Information Agency or a centralized Energy Commission -- Senate Interior Committee, 1974: 11-17; BNA, 1976: No. 139, A-3; Tribus, 1975: 317-22. The primary motive behind these proposals has been the desire to centralize a system in which numerous Federal agencies are involved in collecting energy data.

Three major problems have resulted from this fragmented data system. First, because performance information on energy options frequently has been collected and analyzed to meet the specialized needs of a particular agency, significant overlaps and gaps exist in the data that are available. For example, the Bureau of Mines data activities are organized around the needs of the specialized mining community. The Bureau of Mines cannot be expected to collect data of primary interest to the Department of Labor, but Labor may have no resources to support collection of the needed data in this area.

Second, performance data has been fugitive because it has been managed by each of the traditional energy policy subsystems: oil, natural gas, nuclear energy, coal, and electricity. Parties not acquainted with the informal channels of information used in each subsystem find access difficult.

Third, this fragmented system is not responsive to new interests which are without access to a technical staff. The data have been produced for the use of the traditional industrial and governmental participants who have their own inhouse technical expertise for purposes of analysis. Without such a capability, the information can be hard to use. New participants face serious problems in obtaining relevant energy information, because without expertise they may not even know what to request. New participants in energy decisions regularly perceive themselves as operating at a disadvantage because of their lack of a credible data base. Such interests have suspicions that the older participants with in-depth capabilities manipulate performance data in ways which promote their policy objectives.

The least credible performance information, in the eyes of most new participants, are economic cost estimates for energy technologies and data associated with environmental residuals. The debates over oil shale development illustrate this information problem. The available data on water consumption, environmental residuals, and production costs of shale oil vary. This variability in turn generates policy uncertainty. Any action which would provide a more homogeneous hardware data base would contribute to a more focused debate and improve the prospects of reaching social accommodation among competing interests. Federal RD&D policy should be designed with this objective in mind.

Our study has identified three sets of data that would benefit from improved Federal dissemination: 1) resource-reserve data for all energy sources; 2) performance data -- this category does not include information from nonhardware RD&D -- for all energy technologies and processes; and 3) a siting schedule for all proposed commercial-scale demonstrations and proposed commercial energy facilities.

The primary deficiency in current resource-reserve data is a lack of comparability. Most resource-reserve data have been collected using categories developed by the various energy industries within each resource subsystem. Definitions of these categories frequently involve distinctions which lead to misinterpretation by newcomers to the system. The range of categories for crude oil include: known resources, cumulative productions, proved reserves, indicated additional reserves, and total original oil-in-place. By comparison, normal categories for coal data include: identified, recoverable, submarginal, and undiscovered resources -- Theobald, et al., 1972. For those not well versed in these systems, data comparability is difficult.

Assuming the future development of solar energy, it will presumably be necessary to develop an additional set of solar resource data. Clearly, the establishment of categories which will facilitate comparisons among the various "apple and orange" resources is to be desired. As a General Accounting Office study of Federal energy data activities concluded:

"Standardization of energy terms and adherence to established definitions are essential for uniformity in the collecting, analyzing, reporting, and interpreting of energy statistics. The proliferation of data collection and reporting that presently exists among Federal agencies and the fact that State regulatory agencies provide data to the Federal Government -- which are subject to their own legal and administrative constraints -- makes it imperative that such standardization be sought," GAO, 1973: 18-19.

Much the same sort of problem characterized data on the performance of various energy technologies -- such as economic costs, energy efficiencies, materials, and manpower requirements, and residual outputs. Performance data categories are often poorly defined and, given political accommodation needs, inadequately reported and analyzed by the responsible agencies. As with resource data, the new participants in energy decisionmaking find access to performance data difficult and information comparability often lacking.

Finally, at the present time there is no single source of information on proposed new energy facility sites. Anyone who has attempted to compile a list of proposed energy developments must be impressed with the difficulties associated with assembling a national or regional picture. Since the impacts of energy facilities are related to the characteristics of the sites as well as the technologies, knowing potential locations seems an essential first step to a process of political accommodation.

In addition, a centrally located national energy siting schedule would have the benefit of providing an early warning system for all parties concerning projected utilization decisions. This would assist policy makers in identifying interested groups, so that accommodation efforts could be initiated at an early point.

A NATIONAL ENERGY DATA CENTER

A National Energy Data Center should be established as a central repository for energy resource-reserve data, performance data for energy technologies and processes, and a national energy siting schedule for all commercial-scale demonstration and commercial facilities.

The previous discussion underlines the need for a National Energy Data Center. Such a center should be user-oriented, highly professional -- i.e., data collection and analysis must conform to rigorous scientific-technical standards -- and have as its sole functions the collection, analysis, and dissemination of energy data. Three purposes should be defined for the Center: 1) to pursue development of a data presentation format which facilitates comparisons among alternatives and is usable to the layman; 2) to facilitate access to energy data for all participants; and 3) to provide data analyses useful to the range of participants.

FORMAT

A data presentation format should be developed, aimed at maximizing comparability and usability.

Our conception of such a data presentation format is available in a study entitled Energy Alternatives: A Comparative Analysis -- Washington: Government Printing Office, 041-011-00025-4, 1976. That study offers a possible starting point for a format that could be used by the National Energy Data Center. Energy Alternatives includes the three essential ingredients for such a format: a description of the various energy resources and the technologies focusing those resources, quantitative data indicating the performance characteristics of each technology and resource system, and a set of procedures for comparing the various alternatives.

The proposed energy data center should publish, each year, an updated volume providing the three kinds of information. Additionally, performance or resource data could be maintained and continuously updated through the use of a storage and retrieval system using such categories as those in Energy Alternatives.

The energy siting schedule to be maintained by the Center should provide three types of summary information: the proposed location of energy facilities, a brief description of the facility itself, and the proposed construction time of the facility. The schedule should be maintained on a current basis and include all commercial or commercial-scale facilities that have either been proposed or are under construction.

ACCESS

<u>All participants should be allowed access to the National Energy Data Center, and data verification should be accomplished, at least in part, through this participatory process.</u>

Unless there is a direct connection established between the Data Center and those groups which have previously been unrepresented in energy decisionmaking, any information provided will inevitably have a lower level of utility. As long as data verification remains an in-house activity of the various Federal agencies and their client industries, the public will continue to raise questions as to its credibility. While traditional verification procedures -- such as on-site audits and the submission of raw data -- should be continued, and even accelerated in many instances, public participation provides another avenue through which independent data verification can be accomplished. The open comparison of differing information bases in a public forum is one of the most effective methods of cross-checking reported information.

ANALYSIS

<u>Data Analyses aimed at serving a full range of parties-at-interest should be a central function of the Center.</u>

The Federal government currently lacks a focal point for analyzing energy data. Although the FEA and ERDA have increasingly assumed a larger portion of the data-interpretation function at the national level, a need remains for a central place where participants can secure effective energy data analysis.

This point needs emphasis, because the Center would not make a meaningful contribution to political accommodation if it were only an archive. It must provide analyses that are responsive to the concerns of the range of participants in energy policymaking. In this connection the most important role of analysis is tied to the earlier focus on developing comparable data. That is, the center should strive to do analyses which allow concerned interests to compare various energy supply options in terms of their performance characteristics.

We should emphasize that the Center should not be a primary data agency. That is, our recommendations should not imply that the functions already carried out by DOI and DOE or other agencies be transferred to the Center. Rather, it should be a central information source. It does appear, however, that the Center should be Congressionally mandated. And the legislation establishing the Center should require that resource and performance data generated with Federal funds be communicated to the Center on a timely basis. Similarly, it should be a legislative requirement that information on all commerical or commercial-scale energy facilities be communicated to the Center.

SUMMARY

The theme of this paper can be summarized very briefly. "The utility of RD&D information is as dependent upon the manner of collection, analysis, and dissemination as it is on the content of the information." In every case the recommendations in this paper seek to involve the new decisionmaking participants in the RD&D process. Only in doing that will the process provide information useful to the achievement of political accommodation.

We have sought to provide for that involvement by:

1. Recommending a new nonhardware research community which includes both a new funding agency and new research institutions.
2. Recommending an expanded role for commercial-scale demonstrations.

3. Recommending public funding of technical expertise needed by the new participants in energy decisionmaking.
4. Recommeding more openness on the part of mission agency nonhardware RD&D programs.
5. Recommending a new centralized source of energy resource and performance data.

[end prepared text]

I'd like to talk much more generally than have the previous people giving testimony.

Specifically, I'd like to address DOE's approach and focus with regard to its energy RD&D program. It seems to me that to do that it's useful to start by recognizing that the energy R and D program is in the business of creating technologies which will have to replace, at some time during our lifetime, almost all of the commercial technologies that presently produce energy.

Unless I'm mistaken, we're going to run out of oil and gas, whether it's twenty years or forty years or fifty years. The evidence indicates that the light water reactor is going to be a thing of the past, at least if the predictions of the available uranium are correct. I gather that we don't have a great many hydroelectric sites left. I've been advocating that we dam the Grand Canyon, but I can't get anyone to support that notion.

And coal, in conventional combustion, is not going to be acceptable.

EPA has been responsible for developing clean-up technology that can be hooked on at the end of that process, but presumably we're going to have to develop precombustion and during-combustion processes also.

So we're roughly in the business of substituting new energy production technologies. A total replacement is going to take place. That I think is an event of some substantial significance.

The new technologies that we're going to have to replace our present production system with are, at least as commercial technologies, unknown. We don't know very much about how they're going to perform. I have read a little of the testimony that's been given here, and I must say that a number of the people are a good bit more optimistic about the processes that are involved than the evidence I've looked at suggests one ought to be.

So R and D must not only demonstrate what technologies will work in an economically acceptable fashion, but it must do something else with regard to these new energy technologies, it must identify and assess the whole set of non-energy impacts that are going to result from this new generation of energy-producing technologies.

That means that DOE's R and D program has to satisfy two populations. R&D has to satisfy the potential users of the energy production technologies -- the utilities, the oil companies. We don't have much experience in a relationship where government pays for the development of energy technologies which the private sector picks up and uses.

And the evidence to date is that we're not progressing with a great deal of speed in that direction.

Now that's not a criticism of anyone. It's simply the new ballgame. We've never had a major Federal R and D program which was self-consciously aimed at creating commercially usable technologies, that is, technologies paid for by the government which would be picked up and used by the private sector. We've got to learn a lot about that and presumably the DOE program has to demonstrate that these new energy technologies are going to make a profit for the energy companies, or they're not going to pick them up.

So that's one set of users that has to be satisfied.

But there's another set of people that have to be satisfied with regard to the new energy R and D activities, and that's the collection of people that are going to be impacted by the residuals, by the non-energy outputs of these technologies.

In general it is my impression that these potentially impacted populations are suspicious of DOE, and they're suspicious of DOE not because there's anything peculiarly bad about DOE or its predecessor -- ERDA -- but rather people tend to be suspicious of agencies that promote particular technologies. They tend to believe that DOE has a certain bias toward getting the technologies used. I certainly hope DOE has that bias, anyway.

Promoter agencies are thought to play down -- sometimes perhaps even cover up -- the unanticipated consequences of these new technologies, so that the DOE R and D program and the Government's energy R and D program must concern itself with providing not only information on how the processes work, but information on what the non-energy impacts of using those technologies will be.

This is necessary, because energy decisions in this society require building a political consensus. That is, you have to build some kind of a majority or at least a substantial minority of people who believe that the adoption of these new technologies is in the nation's interest, or their interest.

I think that it's clear that this broader public is now demanding that it be rung in on the process of decision-making with regard to these new technologies.

In general, it is my impression that the ERDA and DOE programs have not been as self-conscious about the need to ring in this broader public on the decisionmaking with regard to energy R and D.

Two things appear to me to be necessary to satisfy this population which is concerned about the non-energy impacts of the Federal R and D program. Research on the impacts of these new technologies is not going to be credible unless that research is funded by an agency that is perceived as being more disinterested than DOE.

Iet me state it in the following way. The people that I talked to express a substantial amount of concern and even skepticism about studies of the impacts of coal synthetic technologies carried out by National Labs. They express skepticism -- and I'm not suggesting that it's justified, I'm just suggesting that it exists--they express skepticism because they have a sense that anything that's too negative will not be widely reported -- that is the impacted populations may not be made aware of any negative impacts.

Secondly, it seems to me if one is going to build this consensus which includes people who are concerned about non-energy impacts, research probably has to be carried out by professionally competent and disinterested research organizations, and there are not many of those around.

It seems to me that in looking at the previous ERDA efforts in this connection there has been far too little emphasis on producing reliable, credible information about environmental-social-economic impact of new technologies, and what work has been done has not been done with sufficient concern and attention to insuring that the work on assessing impacts is done in a way that is credible to these impacted populations.

I would conclude my short comments by saying that if I were constructing an ideal world, I would put responsibility for assessing the impacts of these new energy technologies in a totally independent agency, and in addition I would have that agency self-consciously get into the business of constructing a set of research organizations which were its research organizations.

The idea of going to non-profits, to National Labs, to profit-making organizations, or even -- in most instances, I think -- to universities with the hope that you're going to get credible -- that is believable results, results that are believable to potentially impacted parties, is not terribly encouraging, to me. It's not encouraging because most of the research organizations have old and well-established links with either the regulatory agencies -- which are every bit as suspect, that's EPA -- or with a promotion agency, which is DOE. In both instances it seems to me that this is just not sensitive to the social-political reality with regard to this consensus building process.

Thank you.

DR. REZNEK: Thank you. Does the panel have any comments?

QUESTIONS AND REMARKS

DR. MACKENZIE: Well, the last time this conference was held I was on that side of the microphone and I said basically the same thing, so I'm sympathetic.

DR. KASH: Well, you're a right thinker.

DR. MACKENZIE: I'm wondering -- my own thought was that there should be kind of at least someone who generates basic data, if not -- and perhaps critical analysis too, but clearly this has to be -- it's going to come within the political sphere, and I don't see how you can get your complete, you know, isolation that you would seek.

DR. KASH: Well, there's nothing complete in the real world.

DR. MACKENZIE: Well, how would you see this thing administered? Or where would you see it administered? A separate laboratory? A national --

DR. KASH: My written testimony has a series of recommendations which start with an independent agency and then those recommendations go on to recommend that that agency create a whole new constellation of research organizations.

DR. MACKENZIE: Is this like a technology assessment agency, would you --

DR. KASH: Well, I suppose that that's a label that's in this year, and it's one that I have some affection for. I don't really care much what the label is.

I think that we are talking, however, and we're legally responsible for looking at a range of impacts which goes from environmental impacts to a set of socioeconomic impacts, because that's required by the courts' interpretations of NEPA at the present time.

Now there are a lot of problems in trying to do this with regard to new energy technology. The first and most striking thing to me -- and note I'm a political scientist who has spent the last eight years living as a kind of parasite off disciplines that do things -- that is, looking at the energy technology area -- is the tremendous variation in numbers that one gets about the quantities of residuals that come out of different technologies. The variation is incredible.

I'm now inclined to think that I'm very lucky to be in a hard discipline and not a soft one like most of the engineers are in.

[Audience Laughter]

DR. KASH: The variation is incredible.

Now that starts with the margin of error, and my disposition is to say that engineers are people that build things within a range of a hundred percent of margin of error. The error gets a lot greater when you move on to trying to understand what the impacts of those residuals will be on the environment and on the social system.

This work is not a science, and it isn't even a very well developed art. It's a series of speculations and judgments.

Almost every conclusion about impacts can be challenged by legitimate professionals. If you're going to find this information to be very useful in this society it becomes doubly important that the people that do it not seem to have some vested interest in either promotion or regulation.

I think we really have a classic political question involved here, and we're in a position where we need to try to sanitize these organizations. You can't make them objective. All you can do is try to eliminate either regulatory or economic self-interest in a direct and obvious way, and I think that's pretty important.

DR. REZNEK: Are there are other questions?

Don, assuming Congress wanted to do it tomorrow, how long would it take to put these institutions having the capability for conducting credible non-hardware research in place?

DR. KASH: Ten years.

DR. REZNEK: Don, that's kind of --

DR. KASH: If you have enough money.

DR. REZNEK: That's kind of unfair, but I've learned over the years to listen to what you have to say. Now I want to spring a new line of questioning on you. You can duck it if you want.

One of the major controversies in the energy/environment area right now is the question of opening up a set of options. I've heard it expressed in lots of ways. For instance, a few years ago, if you were trying to build a power plant, you could choose among oil, coal, nuclear, or, I guess, a few other options. You could even look around for a hydro site. Now you can't do any of these things. Furthermore, it used to take two years to get a power plant built and now it takes twelve to fiteen.

The "maximizing options" logic runs along these lines: Let's not try to make decisions now. Let's try solvent refined coal. Let's try fluid bed. Let's try gasification. Let's try biomass. Let's try a whole bunch of things.

The questions I'm leading to are: If you're going to try everything, then why do we have all this discussion over the numbers that vary a hundred percent, or what the residuals are? Why try to make those decisions if we are going forward on all fronts? At this point in time, do you have any thoughts on putting into perspective the opportunity costs for the various options to provide input to rational decisionmaking?

DR. KASH: Well, I don't think that anyone knows how to build opportunity costs in for technologies that are at this stage of development. It's very uncertain.

I must say that I have some more confidence in the political system than some of my colleagues do at the present time, and I have confidence primarily because we haven't chosen one or two options.

Given what at least I perceive we know both about the processes and about the impacts of the various energy processes, I think we're taking the right approach in keeping open as many options as possible.

That really comes on my part from a kind of basic chemical caution, and it says that if I haven't got a pretty good judgment about what's going to be successful, both economically and socially, then I'd like to keep as many doors open as possible.

I don't think it can be built in at the present time. I would be inclined to move on the fairly broad front that it looks to me we're moving on at the present time, but I do think that it's necessary to start looking at residuals and potential impacts right now and have those looked at as the technologies move along.

And I just think it's a silly game to talk about opportunity costs. I know that there are people in this audience who disagree with me with regard to various ones of the technologies, but I'm just a gut skeptic. I find what appear to me to be perfectly credible professionals disagreeing all over the place on the operation of most of these new technologies. I don't know whether there are any credible professionals assessing impacts, but we're stuck with assessing.

MS. VAN SICKLE: It's really difficult for elected officials to set priorities and select from alternatives when you have so many different sources of information. A lot of times they will contradict one another. I agree with Dr. Kash.

DR. KASH: Well, I, you know, have got an incredibly large ego, and my wife will testify that I work sixty, seventy hours a week.

Now, I've had that ego and that sixty-seventy hours of work a week going on for eight years. Someone asked me what I would do if I were made the energy czar, and I told them that I just really wasn't sure, but I was reasonably confident that I'd make things worse at the present time.

I really think there's a great deal of uncertainty. We are talking about substituting the whole -- a whole new technological substructure in the energy area, in my lifetime. We're talking about a socioeconomic change of a kind that I see as just absolutely fundamental. And I think we can take some time.

What we have to do, however, is we have to recognize that we're not just developing a bunch of technologies. We're talking about a fundamental social change, and as we develop those technologies we've got to develp the kind of social-political support for those technologies which make them operate.

Now, I've been impressed time after time that the first thing that happens is that many of the people who are spooked by new technologies don't know anything about them. Well, that's a common criticism of people in the industry, and it's quite a legitimate criticism.

It's also true that most of those people don't have any way of getting decent information. That is, they don't have a way in the sense that they don't have the resources to look at it in detail.

Now I've at least witnessed one or two cases -- well, let me tell a story about a study that we did a number of years ago that had to do with off-shore oil development, and I was in Washington one time and I had a lawyer from one of the environmental interest groups come up to me. And he said, "Do you know that you guys are responsible for us not taking the Department of Interior to court to block a lease sale?"

And I said no, I didn't know that. I said, "I assume it was because of the trenchant character of our analysis, the persuasive arguments we made, the care with which we approached things."

And he said no, it didn't have anything to do with that. He said, "We were going to oppose it because we were suspicious of down-hole safety valves, and we read your description of a down-hole safey valve and we decided not to go to court."

I said, "But that's the industry's description."

He said, "Well, I know that, but we believe you and we don't believe the industry."

Now, there is this problem of credibility which has nothing to do with the question of reliability in the sense that a scientist or an engineer talks about it, and it is an inherent part of the development of these new technologies, and we just must address it.

DR. REZNEK: Thank you, Don. Any further questions?

DR. KASH: Thank you.

DR. REZNEK: It's my belief we have one witness left. It's Otto Raabe from the Radio Biological Laboratory, University of California.

STATEMENT OF DR. OTTO RAABE
RADIO BIOLOGY LABORATORY
UNIVERSITY OF CALIFORNIA

DR. RAABE: Mr. Chairman and members of the panel, I appreciate this opportunity to discuss important issues concerning environmental and biomedical research which is needed for the safe development of non-nuclear energy. I am Otto Raabe, a research scientist and Associate Adjunct Professor at the University of California Davis, CA. My research activities are performed at the Radiobiology Laboratory, a laboratory conducting energy and health research sponsored by the Division of Biomedical and Environmental Research of the U.S. Department of Energy.

About one-third of the current research at the Radiobiology Laboratory is directed at evaluation of health risks associated with coal utilization. I serve as coordinator of this DOE-sponsored non-nuclear energy related research program. This program currently involves five projects: (1) studies of the biomedically relevant properties of particulate and gaseous products of energy technolgies; (2) health hazards associated with advanced technologies for fossil fuel combustion in electrical power generation; (3) reparative and adaptive mechanisms in respiratory systems of rodents and monkeys exposed to sulfur compounds and fly ash particles; (4) health effects of coal gasification and liquefaction processes, and (5) assessment of health effects of energy systems. One of the reports from this Department of Energy-supported research was referenced by Congressman Andrew Maguire in earlier testimony (Chrisp, C. E., Fisher, G. L. and Lammert, J. E. "Mutagenicity of filtrates from respirable coal fly ash," Science 199, 73-75, 1978) in which the presence of mutagens in stack-collected fly ash was reported.

My special areas of competence are in aerosol physics and related inhalation toxicology. I am the author or co-author of over one hundred scientific papers and government reports concerning aerosol properties, inhalation deposition, lung airway structure, and retention of deposited particulate material in the lung. "Aerosol" as you know is the scientific term used to describe a relatively stable suspension of droplets or solid particles in a gas, most commonly air. An important aspect of inhalation toxicology centers on the fate of inhaled aerosols. Respirable aerosol introduced into or formed in the environment as a result of non-nuclear energy systems including coal combustion, may lead to ill effects among members of the population who inhale these particles.

The orderly development of our Nation's energy future requires a balanced assessment of the public risks associated with various alternative systems and technologies. There is not currently available sufficient information concerning potential health risks associated with coal utilization and many other types of non-nuclear energy technologies to conduct such a balanced assessment.

As a point of comparison, let me call your attention to the relatively large body of information available concerning the nuclear-energy-related health implications. In nuclear energy development we have relatively extensive data and understanding concerning the important radioactive species, their chemical forms, environmental and biological behavior, target organs, and long-term health effects. This body of information has been developed primarily under federally funded programs in nuclear energy under the former Atomic Energy Commission and Energy Research and Development Administration, and continues to be supplemented by current Department of Energy and Nuclear Regulatory Commission programs. Although there may be some unanswered questions, there is enough information available to intelligently predict future risks from nuclear power. Low-level radiation effects similar to natural background levels are a concern of some, but review of the health status of people living in the high background Rocky Mountain states does not reveal detrimental effects associated with elevated natural background radiation levels as high as 100 mr/year.

In contrast, adequate detailed information concerning non-nuclear energy-related biological effects as required for public health risk assessment is not currently available. Some may erroneously believe that greater information concerning nuclear risks implies lesser hazards associated with non-nuclear systems. This is most certainly not the case. Most knowledgeable scientists believe potential health hazards associated with coal utilization are serious and need to be thoroughly evaluated in vigorously administered research programs. It is possible that the health impact associated with coal combustion may be 10 or more times as much as that associated with an equal level of nuclear power generation. Since our country will probably have to use all available technologies to meet our future energy needs, it behooves us to give attention to biomedical research at all levels but most especially during the course of development of new technologies.

With respect to coal combustion, consider the current situation. We still know relatively little about the exact chemical species of potentially biomedically important agents released from power plants. Besides large quantities of oxides of sulfur and nitrogen, these emissions involved fly ash, primarily aluminosilicate (sand-like) particles containing a spectrum of naturally occurring but potentially toxic elements (Ni, As, Sb, Se, Cd, Be, Zn, Cr, Pb, V, Mo, Th, U) in high concentrations, especially in the fine particle size range. Also there are some iron oxide and carbon particles. Further, as these aerosols pass through the abatement systems, the smaller, respirable particles are most likely to penetrate these devices and be released. In addition, potentially dangerous volatile chemicals including several important trace metal compounds and polynuclear aromatic hydrocarbons also are not effectively prevented from being released. Mercury, a known poison, is probably totally released in the effluent stream as a gas. In the course of cooling, volatile metallic compounds and hydrocarbons collect onto fine particle aerosols and coat their surfaces. This leads to much higher relative concentrations on the small respirable particles (smaller than 2 μm in geometric diameter or approximately 3 μm in aerodynamic diameter). Hence, one can see the scientific prudence of basing control on the release of respirable particles as is being done in New Mexico, rather than on total emissions. It is these smaller particles which are coated with biologically active agents including potentially carcinogenic forms of trace metals and polynuclear aromatic hydrocarbons which are more biologically available than material on the inside of the particles.

But until we identify the culprit agents which are released or formed from the effluents and emissions, and determine their physical and chemical characteristics, environmental and biological behavior, target organs and measure their dose-response properties in causing disease, we must base emission controls and measure of environmental quality on secondary and possible circumstantial characteristics. For example, two power plants may release identical masses of respirable aerosols, but because of differences in mineral contents or combustion temperatures, the potential health impact of one plant may be significantly greater than the other because of greater concentrations of specific toxic agents such as vanadium or polynuclear aromatic hydrocarbons. In our own research on the mutagenicity of fly ash, we found the ash collected by power plant electrostatic precipitators had no detectible mutagenic activity, and only the smaller particles released into the smoke showed the mutagenic activity. Apparently the mutagens pass through the abatement system independently of the collection of particles. Hence, even the presence of small particles may be circumstantial if the dangerous agents are gaseous prior to release. When we identify the biomedically important agents we can base control systems and environmental evaluations on these agents rather than expensive control of total emissions. Also, we can properly evaluate the environmental and health impact of the releases that do occur. Based upon currently available information, large-scale increases in the generation of electric power using coal combustion should be approached with caution since the public health and environmental impact may be substantial.

Meaningful biomedical research requires time and is expensive since important biological effects to be tested, including cancer and cardio-pulomonary disease, require controlled studies with experimental animals whose life-span exceeds five years in order to provide dose-response relationships that can be extrapolated to people. The needed biomedical research will have to be part of Federally-sponsored programs. Energy producers in the private sector are not anxious to conduct extensive research which may demonstrate adverse effects from effluents currently being released. (An exception are studies supported by the Electric Power Research Institute.) State programs tend to be aimed at very specific problems and usually involve modest funding. Federally sponsored research programs with their stability have and should continue to have the lead role in developing the substantial information on health risks from non-nuclear power developments.

The Department of Energy biomedical and environmental research program is appropriate and particularly valuable. It is during the development of new energy technologies that essential biomedical and environmental research needs to be performed and integrated into long-range planning. The Department of Energy's important role in biomedical and environmental research needs to be given continued vigorous support by the Federal government.

Biomedical research by other agencies is also valuable and indeed complementary. This includes important research being supported by the National Institute of Environmental Health Sciences, the National Institute of Health, the Environmental Protection Agency, and the National Cancer Institute. The various diverse perspectives of these agencies are complementary and mutually contributory in obtaining the necessary health effects data. I would oppose a move to centralize all energy-related health research into one agency since I believe that such a reorganization may be disruptive, desirable confirmatory information may be lost, the multi-pronged attack of several agencies is leading to the required results, the current programs are mutually supportive rather than duplicative or conflicting, and several centers of reaserch emphasis are both necessary and desirable. A high priority needs to be given to adequately support biomedical and environmental programs and create appropriate new programs aimed at providing the necessary information concerning the potential health effects associated with non-nuclear energy technologies and especially coal utilization. We must be wary of underestimating the possible grave public health impacts of large increases of fossil fuel combustion.

That completes my formal comments. I'd be happy to answer any questions.

DR. REZNEK: Thank you. Does the panel have questions?

QUESTIONS AND REMARKS

DR. REZNEK: I have a brief question. The list of chemical characteristics that you read off at various points is certainly large. The amount of money that has been spent on research on the biological effects of radiation over the past years is enormous compared to what the Federal government is currently spending on a considerably longer list of chemical characteristics.

I don't think that we're ever going to get to the point where we have the data base large enough to characterize chemical pollutant problem to the same degree as we have radiation. Therefore, decisions will be made without the benefit of scientific certainty. Furthermore, the question of whether it is better to become more protective or more risky is fundamentally a non-scientific question.

Have you, in your own experience, adjusted the type of work you are doing to reflect an awareness of the impossibility of ever generating complete data?

DR. RAABE: I think you're correct in that this whole area of non-nuclear risks is extremely complicated, and that it may be difficult to totally understand the kinds of dose-response relationships, as well as we do in the nuclear area.

There certainly has been a tremendous amount of money and research gone into working with radioactive materials. However, I think that if we can identify the key culprit agents that are released -- and I think that this is possible -- then we could base a lot of our estimates of health effects on these agents.

Also, I think the lessons we've learned in dose response relationships in the nuclear field and in other areas will apply equally well to the kinds of problems that we encounter with non-nuclear health effects. So that when we're doing some extrapolations we would have some understanding of the possible dose-response relationships by which we can extrapolate.

This is always necessary, since the data base for effects usually involves relatively high concentrations, as compared to the lower concentrations of toxic agents to which the average person in the public maybe exposed.

DR. MACKENZIE: I just wanted to make a comment that I'm not as convinced as you that all the effects of the low levels of radiation are well understood. I agree with you completely that thirty, forty rads or more, people seem to have a good understanding, but in fact, if you live around here. over the past several months there's been quite a bit of activity on low levels of both heavy radioactive nucleides and light ones and I think this is obviously a difficult one to explore in the laboratory because of the small effects among large populations.

And I think in fact now it seems to be heating up again, after seven years of dormancy, the low level effects, of both ionizing and non-ionizing radiation, seem to be quite --

DR. RAABE: Yes, I agree with you and I feel that this same problem occurs with the various agents released in non-nuclear power production.

If we put hundreds of tons of cadmium into the air every year from coal combustion, this represents a low level exposure of our population. We have exactly the same problem that we have in the nuclear area, and this is what I meant by saying we could learn from that experience. We could do experiments in the laboratory with these agents -- such as cadmium -- and we can learn a lot about the dose response relationships that occur. This can be done for short-term acute exposures and for long-term exposures, but only for higher doses within a reasonable sized population of experimental animals over a reasonable time period.

We consequently always must come back to the question of what this means to low-level exposures to the large population of the United States, and that is a common problem and is not just a special problem to the nuclear area.

MS. VAN SICKLE: What were the specific bacteria mutagens that you found?

DR. RAABE: The mutagenic activity studies were done with the salmonella system that was developed by Dr. Bruce Ames at the University of Californa Berkeley laboratory, and this is a well-known cell test system for testing mutagenic activity in chemicals.

Now, the fact that there is mutagenic activity in power plant fly ash associated with fine particles being released, does not prove that this material is carcinogenic, by any means. These are not mammalian cells that were studied, these were bacteria.

However, it certainly does raise a caution flag that we need to do further work in this area, and to recognize that we may in fact have potentially carcinogenic materials being released from coal combustion, and released in large quantities. We should try to get the information we need to evaluate the significance of these releases.

MS. VAN SICKLE: Also, do you have enough data to evaluate the dose-response for specific things like vanadium and your aromatic hydrocarbons? Is the technology available such that the plants could actually control these emissions at this time?

DR RAABE: In some cases. Yes. But I think more importantly -- as I mentioned in my statement -- that if we know exactly what the culprit agents are, what the really important hazardous materials are that are being released, we can look at those.

Currently we're forced to talk in generalities. The whole question of environmental quality is a generality.

Now, in one case, the state of New Mexico, as one of the speakers said this morning, has decided that we should control on fine particles. We should control on respirable particles and not look at all of them, and that's a step in the right direction, because the bigger ones are not as important to the health impact.

But a further step is to control on what's in fine particles that's the problem, because the particles themselves are basically alumino-silicate, which is probably not a very hazardous material. It's what's on them that's a problem. So okay, we can control on the fine particles, but if we don't look at what's on them and figure out which hydrocarbons are the ones that are really the most potentially hazardous, then we're always working somewhat in the dark.

I think that's the main point I was trying to make.

DR. REZNEK: Any further questions?

Thank you.

DR RAABE: Thank you.

OPEN DISCUSSION ON AUDIENCE QUESTIONS

DR. REZNEK: I received several questions on biomass. They cover the whole question of biomass from its net energy balance, to its ecological impact, to processing of the biomass materials, to recycling of nutrients. Several people have questioned the wisdom of not returning fibrous material to the soil. Another question is what happens if you increase the percentage of land from which you are harvesting biological materials?

I don't really think that this is a forum to do anything but mention those questions and say that I know in many cases, DOE, EPA, and other agencies such as the Department of Agriculture, are trying to look at some of these questions.

DR. MACKENZIE: I think that's true, and I think that's probably characteristic -- the same questions could be raised about the way we farm, just growing food, whether or not it has a long-term depleting effect on the soils, and so forth, and I think it's symptomatic of these new technologies to insure that the right questions are asked and reviewed, and I think this is just one good class of questions.

DR. REZNEK: If there are no other questions from the audience for the panel or for anyone else, thank you. We'll meet again tomorrow morning at nine o'clock to go through -- that's -- the speakers for those days are directed towards energy conservation, appropriate technologies, and solar programs.

Thank you.

(Whereupon, at 4:15 p.m. the hearing was concluded.)

energy conservation and solar programs

THURSDAY 30 MARCH 1978

PANEL:

DR STEVEN REZNEK, Acting Deputy Assistant Administrator for Energy, Minerals and Industry, Environmental Protection Agency

DR JAMES MACKENZIE, Council on Environmental Quality

MR HENRY LEE, Director, Massachusetts Energy Office

MR ROY GAMSE, Deputy Assistant Administrator for Planning and Evaluation, Environmental Protection Agency

MR ERIC OUTWATER, Deputy Regional Administrator, Environmental Protection Agency, New York

Federal
non-nuclear
energy
R&D Program

contents

MORNING SESSION

AFTERNOON SESSION • EVENING SESSION

30 MARCH 1978

The hearing convened, pursuant to Notice, at 9 am
Dr Steven Reznek presiding:

opening remarks

DR. REZNEK: Good morning. My name is Steve Reznek, and I'm the Acting Deputy Assistant Administrator for Energy, Minerals and Industry in EPA. This is the second day of our hearing. The purpose of the hearing is to review the relative emphasis given to environmental effects and energy conservation in the Federal Non-nuclear Energy Research and Development Program.

On the first day, we heard witnesses on the general subject of energy development patterns and national coal use. Today we're concentrating on the energy conservation, soft technologies, and solar programs. Tomorrow we'll examine coal use, particularly synthetic fuels derived from either coal or oil shales.

We have with us today on the Panel Mr. Henry Lee on my left, who is Director of the Energy Office in the State of Massachusetts; next to me on the right is Roy Gamse -- he's the Deputy Assistant Administrator for Planning and Evaluation in the Environmental Protection Agency; next to him is Eric Outwater, who's the Deputy Regional Administrator in one of the regions, New York, that has its share of high-priced energy and energy problems; and Jim MacKenzie on the end, from CEQ. He's the Senior Staff Member for Energy in the Council on Environmental Quality.

Our first witness today is Mr. Cecil Phillips from the Georgia Conservancy.

If any of the members of the audience have questions which they wish to address to the Panel or to a witness, there are three-by-five cards available; just turn them in to the receptionist.

STATEMENT OF MR. CECIL R. PHILLIPS
EXECUTIVE DIRECTOR
THE GEORGIA CONSERVANCY

MR. PHILLIPS: My name is Cecil R. Phillips. I'm Executive Director of The Georgia Conservancy, which is a private, non-profit citizens' organization actively promoting environmental quality in the State of Georgia. We are supported by over 4,000 individuals, families, clubs, and businesses in the state, plus a number of rather outstanding Georgians who have moved here to Washington over the past fifteen months.

I wish to begin my testimony by saying that I believe EPA is sincerely interested in what I have to say. I believe this because we received the first invitation to this hearing several months ago. Furthermore, realizing that non-profit groups like ours can't afford many trips to Washington, EPA has provided some travel expense funds for us. Now, this invitation was in marked contrast to the hearings held a year ago on the National Energy Plan conducted by the Energy Policy and Planning Office of the White House, which has since become the leadership of the Department of Energy.

On that occasion, we received less than one week's notice. We boycotted and protested those hearings as being merely window dressing, not a sincere effort at public participation. Today, we are pleased to be able to appear and to commend EPA for going about getting the public viewpoint here in a sincere and effective manner.

In the subject matter of this hearing, our organization offers no special expertise other than that of reasonably well-informed citizens who take a particular interest in matters affecting the environment of our state. We don't consider ourselves a special interest group because we're concerned about our economic health as well as our physical health, and we work for the well-being of all Georgians, including minority groups, low-income people, business people, farmers, inner-city dwellers, and others.

We advocate a balance between the economic, social, and environmental needs of society. To take a current example, we have not opposed the exploration for oil on Georgia's outer continental shelf; rather, we have worked hard to see that such development is handled in the safest manner and that our coastal communities plan adequately for the possibility of petrochemical-industrial impact. The South Atlantic lease sale number 43 took place as scheduled on Tuesday of this week.

One of the questions that you asked in this material for this hearing was the government's role in energy RD&D. We feel that the role of the federal government in energy RD&D should be a strong one. The government should be in a position to manage this vital resource in whatever ways are necessary to protect the national security, to avoid economic and environmental shocks or disasters, and to see that narrow special interests do not dominate any aspect of energy production, distribution, or consumption. We desperately need for the government to take this role and play it with vision, good judgment, and technical competence.

No element of our society has played this role creditably in the past. The energy industry, the universities, the various levels of government have all failed to prepare this nation for the impending scarcities of oil and natural gas, and for the adverse environmental and health effects of our energy production and consumptive patterns.

Although we achieved temporary economic strength during the first half of this century by exploiting our large deposits of cheap fossil fuels, we did so by mortgaging our future. We developed a society hooked on cheap gasoline and electricity. We created a man in the street who takes energy for granted -- who is incredulous and acutely suspicious of anyone who tries to advise him that the nation's fuel tank is getting low. He automatically assumes that if any changes in his energy consumptive habits are forced upon him, he will suffer some kind of agonizing or fatal withdrawal symptoms.

I might interject here too, we have also created labor unions and businessmen who believe that conservation measures are bad for employment and bad for business. I believe these are erroneous beliefs, but this is the atmosphere we've created.

To document the government's role in contributing to this energy addiction we need only consider the energy RD&D funding from 1953 to 1973: over 99.9 per cent of it -- over $5 billion -- went into only one risky option, nuclear fission. Conservation and solar options were virtually ignored, in spite of warnings by scholars, scientists, and environmentalists.

Now, we often hear the argument that if the government botched the job before, why call on them again? The answer is that the top management job is clearly a government responsibility; no other sector has the inherent objectivity and authority to do it properly. We know, from the example of the

NASA space program if nothing else, that the government can do it well. It's our responsibility as voters and taxpayers to see to it that our government does its job right. That's the burden and the opportunity of our democratic system.

I'd like to interject another thought at this point, that this belief does not diminish the role of private industry in research and development and demonstration. Private industrial laboratories and manufacturing firms serve as contractors to the Department of Energy and other agencies and should continue to do so. I'm referring here to the government's role in top management -- the oversight responsibility. Also, it doesn't diminish the role of private inventors -- and there was reference made to this in testimony yesterday: that sometimes the most creative minds are not in the large industrial organizations, and certainly they should be encouraged by the government, too.

I also want to add an issue that was touched on yesterday -- a belief that I agree with the speaker, Dr. Kash, yesterday. He said that not all research and development in energy should be within the Department of Energy; that's, in particular, not a credible source when it comes to research related to protecting the environment.

Considering the complex nature of our energy problems, one of the most pressing needs is a systems approach. Our study of the National Energy Plan and the 1979 energy RD&D budget gives us the impression that a great deal of work is being done on bits and pieces: a new coal refining concept here, a weatherization program there, a wind turbine development there, and so forth. We do not see a concerted effort to pull these pieces together into a cogent, strategic attack on the energy problem itself and on some of its directly related problems -- the economy, the environment, and national security.

Let me hasten to interject that we are highly gratified that the energy program has broadened considerably since the 99.9 per cent nuclear years. We'll comment further on this later.

But our point here is that now, given the breadth of this program and the recognition that energy policies and energy technologies have heavy impacts in the fields of public health, employment, international trade and diplomacy, and other facets of our national destiny, we need to deal with this complexity in the most up-to-date manner available. The recent developments in systems analysis, especially the methods utilizing computer models that enable the analysis of thousands of interrelated variables, would seem to offer the most effective tools. Are we using them?

In the 1979 DOE budget, we see $8.8 million allocated for "modelling and forecasting", but we really don't know the nature or scope of this work. For example, is Dr. Bruce Hannon of the University of Illinois to be employed to expand his computer studies of the relationships between labor, capital, and energy alternatives? Or has the government asked Jay Forrester of M.I.T. to create a national model of energy, economics, and environmental dynamics? Or has Dr. Howard Odum of the University of Florida been supported in the refinement of his innovative analytical approach to these same questions? Or better yet, has RAND or a similar think tank been set up and charged with the mission of strategic energy planning, incorporating the effects on the economy, the environment, and national security?

Now, we're not saying that the particular systems experts mentioned above are necessarily the best or the most appropriate minds to employ on this problem. We don't know. But their work exemplifies some of the latest in systems analysis technology, and surely the nation's most crucial resource problem deserves the most advanced methodology for strategic analysis.

Thus we're asking, what is DOE's thinking on this? EPA's? OMB's? Are the billions of dollars being spent on energy programs being allocated in accordance with a systematic strategy, in which the diverse ramifications in the economy, the environment, and other national interests are understood?

Now, if this is too much to ask at this point -- and it may well be -- what's being done with systems analysis on a more limited scale?

Another question that we ask, along with many other concerned citizens, is whether the government is looking at the short-range energy problem as a marketing challenge. We're convinced that enormous savings in energy are available to the U.S. right now, derived from modest changes in energy consumption habits, using off-the-shelf hardware, and in applications of proven technologies.

Yet there remains much ignorance about these facts as well as various institutional barriers. In other words, the products are available at competitive prices, but the potential customers are not yet aware of them. Describe that situation to any business executive or even a business student and you would get an obvious recommendation: you need an advertising and sales promotion campaign.

While there are significant marketing efforts being built into the energy strategy now, we question whether they are nearly large enough to match the potential for quick energy savings and to begin to change public misconceptions about the fundamental energy issues.

Some applications for solar energy, for example, are proven and economical now. An extensive demonstration program would add greatly to the public awareness of these facts and accelerate their widespread implementation, yet the solar budget has been cut, with the explanation that some of the technological problems have been solved. It appears to us that DOE needs a stronger dose of Madison Avenue in its thinking. When you've got a new product available, you don't just put it in the warehouse; you go out and promote it.

Another issue mentioned in the advance material for this hearing was the matter of the factors to consider in reaching decisions on conservation and solar funding. Some such factors are obvious, such as the potential payoff in terms of energy savings. This consideration leads to emphasis on industrial processes and transportation, for example. Other considerations that we believe should rank high in the priority scheme are the following.

One: the promotional value of the item. Will it help sell conservation and solar to the public, to builders, architects, and so on?

Two: the value of the item in helping to solve related problems; for example, provide needed data or ideas to serve the needs of systems analysis. Some of the related problem areas include air pollution, waste disposal, employment and inflation, international trade, materials conservation -- that is, recycling -- litter and other forms of visual pollution, land use planning, water conservation, agriculture and forestry. Now, private R&D programs in energy are not as likely to consider these national problems in the integrated context that appears to be needed.

We promote funding priorities to other promising RD&D ideas not likely to be funded by the private sector for various reasons, such as the prospect of a long time before expected payoff or the prospect of a limited market for products or services. Some aspects of appropriate technology fall in this category, as well as into the category of being promotional, since appropriate technology often deals with adjustments in life styles rather than in the creation of new business opportunities.

For example, we commend the work of the National Center for Appropriate Technology as a highly appropriate service of the federal government in promoting new attitudes about our way of life.

That concludes my testimony. I'd be glad to answer questions if you have any.

DR. REZNEK: Thank you. Do members of the Panel have questions? Jim?

QUESTIONS AND REMARKS

DR. MACKENZIE: First of all, Bruce Hannon is doing a study for the Council at the moment on the effects of conservation on employment and evaluating the various taxing strategies and so forth, and Lawrence Berkeley's doing work for us on institutional barriers to conservation, so --

MR. PHILLIPS: Is that under CEQ?

DR. MACKENZIE: Yes.

MR. PHILLIPS: I see.

DR. MACKENZIE: But it's under non-ERDA monies from the Act which, in fact, sponsors this hearing today.

MR. PHILLIPS: Good.

DR. MACKENZIE: There has been some misunderstanding on the budget, and I'm not certainly going to try and go into it, but in the solar budget, for example, there is a lot of money which doesn't appear in the budget. For example, there's the Tsongas Amendment, which brings $19 million worth of photovoltaic buys, and that doesn't show up in here and yet it's certainly planned for to bring about $12 million worth of buys.

And then there are the tax credits on the order of $60 million, according to OMB, which was meant to substitute for part of the demonstration program on heating and cooling. When you factor those in, it may not go up as much as one likes, but at least it goes in the right direction.

MR. PHILLIPS: I appreciate that information.

DR. REZNEK: Roy?

MR. GAMSE: In the "Factors to Consider in Funding Priorities" section of your testimony, in point two I think you raise a good point in listing the factors that you think government can consider in its assessment of technologies and decisions as to where to place research money -- factors that the private sector will not consider.

My question would be, do you have any further guidance to give us as to how to incorporate these factors? One kind of dilemma that I think we would frequently face is an energy technology which would seem to be, for instance, very polluting in terms of air or water pollution. One approach would be to tend to put less money into research in that area; another would be to put the same amount of money that you would have otherwise, but perhaps put more money into research in control technology or ways of using that technology while attempting to minimize the adverse environmental effects.

Do you have any advice for us in that regard?

MR. PHILLIPS: I've already mentioned one bit of advice on that, and that's the way not to do it. The way not to do it is to have all the research done in the Department of Energy, because their viewpoint, being promoters of energy technology and not necessarily promoters of environmental quality, is going to give a very biased viewpoint. I think we might extend that concept to say that some of the research might be done in the Department of Agriculture; some of it might be done within EPA, of course. It might be done in other agencies or managed by other agencies.

I'm not saying that the work should be duplicative or not controlled or managed. As I have argued -- I hope strongly -- the government needs to have an overall body somewhere. Dr. Mackenzie makes reference to the possibility -- correct me if I'm wrong -- that CEQ is at least looking at strategic planning. Somebody needs to be doing the strategic planning that considers all these factors. I don't know who that should be.

The RAND operation in California was very successful in looking at military and other national strategic planning problems, and something of that nature with regard to energy and its related areas of study certainly deserves to be considered, I think.

DR. REZNEK: I was fascinated by your comments about the promotional role of government for these new technologies. This problem raises the fundamental question of the role of government in our society. The experience in the past with governmental promotion of particular technologies has been mixed.

Have you done some thinking on how the Federal government should be involved in promoting, say, solar systems or Franklin stoves or whatever?

MR. PHILLIPS: Some. We have in Georgia, not far from Atlanta, what is billed as the largest building heated and cooled by solar energy. It's the Recreation Center in the town of Shenandoah, and it's working beautifully. I was there last summer on a hot day, and the solar-powered air conditioning was working beautifully; it was very cool and pleasant inside. That's a demonstration effort funded by ERDA, and it was very effective.

However, there are not many large buildings or opportunities for large buildings like that. There are many opportunities for homes or smaller buildings, and it would make sense to me to apply the demonstration funds to the kinds of structures that there are millions of or opportunities for and in the population centers where they can be easily seen, and to promote tours of them and advertise them on TV -- just a little hucksterism with respect to very fundamental types of applications that are commonly applicable in the types of housing that we have.

DR. REZNEK: Thank you.

MR. OUTWATER: My problem was the same as Dr. Reznek's -- the difference between marketing a government policy and public education as a moral issue is very complicated. I perceive that you, when you talk about the "Madison Avenue approach" and the private sector, really perceive that maybe a bundle of money should go out there to sell or to market these particular systems in the Madison Avenue way. Is that --

MR. PHILLIPS: Yes, because we have different types of barriers to these technologies. Of course the technical barriers themselves, but some of those are being overcome already; then you have institutional barriers -- taxes and so forth -- and those are being approached.

But one of the barriers that is fundamental, it seems to me, is just the attitude of the public: the attitude of the businessman; the attitude of the labor union; the attitude of the NAACP, which has made a statement opposing some of the energy policies; the attitudes of various interest groups. It seems to me that the government needs to take an appraoch aimed at these attitudes. We won't get anywhere if the public-at-large doesn't believe that conservation can save energy in an effective way without losing jobs -- and there are a number of papers being published on this.

I have one here by the organization called Environmentalists for Full Employment. It talks about jobs and energy and promotes the idea that energy conservation can mean higher employment. There's a paper here by Widmer and Giftopolis of M.I.T. talking about "Energy Conservation and a Healthy Economy", and as far as I can tell, this was not funded by the government but was funded primarily by a private firm. This was published in "Technology Review".

Now, some of you people read that and some of us read it, but the man in the street's not getting this message. I think that the approach I'm promoting is that the government needs to get to the man in the street and promote these ideas, if in fact they are valid. It may take research and development along these lines -- in economics -- and, of course, that's what I'm advocating, too.

MR. LEE: I just have one question. If you believe that government ought to provide a program to promote things such as conservation and solar, if you gave the government promotion money, wouldn't you also run the risk of them promoting things that you don't believe so strongly in?

MR. PHILLIPS: Oh, yes, of course, and that gets back to this question of why give the government another job when they botched up the last one. I just have the faith, I have to say, that we have to depend on the government for certain roles, and strategic planning and long-range development of technologies and institutional procedures for the energy problem fits into the category of a government responsibility, and it's up to us to make sure the government does it right.

Granted there are going to be some bureaucracies and some waste of funds and some misdirection, but I honestly believe that we need to think out the proper role for government, as opposed to private industry and universities, give government that role, and then watchdog the hell out of them and make sure they do it right.

DR. REZNEK: Any further questions?

DR. REZNEK: Thank you.

MR. PHILLIPS: Thank you.

DR. REZNEK: Our next witness is Dr. William Jones, whose affiliation with the Energy Laboratory of the Massachusetts Institute of Technology the previous witness has just advertised.

STATEMENT OF DR. WILLIAM J. JONES
ENERGY LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DR. JONES: Thank you for the opportunity to speak before you here today. My name is William J. Jones, and I live at 86 Bullough Park in Newton, Massachusetts. I am educated as an Electrical Engineer, and I am presently employed at the Energy Laboratory of the Massachusetts Institute of Technology in Cambridge, Massachusetts.

My purpose is to suggest that the Department of Energy, in concert with the Environmental Protection Agency, or the Environmental Protection Agency in concert with the Department of Energy, anticipate the existence of a situation which could be detrimental to the policies and gains in environmental protection that have been reached in a very difficult way over a long period of years.

A number of studies of world supplies of petroleum and the demands for same have been completed recently. In the conclusions, all agree that the demand for petroleum will probably overtake supply sometime between 1985 and 1995. Clean fuels will be particularly scarce. It is possible that the optimistic predictions of discoveries may be realized and, along with slow economic growth and activity, the crunch could slide a few years downstream, but the situation will have to be confronted in any event.

The current research and development activities for alternatives, such as synthetics from cleansed coal -- or rather synthetics as cleansed fuels from coal -- will not result in commercial production at levels sufficiently high to have a noticeable impact on the situation. There are, it is conceded, always opportunities for surprises and disappointments, but the likelihood of surprises within the next ten years that can be beneficial or can minimize the effects of the crunch are very slim. Review of the regulations which restrict the use of dirty fuels or require the employment of pollution abatement measures or equipment are necessary.

Conservation will have to be enacted and practiced with zeal. Conservation, however, includes the concept of increased energy productivity -- that is more usable energy output per unit of input pollution abatement equipment energy. Pollution equipment and practices are frequently accompanied by a reduction in energy conversion efficiency.

As a direct consequence of scarcity of supply and the requirement to increase energy production and reduction in cost, the Department of Energy and the Environmental Protection Agency and the myriad of state and local regulatory agencies will be assaulted by lawyers and deluged with requests to relax, waive, and cancel the established pollution abatement constraints that manage, protect, and/or improve our natural resources and environment.

The majority of the petitions will be legitimate. There will be some that will have been filed because of perceived opportunities to avoid responsibilities considered costly or inconvenient. There will be some petitions that will have no foundation on or relationship to fuel or energy scarcity but that purport to be in the public interest.

The Department of Energy and the Environmental Protection Agency must begin now the preparation of contingency plans and procedures to cope with the crunch. It is almost certain that if the crunch situation is not anticipated or there is delay in the establishment of plans to take care of the necessary and desired pollution abatement waivers, the agencies will be faced with inescapable pressures to make quick and expedient decisions. In the absence of well-thought-out, equitable, rational plans, the agencies will have soon lost respect, and the number of successful challenges will increase algebraically -- that is, the number of successful challenges to environmental protection regulations will have increased algebraically, and, in effect, there will have been a default of responsibility.

I'm not speaking about the current or ongoing functions and activities of the DOE and the EPA with respect to environmental management and energy resource expansion. These activities must continue at the rate that they are now. What I am pointing out is the need for an ad hoc group -- albeit that the ad hoc status may exist for several years -- to separately concern itself with the predicted crisis.

Its attention must be directed towards the anticipation of conflicts between environmental protection policies and the diminished supply of clean fuels. The charge to the group should include: to prepare a defense of the gains made in environmental protection against pressures for waivers based on real, contrived, or imagined difficulties with energy shortage; to insure against needless waivers of standards designed to protect our health and environment; to guard the gains that have been won only after long and bitter battles with rational, reasonable, and mutually accepted agreements, reached as a result of discussions that have taken place long before the fact -- discussions that have taken place in a calm and relaxed atmosphere and discussions that have involved technicians, economists from both sides, regulators, and community interest groups.

Such agreements reached in the relaxed periods before the crunch can be far more in the national interest than decisions reached during the crunch based on narrow issues -- as necessary in legal proceedings -- as a result of protracted or hasty litigation by an already overburdened court system.

Procedures recommended by the ad hoc committee must not be rigid or blind in an attempted adherence to pollution abatement regulations. It is entirely possible that inflexible policies on the part of the government could be the small pebble in the path of the U.S. industry over which it could trip and lose any competitive edge or leadership in international trade that it now enjoys. Too formalized a plan may stifle an agency's ability to react fast enough to unexpected opportunities or problems.

On the other hand, too loose a plan could result in only post facto actions, where an agency can only go through the formality of assessing a situation and is then left only with the option of continuing unenforceable regulations that have already been neutralized on the books or eliminating those regulations gracefully.

What is the extent to which the environmental problems should be considered or should be attempted to be forecast? Two basic situations are easily imaginable. One, a scarcity of supply of clean fuels results in petitions to burn, without restriction as to meteorological conditions, length of time, or geographical location, any available fuel. Two, removal of pollution abatement equipment or cessation of pollution abatement measures or actions is requested so as to increase energy efficiency. Flue gas scrubbers, as presently designed, cause an increase in the heat rate for electricity production -- that is, the number of Btu's of input energy required to produce a kilowatt of electricity increases with most conventional flue gas scrubbers.

Before any decisions are reached, it is desirable to have an understanding of what effects the various responses to petitions for waivers would have on jobs, inflation, and other requests that lie waiting in the wings. Any and all measures or actions will cause increased benefits to some sectors and decreased benefits to others. They must be ascertained, evaluated, and compared before an adjustment measure is enacted.

Industries and the general public must not be required to face uncertainty as to what they will be permitted or not permitted to do when a difficulty arises. Waiting for long periods of time until requests are acted upon will cause anxiety. Perhaps both compensatory benefits and actions to contain excessive gains will have to be initiated simultaneously and in proportion to the types and extent of gains and losses. Environmental waivers can be for specific seasons, specific geographical areas, and at various levels of intensity as situations warrant or dictate.

Labor, industry, federal and state agencies, and environmentalists must be made aware of the probability of a crunch; they must be brought into the discussions about actions and measures that have to be considered for environmental pollution abatement; they must be brought into discussions long before the most pessimistic date of the crunch arrives. These groups must understand why, when, and how necessary adjustment measures will be implemented. The facts, assumptions, conclusions must be made available to the public beforehand. Only with the full participation of those affected and the support of onlookers can a political consensus in support of the decisions be realized.

Research and planning should include assessment of the riskiness of various options so that one can be well prepared to react, choose, and pursue any of a set of strategies that represent acceptable levels of risk and cost to all concerned. The basic notion of uncertainty implies that events will cause a greater or lesser surprise. Unforeseen or ignored probable events frequently alter the courses of men's lives. The ad hoc committee's responsibility should be to see to it that unforeseen or anticipated events need not needlessly affect the course of human events or pollution abatement goals.

In summary, the Department of Energy and the Environmental Protection Agency, in concert, should try to be able to predict the effects of the forecast crunch and to predict the effects in the various sectors of the economy that are energy intensive and/or dependent. They must begin to prepare a plan and a scheme that will permit discretionary response, so that the adverse effects on the national environmental policies as a result of pollution abatement modifications as required to increase energy efficiency or to permit the use of prohibited fuels or processes can be reduced or ameliorated.

The bureaucratic review and overview during the period of crunch should be a minimum. Plans that require constant vigilance on the part of regulatory bodies are always accompanied by expensive external and internal costs. The agencies should begin now to organize the ad hoc committee, and the ad hoc committee should be required to submit for public discussion and debate by 1982 or 1983, a plan which will permit the agencies to upgrade it by constant review and adjustment as developments take place.

Thank you.

DR. REZNEK: Thank you. Those are very stimulating remarks. Do we have questions? Eric?

QUESTIONS AND REMARKS

MR. OUTWATER: I have an observation. I suspect Dr. Jones knows --

DR. JONES: I'd like to make an observation. You have plenty of water on the main table, but the witnesses --

[Audience Laughter]

MR. OUTWATER: Having been a Regional Official during the energy crunch, when we were involved in the granting of variances to allow fuel switching --we've got two things we have to concern ourselves with. One, you're talking about the long-range review of the whittling away of our advantages --the advantages we've gained in pollution control by virtue of the impact of saving energy, and then we've got the other thing, and that is the short-term things that we have to do to safeguard public health.

I must say, from the point of view of where I sit up in New York, I'm somewhat convinced that the procedures for the revisions of state implementation plans -- and, as you know, the maintenance of air quality and the achievement of primary air quality is in the hands of the state -- that the procedures there are pretty good in terms of allowing a review. In fact, it's almost impossible to grant a variance with less than ninety days. There's a provision for public participation; there's a provision for public notice; there's a provision for the review of the documents which, in turn, allow the type of input, I think, that you're talking about.

We do, of course, have the additional problem now of the PSD or the prevention of significant deterioration which falls into this, which we're now struggling with in the courts, but I'm not as discouraged as you are that there isn't enough of a period here for review and that things are going to happen so hastily that we're going to lose our gains.

DR. JONES: You've covered a lot of territory. I have to review it quickly. Number one, the CIA, the Congressional Research Council, the Workshop on Alternative Strategies as chaired by Carol Wilson, and the World Oil Project at the Massachusetts Institute of Technology, oil companies, et cetera, all anticipate this, shall we say, a gap between supply and demand. Somewhere downstream from there one will have, hopefully, solved the problems inherent in the liquefaction or gasification of coal and the disposal of the residues in those processes.

Anything for which concrete is not being poured in a hole today will take ten years to come on line, and if we look at the opportunities to use these improved fuels or to use alternatives or for sufficient solar utilization to come on line, this is a period longer than ten years, yet this crunch 1985, is seven or eight years from now. Again, the time 1985 is a crossover point; it may slide one way or the other, depending upon what happens in the Middle East and the OPEC nations and also the level of economic actvity.

But before that point, and one should consider it not a point but a circle, prices will begin to vibrate; supplies will begin to show some perturbations two or three years above this, so that the length of time in which we have to address this situation is relatively short, and it's going to be universal, in the sense that this will be a world-wide competition for these fuels. It will be particularly acute in the United States because of the anticipated dependency on imports.

We can imagine a situation in which there will be a finite length of time in which clean fuels will not be available. The hazard is that waivers become permanent; the hazard is that the gains made will be lost or seriously decreased; the hazard is that decisions will be made quickly under political pressure because of employment, et cetera.

I think that what the agencies -- that is, the Department of Energy and the EPA -- can do is to really examine situations and come up with tentative plans. For example, imagine a situation in which an installation burns oil. It may be desireable to require two storage tanks, one with high sulfur fuel and the other with low sulfur fuel; and under certain meteorological conditions depending upon the season of the year, one will have to burn 100 percent low sulfur fuel and under other conditions they may be permitted 100 per cent high sulfur, or there may be a mix.

I don't know if all equipment can burn all types of a fluid or mixtures thereof.

One might say that you are denied this opportunity because you are in an urban area and the background is too high to permit this. There may also have to be an allocation: "You here on the East Coast can burn high sulfur because the fallout is over the ocean; you all in the Indiana section are not allowed to burn high sulfur because acid rain will fall on the East Coast."

Now, I'm not suggesting that these are solutions. What I'm trying to imagine are some hypothetical decisions or hypothetical rulings that can be discussed to determine whether these are, in fact, reasonable decisions to make.

The economy will have suffered, because of high prices or scarce fuels, enough perturbation, so that any unnecessary or perceived undesirable stress placed by environmental protection or pollution abatement measures will be just ignored: "We just can't consider these at all; it's too important to keep people working" and just strike them off the books. Then one has to go back to square one and start all over again.

That's the kind of thing I'm suggesting can be taken care of.

DR. MACKENZIE: I have just one comment. I am more pessimistic than you because I don't think that there will be areas for large substitutions. If liquid fuels go first, if they start hitting a crunch, you're going to have cars, homes -- which will certainly not be able to use coal -- and maybe some industry, which may not have the capability either.

DR. JONES: Well, let me think about this. You know, no automobiles moved within Boston for five to seven days, and there were some air quality measurements made, and as I understand it, there was a tremendous reduction in pollution, which would suggest that perhaps the automobile is the greatest offender. The allocation of fuels might be such that the utilities are granted far more leeway than the automobile industry in the use of dirty fuels.

Now, I don't know what percentage of cars will have catalytic converters; I don't know what the contaminants will be. I'm suggesting that this situation should be examined. It may very well be that someone would come back and say, "Bill Jones, there's no problem." I hope so. On the other hand, he could say "There are no problems except in these areas."

But to stand by and say, "Well, I'm optimistic; I'm not optimistic; and I think that everything will take care of itself" I don't believe is a responsible posture to assume.

DR. REZNEK: Any further questions?

Thank you.

DR. JONES: Thank you.

DR. REZNEK. Our next witness is Mrs. Ellen Winchester, and she is the Chairperson of the National Energy Policy Committee of the Sierra Club.

STATEMENT OF MRS. ELLEN WINCHESTER, CHAIRPERSON
NATIONAL ENERGY POLICY COMMITTEE
SIERRA CLUB

MRS. WINCHESTER: Mr. Chairman and members of the Panel, in speaking today I am representing the Sierra Club, a national organization of approximately 180,000 members. In the short time I have available, I cannot touch upon all our concerns relative to the renewable resource aspects of the federal energy program, and my remarks should not be construed as a complete catalogue of them.

President Carter has said that his first choice for a future power source is the sun. The sun is also the first choice of the Sierra Club, and we would welcome the powerful support of the Carter Administration in bringing our country and the world closer to total reliance on solar energy, viewed broadly as the full range of renewable resources.

However, the 1979 budget submitted to Congress has gravely disappointed us by its imbalanced support for the development of nuclear and fossil fuels. The potential contamination of air and water from nuclear power is sufficiently well known to make it unnecessary for me to dwell on it at this time, yet the '79 budget authorizes $1,217,000,000 for nuclear energy. It is equally well known that the world's store of fossil fuels is finite, with the depletion of oil expected to have an observable impact on energy use within the next two decades -- about the time world energy demand is expected to double current demand -- yet in 1979, we plan to spend $4 billion for a few months' supply of oil to be used in case our Middle Eastern supply is cut off.

Even all the dollars in Araby could not buy us enough oil to serve as a bridge to a renewable resources future, so it is understandable that we plan to spend about $620 million in '79 on coal research and production, some of it to make the use of coal less polluting. But coal is also a finite resource. Even with the best available control technology, it is polluting, as your Fact Book illustrates. It imposes on society long-term health stresses that are not yet well understood. CO_2 from its effluents may cause disastrous climate change.

Furthermore, we know more about how to use it than we know about renewable resources -- the only resources on which we can safely depend for as long as earth can be expected to last on this cooling planet. And on that clean and safe ultimate resource of last resort, which we will not be able to exploit unless we begin while we still have inexpensive sources of energy, the '79 budget allows only $400 million, including $27 million for biomass.

It seems a tragic ordering of priorities which, if held to in succeeding years, will close off the renewable option and leave us only a nuclear future for as long as it lasts.

Secretary Schlesinger has stated that funding for solar heating has been cut because it has become cost effective and can now compete on its own. If he is correct, he is describing a happy situation that nevertheless needs a great deal of expensive demonstration, manufacturing stimulation, and public education. In my own state of Florida, where conditions for solar space heating are optimal, only an adventurous home builder employs it and only well-off idealists retrofit with it.

Perhaps Secretary Schlesinger was thinking of water heating or of electric resistance heating as competition for solar, not of oil and gas. The Solar Intelligence Report states that, vis-a-vis the latter, "Solar space heating costs remain higher on both twenty- and thirty-year time horizons." As for solar cooling, it is nowhere, yet the economic growth of the whole southern half of the United States depends on the artificial environment electric cooling creates, most of it dependent on oil or gas.

We are very pleased that the House Science and Technology Subcommittee has added $36.5 million to solar heating and cooling demonstration and development, and $13.5 million for research and development. We hope the Senate Committee will do as well.

An area of solar innovation that has only within the last two or three years begun to receive much attention is passive heating and cooling based on principles as old as cave dwelling. It demands a whole new architecture -- one designed to live with nature instead of in defense against it. In much of the south, passive solar can do the whole heating job, and in the north, it can handle summer cooling.

We have no doubt that private industry and the public will respond to the push-pull theory governing market incentives of the National Energy Plan, but we still believe solar space heating needs more of a push than even the House Subcommittee has provided.

The Sierra Club believes that biomass has extraordinary potential as a substitute for oil and natural gas. It can be used as a feed stock, for petrochemicals, be converted into methane to be burned for space heating and electricity and into ethanol to be used as an additive to extend gasoline.

We are anxious about the environmental degradation and human suffering that could result, particularly in the developing countries, from the use of arable lands for energy production, so we believe fuels from biomass conversion should be developed with caution, but that they should be rapidly developed. Biomass conversion can be a means of storing energy; it can provide fuel for electricity in northern winters; if grown in conjunction with sewage treatment facilities, biomass can improve water quality rather than degrade it.

It is encouraging that the House Subcommittee recommends increasing biomass authorization by $27.5 million, but again, the sum seems a pittance in contrast to the astronomic sums being spent on the strategic petroleum reserve and coal liquefaction and gasification. In connection with spending on synthetic fuel development from coal and oil shale, it should be noted that mounting evidence shows that limited availability of fresh water will act as a constraint both on the production of synthetics and on their use to produce steam-generated electricity, to say nothing of the disturbance of water quality and supply caused by the initial mining of coal.

On the other hand, wind-generated electricity, certain photo-voltaic conversion systems, and solar thermal conversion systems use very little water beyond that required in the manufacture of equipment. Solar heating, cooling, and passive solar have the same virtues, yet hidden and not-so-hidden subsidies for non-renewables keep costs down and make it harder for solar to compete. We believe that if the full environmental costs of fossil synthetic fuels were factored in, solar energy would seem cheap.

The Sierra Club is keenly concerned about the rapid development of the photo-voltaic cell, surely one of the world's most magical inventions. Not only can photo-voltaics provide electricity, they can provide thermal energy, the equivalent of co-generation, through the use of water pumped over the back surfaces of collecting cells.

A possible competitive disadvantage of photo-voltaics, the fact that economies of scale are not anticipated, can be turned to advantage by the fact that small systems can be built on roofs and walls, wherever the sun lands on your buildings, than can use this thermal energy potential. Expensive distribution networks and environmentally damaging high voltage lines are not needed, a particular virtue in developing countries.

Tailoring to community needs is possible; systems can be built quickly and jobs can be provided for local building contractors and local labor.

Henry Kelly of the Office of Technology Assessment answers the question of how much federal spending the government should be willing to invest in promoting a single photo-voltaic approach much needed to reach low cost goals by the early 1980s, by pointing to the proposal to spend $2 billion for the Clinch River breeder.

The Sierra Club is not eager to see the solar energy industry develop giant power stations analogous to the two- and three-thousand megawatt plants planned for coal and nuclear today. We prefer decentralized solar strategy, matching appropriate energy sources with compatible uses, but we do believe there is a place for smaller central-stationed solar electricity for urban needs and that much more work needs to be done to develop it. Hammond and Metz in "Science" say that the size of present power towers is arbitrary, not the result of careful study. Perhaps it is time for careful study.

CEQ points out that solar collectors using tracking mirrors less sophisticated than the power tower can also produce a low temperature heat needed for food processing and in a variety of other commercial uses. Agriculture in the United States and in developing countries urgently needs solar power for irrigation pumps.

We had understood from earlier Department of Energy reports that wind was its favorite horse in the renewable sweepstakes. The budget authorization of $14.7 million is all the more disappointing. Hammond and Metz also report little government study concerning the optimal size windmill for research. We believe a generous system of grants to encourage inventiveness in the area of small wind machines would make a big return on the investment.

The Sierra Club is not an advocate of the idea that energy problems can be solved simply by throwing money at them, but we have observed that large amounts of money spread on the research waters have helped EPA develop its scientific expertise for analyzing pollution effects. A lot of money also put men on the moon.

Advocates of rapidly increased funding for solar development are frequently told that the infrastructure to use more R&D funding does not exist, that the workers in laboratories do not exist. It therefore surprises us that under the category of "Basic Sciences", no line item is listed for renewable resources. "Nuclear Sciences" gets $29.7 million.

The House Subcommittee has added $4 million to "Basic Sciences" specifically for long-range basic research and direct conversion of solar radiant energy to electricity. Anyone who knows anything about university funding knows that four reasonably ingenious and aggressive professors could soak up that much money in running four rather small research groups.

[Audience Laughter]

MRS. WINCHESTER: Another aspect of the argument that renewables can't use money the way fossil and nuclear power can, is that the DOE staff to administer solar research and development is incredibly small. The exact number varies according to source, but apparently the staff is no larger than 125 people, only a small part of whom have the job of actively fostering R&D through recruitment of proposals and follow-up.

Even an environmentalist working with a very small budget knows that you have to spend money in order to spend money more usefully, and that's something EPA excels in. It doesn't seem to us to be naive to be wishful, or to be wishful to believe that with appropriate funding and encouragement from the DOE the nation could achieve a lunar landing kind of success with solar energy.

The Department of Energy should, as soon as possible, develop a total solar future plan for the whole United States, using all forms of solar, including low heat hydro, and addressing problems of job transfer. It would, of course, include plans for increased energy efficiency and lower per capita consumption.

If we can show the developing nations of the world how to achieve self-sufficiency with renewable resources, while at the same time we and other industrial nations scale down energy use, a prime cause of future war will be eliminated. That would be a clear gain for the environment and would save a lot of energy.

Thank you.

DR. REZNEK: Thank you. Does anyone have questions?

MR. GAMSE: Yes.

DR. REZNEK: Roy?

QUESTIONS AND REMARKS

MR GAMSE: Most of your comments are addressed towards the need for more money for solar and other technologies which you see as being desirable. You made some contrasts between the amount of money deveoted to solar energy reserach and nuclear energy.

Would you care to be more specific about your desires for research spending in the other areas besides the renewable resources?

MRS. WINCHESTER: Well, actually I came prepared only to speak to renewables; that was my arrangement with your program Chairman.

DR. MACKENZIE: Would you care to comment about what you really think the government should be doing in implementing solar. Do you think it should be going far beyond simply research and development and what is a legitimate goal?

MRS. WINCHESTER: Well, we think a much larger procurement effort, for example, for photo-voltaics on the part of government purchasing would be an excellent idea in facilitating marketing processes and giving a tremendous boost to private industry and getting the bugs out of photo-voltaics, making it much more possible for Sears and Roebuck very soon to have them listed in their catalogues. That's one angle that we specifically feel government spending could make a big improvement in the situation.

Another problem -- if I may just speak to that. When I talk to legislative aides, for example, about the necessity for increases in solar budget, they say to me, "Well, you must come in and tell us specifically how we could spend this money, because as things stand, we just don't see how we could spend any more." This is one of the handicaps that an environmental organization such as mine has. We simply do not have the large staff that can do the research that is necessary to show us how we can spend money more efficiently and more helpfully on solar energy development.

That's why I called for, in the talk I've just given, more spending in the Department of Energy on staff that can work on precisely this kind of problem. It requires a tremendous, even revolutionary change in the way the United States does things.

Now, to expect an organization like the Sierra Club, with a budget of about $7 million, to come up with a blueprint for how this can be done is excessive.

MR. LEE: I just have one question, and that is: the Administration has made it clear that they feel that the demonstration program that they've run over the last three years had sort of a diminishing return -- that the technology for space heating and cooling from solar is really an economic ballgame now; it's not an R&D ballgame. It is an R&D in photo-voltaics, but not in the other area.

Can you be more specific on how you would use increased funding for demonstrations in the solar heating and cooling, because I think that's one of the major points that's been brought up in controversy between the Administration and some of the committees on the Hill.

MRS. WINCHESTER: Well, in the first place, I don't agree that the equipment has reached that point which they claim for it. If it had, then the various friends of mine who have invested in the equipment would not be having the trouble that they are having with it now, and I am very concerned that if we don't have a lot more government spending in developing the equipment, we are going to have the very disastrous effect of consumers being disillusioned with solar and the whole thing will go down the drain, as it were, when it certainly doesn't need to.

I believe that the research has gotten to the real kick-off point, but it's just at the edge and it needs a tremendous push to get it there. Do I make my meaning clear?

MR. LEE: Yes.

DR. MACKENZIE: Let me comment on that again, because we were involved in this sort of issue during the budget process last fall. In the National Energy Plan, one of the few things that has been agreed upon by the Conference Committee is the credits for residential conservation and residential solar energy. OMB, for example, estimates that it could be up to maybe $50 million out of the budget to homeowners to purchase solar heating equipment.

I think that that would, in fact, accomplish much of what you're asking. I think that in the heating business, the problems are less for a need for government developing a better flat plate collector than to work on the institutional problems of financing, servicing, reliability, standard procedures for a claim, performance standards, and that sort of thing. I think there's more work certainly needed on cooling; I think that there's a clear research need. But as far as heating is concerned, I think that there is some merit to the reduction -- you know, building more homes just like the last one is not going to accomplish the goals nearly as well as an increase in the tax credit, which will make them more economic, and working on these institutional problems.

MRS. WINCHESTER: Well, Dr. MacKenzie, I have great regard for your qualifications to speak on this issue, and you've undoubtedly done a lot more study on it than I have, but I don't agree with you. The Solar Energy Report, which I've quoted, does mention that, even using the net tax credits, it would be twenty or thirty years before solar heating can be cost competitive.

As far as I can see, unless far, far better equipment -- and that includes the plumbing, which is, God knows, vastly complicated as things stand today; it includes the materials, which tend to leak today; it includes simply simplifying systems; it includes a lot that I don't even know about that will not be improved simply because people have generous tax credits to go out and buy equipment that doesn't work. They will install it, and then they will be turned off.

DR. MACKENZIE: People will not install such equipment -- well, all right.

DR. REZNEK: You made the statement that this solar technology, as a small scale home appliance, does not have to work as poorly as it does. But one of the contrasts between solar power, as you described it, and a large nuclear power generating plant is the fact that, because it's dispersed, it will have to be delivered and maintained by a new human infrastructure, perhaps one involving the homeowner. The people of this infrastructure cannot and will not be as highly trained or as technically competent as the people associated with the higher, more advanced technology, for example, nuclear.

In fact, a movement towards decentralized energy technology will, by necessity, be accompanied by lesser reliability because of the skill levels and technical capabilities of the people involved. Don't you agree?

MRS. WINCHESTER: Well, I think there has to be -- and this is something also that probably needs to be addressed through some sort of special funding -- a means for teaching the homeowner these new skills. We are a great do-it-yourself nation now, and I think people will learn in community colleges and adult education courses and things of that sort how to handle this new technology that will be so much to their advantage, as far as home heating costs are concerned.

DR. REZNEK: Any further questions? Thank you.

MRS. WINCHESTER: Thank you.

STATEMENT OF DR. CHARLES A. BERG, CONSULTANT

DR. BERG: Thank you. I feel privileged to have been offered the opportunity to comment on non-nuclear energy research financed and otherwise supported by the federal government. I'd like to note at the outset that there's a nearly irresistible tendency in testimony toward the negative, because it is the one chance that a member of the public has to offer comments on what he or she may perceive to be deficiencies in federal government efforts and to offer suggestions toward the remedies of those deficiencies.

For that reason, I would like to begin by saying something about what I think is right in the government efforts. I think there is a great deal to be commended. For example, there is finally a unified and independent Federal Energy Regulatory Commission. It's long overdue that regulation of energy be unified. There is finally a Department of Energy, and energy is finally raised to cabinet level consideration.

I think that in commenting upon what are perceived as deficiencies in the efforts of the government as a whole toward resolution of energy and resource problems, one should not lose sight of substantial progress that's been made, and I want to take this opportunity to commend the government on that progress.

Now, to turn to what remains to be done -- in parentheses, a lot -- and specifically what could be done better, I shall address myself this morning to the areas of solar energy and conservation, especially in industry.

The basic problem in these areas of endeavor, as I see it, is, to put it plainly, a lack of strategy. Both of these areas share a common aspect: it is that new means of using energy are required, and to approach these areas, it's necessary to reach an understanding of the nature and the scope of the problems that will have to be dealt with. Some theoretical framework for addressing those problems and even delineating them is required.

We do recognize that greater use must be made of abundant energy resources and renewable energy resources to offset the use of increasingly scarce resources, such as oil and gas. Now, oil and gas have shaped much of industrial technology. There's a general principle that applies not only to industrial processes but to all processes, and I would like to cite it. It is that the form of energy that is used to sustain a process very strongly influences the design of the process.

We're about to change the form of energy resources that we use to run our processes. We're faced in that change with a selection of the forms in which energy might be brought to the process. That implies, although it has not yet been explicitly recognized, a wide range of choices as to the design of processes to use the energy forms that we will be able to bring to the point of processing.

To give some examples of the choices before us, consider the the use of nuclear fuel or hydroelectricity or solar energy or coal to offset the use of natural gas in combustion-driven industrial processes. Well, coal, for example, could be converted to a gaseous fuel; it could be converted to electricity; it might even be economically justifiable to convert it to liquid fuels.

Nuclear energy comes as electricity, period, as far as I know, and hydroelectricity comes as electricity, obviously. For high quality -- in the technical sense -- thermal performance, about the only thing you can do with solar energy is to generate electricity.

It therefore follows that if any of those alternative energy forms that I've just mentioned are to be used to offset the use of natural gas or high quality distillates in industry, many of the combustion processes now in use are going to have to be electrified.

By the way, I want to note that my statement is not a plea for wholesale electrification of industrial processes; on the other hand, I will state that I think that that is likely in certain processing areas and I don't think that it's a necessarily bad thing.

But the principle I stated, that the choice of the form of energy strongly influences the design of a process is one that I would like to register. There's another principle, and that is that in processes, particularly processes of production, it is net productivity that is the measure of merit, not energy efficiency; it is net productivity.

Now, when you consider the use of the factors of production in a process, you have to consider the use of capital, labor, and raw materials. We have scarce minerals that are used in our production processes; one sub-set of those scarce minerals is fuels. Another important sub-set is the geochemically scarce materials that are used as alloying elements.

It is my proposition, by the way, that the 1980s will see the emergence of problems in geochemically scarce alloying elements that will remind us very much of the problems of scarce fuels in the '70s.

In any event, when one is faced with modifying a process so as to make use of new forms of energy, it is natural -- since the measure of merit of the modification would be net productivity -- to take into account that the processes in many instances were conceptually established over a hundred years ago; the deficiencies in them have been accepted for a hundred years, and so when you redo the process, you would try to redo the process so as to address all those deficiencies holistically.

You would try to control excess use of labor; you would try to control wasteful consumption of mineral resources, as well as wasteful consumption of energy. Now, to do this implies that conservation, particularly as that term may be applied to industry and, in fact, as it's applied to any other sector of the economy, entails nothing less than fundamental transformation of the processes we use. That has three fundamental requirements. It requires basic scientific research to prepare the way for the future, so that the problems and deficiencies that have been accepted in process technology for, say, a century can be addressed with more recent findings, and the findings in science and technology that have occurred over the last hundred years can be embodied in new approaches to those processes. Fundamental scientific research is an absolute must.

There's another thing that is required. The second thing is a reinvigoration of ventures in risk-taking, so that the findings of basic science can be incorporated in embodiments that might offer advances in net productivity -- advances that would be constructed so as to resolve problems of energy resources and other scarce natural resources.

Incidentally, I'm going to interject before I go on to the third requirement that it's my proposition that, whereas in the past, the productivity component of labor has been the first and the principal component by which one examined net productivity, we are moving into an era in which net productivity will first be examined on the use of scarce natural resources.

The third component that's needed is capital formation. Without an hospitable climate for vigorous capital formation, none of the findings of research, none of the products of ventures will be applied where they must be applied to conserve resources.

Now, those observations, I believe, form both the basis for a comprehensive strategy to approach the conservation of energy and other scarce resources, and a basis for friendly criticism of present efforts in conservation.

There are numerous detailed planning documents in energy conservation. The more detailed the planning document, the stronger the tendency of the author to refer to the product as "strategy". Amateurs, among whom I count myself, have a tendency to confuse tactical detail with strategy. Strategy is, after all, the reckoning and the application of the forces at one's disposal to satisfy policy objectives. There are certain elements of strategy that must be taken into account in trying to devise a strategic plan.

I would say that the strategic aspects of present efforts on conservation are reminiscent of a nineteenth-century military predeliction for the frontal assaults. They amount to a frontal assault directly upon perceived energy wastes. They do not incorporate the more subtle and more powerful aspects of strategy that bring indirect forces into play.

I have a list here of some observations of the three elements that I think are required in a strategic plan. On scientific research and the question of whether the government can or cannot play a direct role in scientific research: obviously the government can; it may not be quite so obvious to you that the government must, but that is my proposition. Otherwise the entire institution for the conduct and the support of scientific research would have to be redesigned. That is the way this country does scientific research; it's the way that every advanced industrial country does scientific research. Research is fundamentally a ward of the government.

On ventures: Can the government play a direct role in ventures? My proposition is that it cannot. I also propose that it never can. Much of the strategic planning documents, so-called, in energy conservation are in fact computer models of a synthetic notion of the marketplace, to test out which ventures might be the best to pursue. There is a fundamental fallacy here. The government, for good and sufficient Constitutional reasons, is always held publicly accountable to present consensus. If present consensus were in any way a valuable guide to the merit of ventures, ventures wouldn't exist as an area of the economy; it wouldn't need them. The important thing about ventures is not that one can succeed; the important thing is that one can probably fail, and the government is, because of its accountability to present consensus, constrained not to fail. Therefore, the most valuable and risky ideas, even those that may be predicted to be economically justifiable over the long term, are probably excluded.

Now, on capital formation: can the government play a role; should the government play a role? Well, obviously, the government does play a role in capital formation. For example, public works such as hydroelectric projects are largely government activities. The question of whether the government artificially subsidizes those is a minor economic detail, in my estimation. The more important fact is that the government is the principal in forming that capital.

There is a question as to the extent to which the government could or should extend its role in capital formation. I'll give you my own opinion on it. My opinion is that the government should work through indirect means and should not use direct means to extend its role in capital formation to sponsor more efficient technology in industry. I do not believe, for example, that the government should go into the steel business.

I will pose as a problem what I perceive to be a kernel of difficulty in capital formation. It is this: in private capital formation, the essential ingredient, the vitamin that must exist for healthy capital formation, is an expanding market. The very reason that we need capital formation is to enable us to continue healthy production in markets that are constrained physically by a scarcity of natural resources. We need the capital formation to regain control of the use of those scarce resources.

There is a conflict there between the societal need for increased capital formation in markets that physically are constrained from expanding. This is a political problem. I'm sure that the solution to it can be found without resorting to radical means. But the political problem remains of how the government will, if it can, create the means to stimulate capital development in areas of the economy that are constrained by natural development of resources.

Now, I see from the glances and expressions on people's faces that I've repeated my usual performance and run overtime, and so I will forego exhibiting some things. I would like to offer some examples of what I mean by some of the remarks I have made.

I think it's useful just to cite at least one physical example of industrial processes in which comprehensive consideration of productivity would lead one in a different direction and a more productive direction that a frontal assault on energy waste.

Could I have the first slide, please?

(Slide shown.)

DR. BERG: This is an industrial reheating furnace where stainless steel, which is mostly chromium and nickel -- about 50-50 -- is reheated for forming. That furnace, incidentally, when you count up its total efficiency, is about 5 per cent efficient, and that's not a bad one. The reason it's so low is that while the furnace may be about 40 per cent efficient when it's used, you can't turn it off, and you only use it about sixteen hours a day over a five-day week. But, you have to run it twenty-four hours a day, seven days.

In any event, what I want to point out here as you look into this furnace and see the stock going in, is that that stock going in there is extremely expensive. Because of the limitations of combustion technology, about 3 to 4 per cent of every bit of the stock that goes into there is lost as oxide scale. Now, that's 3 to 4 per cent of the entire production of that mill that leaves that furnace as useless oxide scale.

The conversion of this furnace to a different process for heating -- for example, electric induction in a controlled atmosphere or even in a vacuum -- would have an immensely important effect on the productivity of that mill. We do not have furnaces right now that are suitable for the sort of operations that would be required here that would combine electro-induction with a vacuum; that may not even be the best solution.

The point I'm getting at is that we must consider not only the scarce natural gas that's burned up in there, but the chromium which is going out as oxide scale. Every bit of that chromium is imported to the United States. Moreover, the environmental cost of disposing of that without polluting ground water is an additional burden on the production of that mill.

(Slide change.)

DR. BERG: This is a picture I just happen to like, so I'll show it. You see that red streak on the wall there. This is the wall opposite the furnace. That's thermal radiation coming straight out of the furnace and heating the wall. It would be nice to take care of that, because, as you see in the next slide, this is what happens after you heat that stuff.

(Slide change.)

DR. BERG: You see, the reason that you heat that steel almost to 2400 degrees is so that the thermal radiation leaving it won't cool it to below 1900 degrees before it gets to the rolls, and it's oxidizing all the way across the plant as it goes.

What I intend to show you from this citation of this fairly elementary physical example is this: Knowing that chromium is an extremely scarce resource, knowing that natural gas is an extremely scarce resource, knowing that capital is not exactly easy to raise and that skilled labor is not exactly easy to find, if you were going to do something about the operation of the stainless steel industry right now, you would not put twentieth-century insulation on a furnace of nineteenth-century concept; you would try to find a new concept for reheating -- one that would conserve the scarce resources that are consumed there.

That's all I need on the slides, thank you.

I think I registered my point as well as I can in the time allowed to me; I'll just have to be satisfied with it. I'll close now.

DR. REZNEK: Thank you. Are there questions?

QUESTIONS AND REMARKS

DR. MACKENZIE: Charlie, let me make sure that we have it in English -- exactly what you want to see done. First, you want a lot more basic scientific research into industrial processes as a basis for revamping them and so on, is that right? So first there's basic research.

DR. BERG: Yes.

DR. MACKENZIE: Okay. Number two, more ventures in risk-taking.

DR. BERG: Well, the way I put it was a reinvigoration of ventures in risk-taking.

DR. MACKENZIE: Indirectly by the government rather than directly.

DR. BERG: Indirectly.

DR. MACKENZIE: So this is taxing policies and so forth. Is that basically the tool that you'd use?

DR. BERG: Well, that's one very important tool. Another important tool is the role of the government as a purchaser.

DR. MACKENZIE: But basically government policies to encourage risk-taking and so forth.

DR. BERG: Yes, yes.

DR. MACKENZIE: Okay. And the third one: a hospitable atmosphere for capital formation. Is that again indirect government policy to encourage industry to do this itself, is that it?

DR. BERG: Well, that would be what I would recommend. I think that there's a political consideration involved as to how much of a direct role in capital formation, as opposed to how much of an indirect role, the government should assume. My preference would be the indirect role, because I think it happens to work a little better, especially in respect to the admissibility of new technology.

DR. MACKENZIE: So you're saying if these three major areas were addressed, then energy conservation in, say, industrial processes would be encouraged much more than through present routes.

DR. BERG: If I may respond to that at some length, it would be encouraged much more effectively; it would be encouraged in such a way as to conserve energy in ways that advance net productivity, and that I feel is the key.

DR. MACKENZIE. Okay. So you --

DR. BERG: If I may just add to that.

DR. MACKENZIE: Yes.

DR. BERG: The three elements I've outlined there suggest to me or indicate to me that the proper field for conservation and for solar research, which I really was not able to address myself to by example, is one that pervades all the functions of government. For that reason, I have very strong doubts that the Department of Energy is the proper place for the conduct of a comprehensive government effort on conservation and solar energy.

They certainly can contribute through basic scientific research. But in my estimation, the Treasury, the Commerce Department, and the authority of the Presidency itself are required in setting comprehensive and pervasive policies throughout government, to contribute much more effectively in the final two elements I mentioned.

DR. REZNEK: Any further questions?

Thank you.

DR. BERG: Thank you.

DR. REZNEK: Our next witness is George Löf of the Solar Energy Applications Laboratory, Colorado State University.

STATEMENT OF DR. GEORGE LÖF
SOLAR ENERGY APPLICATIONS LABORATORY
COLORADO STATE UNIVERSITY

DR. LÖF: Gentlemen. Thank you for your invitation. I'm appearing here representing no one but myself. I am a member of the staff at Colorado State University in the Solar Energy Applications Laboratory, where we have a sizeable program of research and development on several solar applications. I also am an officer in a manufacturing company that makes and sells solar heating systems for buildings.

I've been in the solar field for about thirty years, and I have a few comments based on that experience. I would then be pleased to answer questions.

The connection of solar with environmental quality is of course through its substitution for fossil and nuclear fuels; it has a double benefit in reducing environmental problems as well as reducing the requirements for domestic and imported fossil fuels. The principal objective in solar development is to maximize, within economic limitations, the use of solar energy and to minimize the time for its introduction.

Now, I think it's clear that use of solar energy will happen by itself. It will be introduced into the economy on a very wide scale, even without federal aid, but of course it will develop much faster if aided.

The solar uses that I'll talk about briefly are mainly for the heating of buildings and the heating of water supplies -- moderate temperature heat -- which comprise about one-third of the national energy consumption. This is the early application of solar; it's going to precede the others because the economics are better.

Electric power generation from solar energy which is another big segment of the national energy use, is going to happen later because the economics are unfavorable. Transport is a very unlikely prospect, perhaps forever, because of the problems of insufficient solar availability for that application.

The economics of solar energy for space heating and hot water, I am sorry to say, are not very well understood nor is there full agreement. We hear all kinds of numbers from enthusiasts of various kinds. Today, to put a solar heating system in a building, total installed costs are in the neighborhood of $30 per square foot of solar collector. This includes all of the hardware and all of the installation. A number of installations are going in at substantially higher costs than that, but $30 is a reasonable and practical estimate.

This cost results, in a sunny climate, in <u>heat</u> costs of about $20 per million Btu, if amortized at a reasonable rate and with interest charges at 8 or 9 per cent. So $20 per million Btu is reasonably sound price for solar heat today. That's the equivalent of six cents per kilowatt hour of electric resistance heating. Solar heat is therefore competitive with electric resistance heating where electricity prices have already risen substantially.

The likelihood of that cost coming down is remote. If we can keep the cost about there, in terms of current dollars -- in other words, if we can avoid price increases for a few years due to inflation and can make modest improvements and economies, we shall be doing well.

These costs are not discouraging, because as our fuel prices go up -- 7 to 10 per cent per year -- and as we see electricity prices already at those levels in several parts of the country, the opportunity for solar heating to compete with electric heating is great.

There is also an opportunity, perhaps, for solar not only to substitute for the fuel that is burned in power plants, but also to substitute for generating capacity -- a very critical problem today. Some of you may have seen comments of Dave Freeman in relation to his work with TVA, that perhaps a new power plant of a thousand megawatts could be deferred by substitution of solar water heaters in the TVA area. Since that is a summer-peaking network, the use of half a million solar water heaters could eliminate the need for a thousand megawatts of electricity.

The relative investment requirements are about the same. A thousand megawatt nuclear plant costs about a billion dollars and half a million solar water heaters would also cost about a billion dollars, so the proposal looks promising. This concept might also be extended to space heating although there the capacity substitution will require some storage of electric heat on site. Solar heating systems would have to stay off the peak in each utility network by storing some electric heat at night for use in the daytime.

Solar energy can therefore be regarded as a substitute for fuel by replacing electricity for heating, and with proper research and development and application, also as a substitute for some electric generating capacity requirements.

Let us now examine the government role in this field. What is the government doing and what should it be doing? The near-term prospects for solar space heating and hot water require the generation of a viable market. The market today is very small. The principal government role should be the stimulation of that market. Research and development on solar heating is an obvious need, and government is already involved in increasing the quality of the hardware and reducing its cost.

The claim has been made that this technology is all developed and that industry can take over. Industry isn't going to take this over until it sees early profits. The small companies can't afford to, and the big companies have more profitable uses for their money. So it is clear that the government must continue strong support of research and development in solar heating, even though applications are being made today. It is gratifying that the House Committee has marked up the budget for solar heating research -- and that includes cooling -- to $46 million.

Solar heating demonstration is another activity that the government should vigorously continue; it must show the public that this technology is practical. The demonstrations must be improved in quality. There have been too many poor demonstrations, too many that show solar heating is expensive and ineffective. We have to be sure that the demonstrations are not testing programs for unproven equipment. We must also obtain data from these demonstrations because of insufficient information on the performance of operating systems.

The third role of the government is providing incentives for use of solar energy. The tax credit in the National Energy Act will be helpful. The provision of a $2,000 tax credit for space heating systems will stimulate the market. In addition, I think we will need government loans for solar heating systems at attractive interest rates.

Finally, the training of architects, engineers, and installers of solar heating systems is going to require much additional emphasis and support. We don't have enough trained people. That situation is partially responsible for the large number of poor installations that have been made. I have said nothing about solar electricity generation, because I think that application is several decades in the future. I don't agree with massive efforts to pilot plant and demonstrate solar electric at this time, because the results are going to be put on the shelf. Solar electricity is not going to be competitive with commercial electric power generation until the price of fuels for commercial power goes up severalfold. At that time, solar electricity can be expected to move in.

Thank you.

DR. REZNEK: Thank you. Are there questions?

QUESTIONS AND REMARKS

DR. MACKENZIE: I would just like to make an argument in favor of non-economic electric demonstrations -- maybe we disagree and maybe we don't.

Photo-voltaics, as you know, are still quite expensive, on the order of anywhere from $6.00 to $10.00 per peak watt, depending on whether they use collectors and so forth, and that's very expensive electricity. Nonetheless, the advantage of doing demonstrations now with them is that you get the learning experience of how they will be used as costs do drop, as they are anticipated to do and as they are, in fact, occurring, so that when the crossover point occurs, this won't be a new instrument that no one has used.

Secondly, in many parts of the world, as I'm sure you're aware, electricity costs on the order of fifty cents per kilowatt hour, and the markets are, in fact, opening up and don't need any subsidies both there and in places like remote DOD installations and so forth, so in many cases these expensive installations will make sense very shortly.

I guess that's all.

MR. OUTWATER: Dr. Löf, we heard Mrs. Winchester talk about her concerns with the quality of the types of installations that people are getting today. I presume from your remarks that you're saying that the hardware is really pretty good; it's the training of the people that are putting it in now, in terms of residential applications at least, is that right?

DR. LÖF: I think both problems exist. There's a lot of very poor hardware being sold today, unfortunately. There are people in the business that know absolutely nothing about it. Today, inexperienced individuals and companies assemble some solar device and sell it to a customer who doesn't know the difference between a good one and a bad one.

Installation is a second, and very real problem. You can take excellent hardware and put it together into a system that just won't perform at all.

DR. MACKENZIE: May I ask: how would you address that in terms of government programs? What is the most effective way of showing that there are duds as well as good ones? Do you want to get the government directly involved or do you want to do it indirectly?

DR. LÖF: Indirectly, but as with many things, the government is very influential. In the most recent federal demonstration programs, requirements for qualified hardware and warranties that really put the responsibility on the suppliers are going to help a great deal. I wish that had been done early in the program rather than now. I hope the horse hasn't been stolen already. Some of the earlier demonstrations will have a negative effect because of failures. I hope now we can remedy those mistakes.

MR. OUTWATER: On residential solar applications, do you perceive that there are going to be radical changes in the types of installations we're going to see on residential homes, say, in the next ten years, or do you think that the state of the art is pretty much there today and it's just a matter now of getting better quality and better application?

DR. LÖF: I don't expect to see any major changes. There will be minor, steady improvements, primarily, I think, in the direction of durability and efficiency increases, but no radical changes.

DR. REZNEK: My understanding of your remarks is that if the market place were operating correctly, which is to say, if people were going for the lowest cost, then you'd find a far greater number of solar system installations in new facilities, both new homes and other new buildings, than is actually happening. The present cost structure favors solar power, but extraneous, non-economic factors such as unfamiliarity, fear of the unknown, etc., are hindering free market functioning and thus delaying the expected cost minimization and widespread use of solar systems at this point in time. Is that right?

DR. LÖF: That's correct, if it is assumed that electricity is the alternative. Natural gas and oil are both cheaper than solar heat. If you can't get either one, solar is competitive with electricity in a few places today. New York and Boston are examples. And on a life cycle cost basis, over a twenty-year span, solar becomes the cheaper source of heat than electricity almost everyplace in the United States.

DR. REZNEK: Any further questions?

Thank you.

DR. LÖF: Thank you.

DR. REZNEK: Our next witness is Mr. William Partington, Director of the Environmental Information Center of the Florida Conservation Foundation.

STATEMENT OF MR. WILLIAM PARTINGTON, DIRECTOR
ENVIRONMENTAL INFORMATION CENTER
OF THE FLORIDA CONSERVATION FOUNDATION

MR. PARTINGTON: It is with some trepidation that I follow Dr. Löf.

On behalf of our Foundation, we would like to thank you for providing this opportunity to speak on energy conservation and solar aspects of the Federal Non-Nuclear Energy Research and Development Program.

At both yesterday's and today's hearings, I sensed that the Panel and most speakers are extremely sympathetic to the needs to conserve energy, protect the environment, and to protect the citizens' quality of life. The problems we seem to be facing are, among others, "how to" problems: how to coordinate research with policies; how we may encourage more conservation; how we decide which technologies deserve highest priorities; how do we get more businesses, industries, and the public to practice conservation because they want to conserve.

We at our Foundation are dealing with the public directly along at least some of these lines, and I will offer some suggestions on how we might all do a better job, but first I have some general statements to make.

The public is said to be apathetic to the energy crisis, just as it is said to be apathetic to participation in programs such as 208 water quality planning in some areas. If people try to deal with unresponsive officials or hear complicated reasons why something can't be done, it is understandable that they will become apathetic, turned off of nationally important issues, and will withdraw to being concerned primarily with themselves, their families, and with close friends. This has happened, but it is not irreversible.

The really great things this nation has accomplished often have resulted from the activities of a far-sighted, dedicated few who inspired others through their dedication and examples. Even if the polls should someday show that only 25 percent of the public feels the energy crisis is real, that still means that there are over fifty million people who do believe that it is real, and that is a lot of people to work with.

Through reactions to our publications and workshops, we believe there is a powerful element of citizens who want to conserve energy and who will be effective, but these people have largely been overlooked in present federal and state programs. The people I'm referring to are home craftsmen -- the do-it-yourselfers who take pride in their projects and who have an urge to be busy making or repairing something.

We started having lots of contact with home craftsmen three years ago when we first started publishing directions for building a good, solid solar water heater, based on time-tested design -- a Model A Ford sort of heater, if you will -- made of easily available parts. Some 25,000 or more copies of that publication have now been distributed, and some people who have purchased the booklet come back for more information for their specific installation.

A random poll of some 300 who had the plans revealed that as much as 10 percent had built or were building or were intending to buy or seriously intended to build solar water heaters, and most of those that we have talked to that have built them claim at least that their heater works very well and produces savings. We have no way of checking on what these savings are; I'm sure that in some cases they're exaggerated.

These do-it-yourselfers are not concerned with national policies, although the majority appear to believe that the energy crisis is real for them, and they feel that the energy crisis may be caused in some cases by true shortages of fossil fuels, perhaps by government ineptness, or perhaps by corporate tricks or whatever, but the important thing is that they are not people who are about to be very much concerned with federal overall policies, even though they are an effective group that I feel we should approach.

These people need direct one-on-one help, and booklets such as ours are really only a start. They also need local hands-on workshops and some personal guidance on solar heaters, insulation, and energy equipment improvement information for their homes. These are people who are saying, "Help us to help ourselves." They need simple information that is technically sound and tested, offered by sympathetic teachers.

The problem will be to find or to train competent and sympathetic instructors. These people must be good craftsmen, among other things; they must have an understanding of the basic principles involved, in order to explain why something should be done; and thirdly, they should enjoy dealing with people.

Perhaps the most important of these criteria is that they like other people. It appears easier to train a person-oriented person or a good craftsman in enough of the technical principles than to teach a technician to deal and communicate with the public. Such people may be found through local trade associations, or they may be found in civic or conservation groups. Most would like to do this work, we feel, on weekends, when other home craftsmen have the time to spend on such sessions.

Incentives to be a workshop leader could include community recognition for their roles, certification for having taken or passed the training program, and some pay for leading the sessions. However, the sessions should require only a minimum cost to the person taking it -- say in the range of $4.00 to $5.00 -- enough to make sure that he's taking it because he really wants to, but not enough to stop him because of the cost.

In keeping with this theme of more actively involving people in helping themselves, I have a mixture of six other suggestions which are related to some extent to the foregoing.

The first one is: emphasis must be placed on retrofitting existing homes rather than encouraging destructive and potentially wasteful sprawl of new homes. In Florida, I suspect, and I suspect in other parts of the country, most of our homes are fairly new; they will last another fifty years, but they were not built to emphasize energy conservation.

The second one is that similar workshops to those that I have mentioned earlier should be held for practicing architects, engineers, and others, few of whom, by their own admission -- with whom we have had contact -- have sufficient expertise to advise new home clients or builders of commercial buildings on how large a certain window should be, how many windows would be needed, or how high a ceiling should be in order to provide insulation or space for ventilation unless they have expensive consultants. In Florida, too much insulation, we are told, may not allow a building to cool at night in the summertime.

Training sessions for such professionals and others would be most desirable.

The third one is grants for small projects, perhaps up to $5,000.00, for planning, training, workshops, producing materials, demonstration projects and so forth; these should be easily available for groups or even individuals to obtain. They should have a minimum of red tape. They might be doled out through regional appropriate technology centers or such organizations, perhaps, as are run by non-profit groups, through trade associations or certainly with the advice of trade associations, or even through regional federal offices.

The fourth one I have is: exhibits of soft technologies or appropriate technologies or whatever you wish to call them should be favored in areas highly visited by tourists, such as in Central Florida where I'm from. At least some tourists want to feel that they get something useful out of a vacation, and while they have the time to absorb new thoughts, these should be offered and they should be offered as opportunities.

The fifth one is: we need help with reincarnating or discovering or inventing passive systems that may be useful in the humid Southeast.

The sixth one I have is that federal information programs should emphasize the hardware and technology that are currently available. The public needs accurate information on what they may expect for their money to make their own decisions on what to buy on a cost-effective basis, according to their own location and financial situation. They should be told how to evaluate collectors, for example. From having seen collectors that have been built or that have been brought to our office over the past few years, I would agree with Dr. Löf that there are a great number that fall short of being very adequate, although there are some good ones too.

The main thing would be to tell people how to evaluate these -- what points to look for so they can make their own judgments.

In conclusion, energy conservation and soft technologies, applied on a local level by people who want it, may not only be a means of conserving diminishing resources, promoting a lesser consumptive lifestyle, reducing sprawl, and setting examples for others that will follow, but it even can be good for the local businesses, since it depends largely on local supplies and people helping themselves.

That's the end of the statement that I have prepared.

DR. REZNEK: Thank you. Does the Panel have comments?

QUESTIONS AND REMARKS

DR. REZNEK: In listening to your remarks, an exercise in which both EPA and DOE participated comes to mind. I refer to demonstration projects for home insulation, particularly in the north. Night infrared photography was taken of houses and roofs and an information office was set up. People could come to the information office to find out whether or not their house was showing up as heat-leaking and to learn how to calculate the cost discount associated with the capital investment of reinsulating their homes. These demonstration projects were, I think, quite popular and quite succesful in the cities in which they were tried.

I assume that you are modeling some of your projects for solar heating and cooling on these earlier demonstrations since they are the same kind of activity, namely, an information exchange to teach people how to do a cost discount.

MR. PARTINGTON: This is the sort of thing that we would either like to do or we would like to encourage others to undertake. Now, part of the problem in Florida is that we do not have the intense changes of temperature between a house, say, at zero temperatures and a house being heated so that you can get those photographs to show the amount of heat being leaked.

We have a different sort of situation, and I'm really speaking, I think, from the point of view of where I come from, in that air conditioning is probably a larger energy consumer than the heating. For that reason, we have a different set of problems, but also the humidity problem is another one that we have, and to my knowledge, people have yet to cope with that seriously.

Some suggestions have been made that perhaps desiccants could be worked out that would remove humidity from the air that would be naturally ventilated; however, how to remove the water and return the desiccant so that it would be cooled down and not be heating the air in return is apparently a large problem, and if somebody has suggestions along these lines of what to do, we'd certainly like to know how to do it.

I purposely throw out these remarks about workshops and so forth to hopefully stimulate some thinking, because I sense that everyone here is very sympathetic to this whole cause, but somehow or other we've got to get out and get these things going where people are learning to help themselves. I think we do have a vast number of friends out there, and we can start a lot of these programs tomorrow, if we just somehow give them some help.

DR. MACKENZIE: I'd like to ask Mr. Lee -- Henry Lee -- who's a Director of the Massachusetts Energy Policy Office whether this might be something that could be done through the Energy Conservation Plan that the various states are developing. Does this seem like it could -- you know, workshops and solar and insulation and this sort of thing?

MR. LEE: In many cases, the answer to that is yes. We tried to do the do-it-yourself training sessions, and the first year we ran them it went very well. The second year, the attendance dropped off markedly. We had certificates of graduation; we had paid instructors; we did do it on weekends, and in the second year, the attendance dropped so badly that we're not going to have a third year. We're going to run a similar type of operation using high school students next year.

DR. MACKENZIE: Do you have any idea why it failed? I mean, this seems to be an obvious thing.

MR. LEE: It depends on the different areas. You could say that in some areas it wasn't promoted as strongly as it could be, but in other areas it was, and even in the areas where we promoted it very strongly, the attendance wasn't that high. I think it's just a question of there not being enough interest for it.

We think possibly in a high school we'll have somewhat more of a captive audience, and we might be able to be more successful.

MR. PARTINGTON: I believe that Mr. Lee's experience fortifies my statement that non-government organizations, such as trade associations, and grass roots groups, should be encouraged to organize and promote solar workshops. The school approach could also be very productive.

DR. REZNEK: Thank you.

MR. PARTINGTON: Thank you.

DR. REZNEK: Our next witness -- and I guess our last witness before lunch -- is Dr. Marshal Merriam of the University of California at Berkeley.

STATEMENT OF DR. MARSHAL F. MERRIAM
ASSOCIATE PROFESSOR, DEPARTMENT OF MATERIALS SCIENCE
UNIVERSITY OF CALIFORNIA AT BERKELEY

DR. MERRIAM: Thank you. My name is Marshal Merriam; I'm a member of the Engineering faculty of the University of California at Berkeley, and I'm here to speak about wind energy. I have been engaged in work with solar and wind energy for the past six years, and in the wind energy area specifically, I've been a consultant to various government bodies at various times: the State of Hawaii, the State of California, the U.N. Environment Program, the National Academy of Sciences Committee on Nuclear and Alternate Energy study last year, and the Federal Energy Administration. I recently spent several months in Denmark, and I am familiar with the history and present status of wind programs there.

As a consultant to the FEA, I prepared a paper discussing the possible role of wind energy as a source of electricity in the United States, and I would like that paper -- of which I left twenty-five copies with the staff --

to be incorporated as part of the proceedings today. The title of that paper is "Wind Energy Use in the United States to the Year 2000".

WIND ENERGY USE IN THE UNITED STATES TO THE YEAR 2000

INTRODUCTION

The object of this study is to develop a set of projections for the use of wind energy in the United States during the years 1985, 1990, and 2000. These projections are to be used, along with other studies, in delineating the policy options available to the United States as it endeavors to avoid energy imbalances in the next quarter century. Uncertainties in predicting the future use of wind energy in the United States are large, and the reliability of predictions is low. To say what can be done (given the right government actions and overlooking cost problems) is relatively easy, but to say what will occur is another matter.

The major uncertainties, roughly in order of importance, are:

1. Will energy demand (i.e., consumption) continue to increase a few percent each year for the next 23 years, as it has in the past?
2. Will the price of imported oil increase moderately, not at all, rapidly, or catastrophically in the years to come?
3. At what rate will the cost of conventional electric power plants (oil, coal, nuclear) increase in the years to come?
4. Will a shortage or lack of availability of energy sources for generating electricity, such as a nuclear moratorium or an oil embargo, occur or be perceived to be likely within the time period under consideration?
5. Will an economic way be found to make electricity from sunshine?
6. How much encouragement will wind energy receive from the government?
7. What will large wind machines cost in quantity production?
8. How large is the wind resource over the parts of the United States within reach of electricity markets?
9. How densely can large wind machines be placed in windy regions?
10. How many of the millions of potential dispersed users of wind energy are located in areas of sufficient wind and would be able to make use of wind energy?

It will be noted that the first five of these have nothing to do with wind as such. Of the others, one concerns government policy, one is a question of applied science, two are questions of meteorological survey, and one is techno-economic.

There is very little doubt that large aerogenerators can be built and that they can be operated to produce electricity for existing networks. It has been done already, and more than once. Wind energy installations are not likely to encounter the ever-increasing environmental and political obstacles which have caused so much trouble for nuclear and coal plants. There is not even much doubt that land sites, or near off-shore sites, exist for enough large windgenerators to make an appreciable contribution to U.S. energy needs. However, there is some uncertainty about just how large the contribution could be.

Wind energy has been "tried before", in the United States, United Kingdom, Denmark, Germany and France, and elsewhere, as a source of commercial electric energy, but large wind machines have never been produced and installed in more than prototype quantities. ("Prototype quantities" usually has meant just one machine.) Experience with the prototype units led in each case to the conclusion that wind energy would be more expensive than, or at least not substantially cheaper than, the other alternatives available. At that time the other alternatives were much lower in cost than they are today and no one perceived any limit to petroleum availability. Moreover, nuclear power, it was believed, would become extremely inexpensive.

Today, when the economics of wind energy are believed to be more favorable (because the cost of oil, coal, and uranium has increased), there is still no rush to wind electric systems. The situation is marked by uncertainties. The electric utility companies are uncertain about the cost and performance of big wind turbines, and about the magnitude of the wind resource which may be available to operate them. The potential suppliers of large wind turbines are uncertain about the size of the market, or if a market even exists.

In order to be able to offer a product for sale at a commercial price, with guarantees about life-time and performance, a market must exist for at least several hundred units. When these uncertainties are resolved, by government action or otherwise, commercial wind energy will become a reality -- if the price is right.

Likewise, smaller windmills used in a dispersed manner for household electric supply, space heat, or water heat have not appeared in large numbers. Prices are high and reliability is uncertain -- again, mainly because of insufficient volume of production and sales.

We are accustomed to look to R&D and to technological issues as key elements in determining the viability of a new energy source. There are indeed important technological problems in the operation and in the design of wind power plants, and there is an important role for R&D. Unlike fission, fusion, coal conversion, photo-voltaic solar, ocean thermal conversion, geothermal, or oil shale, however, technical issues are not primary in determining wind energy utilization.

TASK 1. PROJECTIONS

The projections relating to wind energy use in the United States in the years 1985, 1990, and 2000 are given for the amount of energy delivered, for the number of machines installed, and for the total installed electrical rated capacity of the machines in each of the three years, for centralized (electric utility) and decentralized (dispersed mode) applications, and for both a base case and an accelerated case.

The base case is defined as including the effects of programs and activities identified in the President's energy policy (1977). The accelerated case reflects the effects of a credible group of incentives and eventualities, discussed below. The accelerated case is intended to represent the maximum credible wind energy penetration which could be expected on a peacetime non-coercive basis. It is to be taken as a reasonable upper bound.

Realization of the accelerated case would require a number of the following eventualities and incentives.

Eventualities:

a) Expanded nuclear fission capacity disappears as an energy option, because of serious nuclear accident, excessive costs, public resistance, or for some other reason.

b) An OPEC embargo is imposed on shipments of oil to the United States, persisting for many months and causing dislocation and hardship.

c) Another tripling of crude oil prices by the producer's cartel is put into effect.

d) Greatly increased public support results in a political imperative for rapid implementation of renewable energy resources. Wind energy receives a large acceleration from such a program because it is implementable in the near term.

Incentives:

a) A federal policy that all capital expenditures on wind energy equipment until the year 2000 will be regarded as part of the engineering development process in implementing this new energy source and may be treated as R&D for tax purposes.

b) Any local property tax assessed on the owner of an operating wind machine will be paid by the federal government until the year 2000.

c) For electric utility companies, revenue from wind-generated electricity, net of fixed costs, and O&M (operation and maintenance) charges will be free of federal tax until the year 2000.

d) Electric utility companies will receive, for each KWH of wind-generated electricity, sold, a federal supplementation payment of ____¢/KWH. A reasonable value under 1977 conditions might be 3¢/KWH, decreasing to 2¢ in 1980. This payment is partly justified as a recognition of the reduced social costs resulting from replacement of polluting sources by wind.

e) Electric utility companies installing wind electric capacity in the 1970s have 90 percent of the capital cost reimbursed by the government. Wind electric capacity installed in the 1980s is 75 percent reimbursed; in the 1990s, 50 percent.

f) Large government purchases of smaller windgenerators for dispersed mode applications (1-50 KW size) are made to stimulate the market. The units are put to use at federal buildings, military bases, and other installations.

g) Manufacturers of windgenerators up to 50 KW receive a federal supplementation payment based on the number of units sold. Initially this could be 100 percent; i.e., for every dollar received from a customer, the manufacturer is rewarded with a dollar of federal payment. The size of supplemental payment could decrease in future years. Though similar in effect to a tax credit for the consumer, this scheme is better. Not all consumers pay federal taxes (e.g., non-profit organizations, local governments). Also, the administration is easier.

h) It is made a matter of federal policy that electric utility companies are prevented from implementing tariffs and policies which have the effect of discouraging the use of wind energy by consumers already connected to the electric grid. This requires recognition of the social desirability of wind capacity, overriding the usual economic basis for utility rate setting. Similarly, a utility has little to gain by accepting synchronous inverter interconnection with small windgenerators, but there is a societal benefit in multiplying the number of small windgenerators.

The quantity of energy to be supplied by wind is not very large on the scale of total United States energy consumption. In 1976, U.S. energy consumption was about 75 Quads. About one-fourth of this was used to make electricity, which means that the amount of energy used as electricity was only about 8 percent of the total, or 6 Quads. Both the total energy use and the electricity use are projected (by others) to increase considerably by the year 2000. Thus, wind energy is not likely to supply a major fraction of either the energy or the electricity used in the United States in the year 2000.

However, this does not mean that implementation of wind energy should not be pursued. Though not a major fraction of total use, the amounts of energy and electricity supplied are large in absolute amount. If, as many believe, considerable shortages of energy and electricity supply develop in the 1980s and 1990s, installed wind capacity will be important.

The fact that even a minor percentage contributor to U.S. energy can have great value can be seen by considering the importance of hydroelectric power today, when there is not even any great shortage of energy sources. Hydro supplies only about 1 percent of U.S. energy or several percent of the energy restated on a 10,000 Btu/KWH basis. No one questions its value.

TASK 2. METHODOLOGY UTILIZED TO ARRIVE AT PROJECTIONS

The steps carried out were:

1. Review the available literature touching on this problem.
2. Review the previous recent projections of possible wind energy use in the United States in the next 10-50 years. Compare, analyze for plausibility and technological feasibility, apply corrections for relevant information not known to the authors or ignored by them.
3. Develop a set of internally consistent numbers in the format and for the years required for the report, using the results of Step 2.
4. Estimate future trends in costs of windgenerators and in conventional power plants. Form an opinion about the future of fuel prices. Compare with the assumptions which are built into the results of Step 3.
5. Consider how much wind energy is likely to be available as a function of cost. Better sites are associated with lower cost energy.
6. Evaluate present and estimate future effectiveness of the government wind energy program in stimulating wind energy development in the United States.
7. Combine Steps 3-6 to arrive at the projections.

Essential elements of the above process were:

1. Cost of windgenerators today.
2. Cost of windgenerators under quantity production conditions.
3. Cost of energy from windgenerators. Comparison with price of oil.
4. Extent to which windgenerators can displace capacity in electric power networks and in dispersed uses, and extent to which they can be effective as fuel savers in networks with fossil fuel generating stations.
5. Estimates of the amount of wind energy available in the United States subject to practical considerations like transmission costs, transmission loss, at locations where wind machines would be erected effectively.
6. Physical constraints on the utilization of this wind energy. For example, environmental constraints, limits on the total amount of extractable energy in a region (independent of the number of machines erected), energy unextractable because of unfavorable windspeed-time characteristics.
7. Cost of conventional electric power plants in the United States.
8. Present and planned ERDA wind energy program.
9. Cost of oil, coal, uranium, natural gas between now and the year 2000.
10. Estimate of availability constraints for oil, coal, uranium, and natural gas between now and the year 2000.
11. Estimate of the probability of low cost electric energy from solar by any of the various possible direct technologies.

Discussion of the steps carried out and of the essential elements:

Step 1.

The literature is quite extensive and growing rapidly. No purpose would be served by listing it all here. A very selected bibliography is given at the end of Task 4. Items listed are mainly those referred to in the discussions following. Also provided is a list of available wind energy bibliographies.

Step 2.

Recent projections of possible wind energy use in the United States have been made by Lockheed-California Corporation (Ugo Coty, Principal Investigator) and by General Electric Company, Space Division (John Garate, Program Manager). These two large (approximately one-half million dollars each) ERDA-contracted Mission Analysis studies are the only large, funded, recent studies of wind power potential in the U.S. which are nation-wide in scale.

Considering the lack of certainty about nearly all the key elements, they reached conclusions which are remarkably similar. Both studies found a large potential for wind energy in the U.S. over the next twenty years, even without fuel price escalation.

Other authors (Hewson, Reed, Donovan) made estimates on wind contour maps and general assumptions about machine spacing without attention to costs. LeBoff argues that wind power for electricity generation on a large scale is not feasible because of non-favorable costs. The Dubin-Mindell-Bloome study (for Long Island only, not for the whole U.S.) claimed that wind energy could supply a major part of the energy needs of the region and at lower costs than other alternatives. Professor William Heronemus of the University of Massachusetts was associated with the wind energy portion of this study.

Steps 3, 4, 5, and 6 were carried out by use of conceptual judgment, without computer modeling. For a discussion of the ideas on which the judgment was based, see the discussion below, under Essential Elements.

Essential Elements 1: Cost of Windgenerators Today

This is not as trivial a question as it seems. It is not even obvious in what units the cost should be quoted. Conventional power stations are usually described as costing a certain number of dollars per kilowatt. This number is obtained by taking the total cost and dividing by the rated output --the nameplate capacity of the generators. For a wind machine, the same procedure gives a considerably less meaningful number. When we speak of a 1 MW wind turbine, what is meant is that the electrical generator is rated 1 MW. To drive that turbine with mechanical energy extracted from the wind by the blades of the windmill requires very long blades if the average windspeed is low and shorter blades if the average windspeed is high.

The blades of the John Brown unit were 50 feet in diameter and those of the NASA-ERDA machine were 125 feet, though both were driving 100 KW generators. The difference is in the rated windspeed. The machine delivers the full rated power when the wind is blowing at rated speed or above. If the wind machine is properly sized to the winds at the site, this is considerably less than half the time. If the wind is blowing at less than the rated windspeed, some fraction of the rated output is obtained. Thus, most of the time a 1 MW wind turbine is delivering considerably less than 1 MW of power.

A low \$/KW figure can be obtained by simply putting a large generator behind a small propeller and rating the combination at some high windspeed. The high rated speed means that the full rated output will be hardly ever delivered at a typical site. Only in a few very windy locations will the combination represent a sound engineering design.

Another way to quote the cost is in $\$/m^2$ of swept area, corresponding to the $\$/ft^2$ so commonly seen in discussion of solar collectors. This approach would seem to have merit, but it's hardly ever done.

If the aerogenerator is considered to be an energy source rather than a power source, then the correct number to talk about is the cost per unit of useful energy delivered -- ¢/KWH or \$/MJ. The trouble with this is that the number for the cost of energy is strongly site dependent -- the same machine will give different cost of energy at different sites. Confusion results when talking about reduction of machine costs by mass production economies.

We will try to use all three measures, understanding that when \$/KW is used it is presumed that the machine is properly matched to the site. A machine properly matched to a site operates with a plant capacity factor (PCF) of about 0.35. The number of KWH delivered in a year is equal to the product of rated output, the number of hours per year (=8766), and the PCF.

Another reason the "cost today" problem is not trivial is that almost all the large units built so far have been one-of-a-kind prototypes. The costs are not well-defined in this situation. The design and development costs in particular, being charged to just one unit, are unrealistically large.

General Electric prepared a detailed quote for NASA for the construction and installation of two 1.5 MW aerogenerators, two-blade propeller type, 190 feet in diameter, rated windspeed 22 mph. In 1975 dollars, the quote was \$1586/KW for the second unit. These were prototypes with no follow-on order expected; consequently, they carry a high learning cost, development cost, and overhead burden. GE projects that the price would be somewhere in the range of \$250-\$500/KW if 1000 units were built.

Lockheed numbers were not based on firm quotes, were somewhat lower, and were for considerably larger rotors. Putnam, in 1945, made a very careful study, based on bids from suppliers for supplying components in 100 unit quantities, of the cost of building wind generation capacity based on the

Smith-Putnam design (two-blade propeller, 175 feet in diameter). His numbers were updated by Hewson in 1973, with no allowance for economies resulting from better engineering materials and design improvements and with probably some loss of accuracy in the updating. Hewson's figure for the cost of 1.25 MW Smith-Putnam wind turbines in 1973 was $700/KW.

A similar exercise, updating the known costs of the 200 KW Gedser aerogenerator (Gedser, Denmark), carried out by a committee of the Danish Academy of Technical Sciences, recently gave a figure of $\$280/m^2$ of swept area, which was converted by M. Ryle, under certain assumptions, to a value of $700/KW.

The CANVA turbine, a 37 m high Darrieus rotor installed (summer 1977) on the Hydro Quebec system at a very good site (Magdalen Islands) was quoted by the manufacturer as costing about $1000/KW (not installed) in 1976 Canadian dollars for the first machine. A second machine would be under $900/KW. Costs per KW depend upon the site, since a small rotor can drive a big generator on a very windy site, whereas a big rotor will be required on a less windy site.

Small windgenerators now commercially available cost well over $1000/KW. The corresponding energy cost is 20-25¢/KWH. If a large windgenerator market developed for dispersed applications, mass production and especially mass distribution would drop these costs.

Essential Element 2: Cost of Wind Generators Under Production Conditions

The aircraft industry is accustomed to estimating production costs of expensive individual items produced in quantities which vary from one to several thousand. One of the accepted fictions, which is known as "learning curve", states that for each doubling of production quantity, the cost per unit drops by a constant factor called the learning curve coefficient or "per cent learning". Thus, if the first unit costs $1000, the second will cost $900, the fourth $810, the eighth $729, and so on for learning curve coefficient 0.9 or "90% learning". Quoted values of the learning curve coefficient vary downwards from 0.9.

The concept clearly has its limitations, since the cost saving at increased production volume must depend on many factors: labor/material ratio, production rate, fraction subcontracted, et cetera. The GE Mission Analysis study tabulated all costs for two learning curve coefficients, 0.90 and 0.85. It makes quite a difference in long production runs what value of this coefficient is chosen. For example, if the cost of the first unit is \$1586/KW, the cost of the thousandth unit is \$480/KW with a learning curve coefficient of 0.90 and \$250/KW with a learning curve coefficient of 0.85.

The Lockheed group used a more complex, and presumably more realistic, learning curve. They assumed no learning at all for the first ten units, then 0.85 for units eleven through one hundred and 0.87 for units between 101 and 1000. The 0.85 is claimed to be consistent with experience in manufacture of similar products. Some one-time costs were assumed to be present also, to be amortized over however many units are produced.

To obtain benefits of the learning curve, it is necessary that the design be fixed as to length of rotor, shape of airfoil, size of generator and gearbox, et cetera. When this is done, the benefits of matching the windgenerator exactly to the site are necessarily compromised to some degree. However, there seems little doubt that the most cost-effective strategy is to give up the benefits of exactly matching the generator to the site in the interest of improved production economy.

The Lockheed group did a detailed costing exercise for a 2 MW design, 260 feet (79.2 m) in diameter rotor on a tower of height 180 feet (54.9 m). The propeller was two-blade, all metal, designed to turn at constant rpm (13.9 rpm). The design was optimized for a site having mean windspeed of 15.7 mph (7 m/s). At that windspeed, the tip speed ratio is 8.2. Account must be taken of the fact that windspeed varies with height above ground: the 15.7 mph is at 10 meters height.

They assumed non-recurring costs of \$4.5 million and supposed 100 units were built. Then the unit price, including profit, was \$1.7 million. If 1000 units were built, the unit price dropped to about \$1.1 million. These numbers correspond to \$860 and \$550/KW. The GE design (190 feet in diameter, 1.5 MW) was for a slightly higher mean windspeed. Another GE design for comparable mean windspeed, resulting in a 219 feet in diameter rotor, 1.5 MW, and with the GE costing formula, was estimated at \$820 and \$50/KW for 100 and 1000 units respectively, if the 0.90 learning curve coefficient was assumed. At 0.85 learning, the numbers were \$500 and \$300.

In another study, Boeing-Vertol Company, at the request of a group studying wind energy prospects in the Texas Panhandle, estimated a cost of \$531/KW leading to an electric energy cost of 2¢/KWH for a machine rated 1 MW at 22 mph. It was assumed that a total of 1000 units would be produced. The cost estimates were in 1975 dollars.

Probably the Lockheed estimates are the most careful, but there is in any case considerable agreement among the three estimates.

It is essentially impossible for anyone outside a manufacturing company to do the kind of detailed costing that leads to the Lockheed and GE estimates. Anyone can make a guess at the learning curve, but the cost starting point -- the cost of the first few units -- and the one-time costs of setting up production cannot be accurately determined without access to all the details that are known only to those in the industry.

Essential Element 3: Cost of Energy From Windgenerators, Comparison With the Cost of Oil

The cost of energy from an aerogenerator depends on a variety of factors ranging from the strength of the wind to the local interest rate. Some of these factors are different for privately-owned utilities and publicly-owned utilities and for utilities and non-utility users, such as industries and residences. Taxes and interest rates fall especially into this category. Thus, the cost of wind energy depends on who is using it.

However, the cost of fuel oil is generally about the same for all large users. Geographical location and quantity of purchase have a small effect on the cost, but the institutional nature of the buyer does not -- at least not much. (This could change if there are changes in the way fuel oil is taxed.) The consequence is that replacing fuel oil with wind energy may be advantageous for some users and, at the same time, not be advantageous for others, even if both have equally windy locations.

To illustrate the above, consider this adaptation from reference 11. For two different interest rates and considering various kinds of taxes, the annual charge on capital (based on thirty-year depreciation life) necessary to amortize a wind power plant is compared for three different types of user -- private utility, public utility, and federal agency.

For the higher interest rate (10 per cent private, 6 per cent public, 6 per cent federal agency), the annual charge rates are .185, .108, and .096 respectively. The meaning of the annual charge rate is that the annual cost of generating energy is 18.5 per cent of the initial installed cost of windgenerator in the private utility case. To obtain the cost of energy, it is only necessary to calculate the number of KWH which the wind machine delivers in a year and divide.

To calculate the amount of energy delivered in a year is not easy. "Estimate" would be a better word than "calculate". The result depends both on the wind characteristics at the site -- which are never known exactly -- and on the design of the wind machine. Some allowance must be made for maintenance time. A very important assumption is that all the electric power the wind machine can deliver can be used. This is the conventional assumption, but if it is not true, then a further reduction in useful output must be factored in.

For the Lockheed 2 MW, 260 feet in diameter unit, the output, estimated as carefully as possible, is 8.1, 9.6, 10.8 million KWH/year at mean windspeeds of 6, 7, and 8 meters/second respectively (1 m/s = 2.25 mph). The mean windspeeds are for 10 meters height; the variation of windspeed with height has been taken into account (since the windgenerator uses the wind at heights much greater than 10 meters) by assuming a relationship between the windspeed at height H and at 10 meters: $\frac{V_H}{V_{10}} = \left(\frac{H}{10}\right)^a$ with a = 0.23. Other authors have used smaller values of a. This value is the one recommended by Justus.

Looking at these data, it is apparent that: (1) the tax and interest rate differences associated with the different kinds of users have more effect on the cost of wind energy than anything else; (2) the number of units produced is next most important; (3) the mean windspeed is third most important. Though it does not show up in the data explicitly, the engineering design of the windmill is probably fourth in order of importance in the factors influencing wind energy costs.

There are various public strategies possible which could shift the private utility 0.185 charge rate (10 percent interest) to 0.145 or even less. These include government-guaranteed loans, issuance of tax exempt bonds, direct subsidy for the energy generated in recognition of its pollution-free nature, et cetera.

The cost of fuel oil used to generate electricity can be easily stated on a ¢/KWH basis. Suppose the price of diesel fuel oil is $15/bbl. There are 132,000 thermal Btu in one gallon of oil and 42 gallons in a barrel. About 10,000 thermal Btu are required to generate one kilowatt-hour of electricity, on the basis that all the Btu chemically present in the fuel are counted as thermal Btu. Combining these numbers gives 2.7¢/KWH. For diesel engine sets and gas turbines, which are less efficient, a better number is 3¢/KWH.

Windgenerators are economically feasible now as fuel savers for public utilities and federal agencies at 100 unit production runs and for private utilities at 1000 unit production runs, provided suitable sites with mean windspeed of at least 6 m/s (13.2 mph) are available.

Essential Element 4: Extent of Capacity Displacement/Fuel Savings

The cost of electricity produced by fossil fuel/nuclear power stations is partly attributable to the cost of fuel and partly represents an amortization charge on capital. The proportion varies, being mostly fuel for an oil-fired peaking plant and mostly capital for a large nuclear plant. Typically, the two components are comparable in magnitude.

If it were possible for a collection of windgenerators totaling 1000 MW rated capacity to eliminate the need for building a new 1000 MW conventional station in the system, the worth of the windpower would be substantially more than it would be if the conventional station still were needed and the wind-generated electricity only went toward saving fuel.

Eliminating the need for the conventional station is known as "capacity displacement". If it could be shown that a substantial amount of capacity displacement is practical with windgenerators, the enthusiasm of the electric utility companies for this unconventional source would increase noticeably.

The straightforward way to improve the supply reliability of a wind generating station -- i.e., to increase the probability that 1000 MW of wind generation capacity can deliver 1000 MW of power when called upon to do so -- is to provide storage. How much storage is required?

Some results obtained by Sørensen are of interest in this regard. Sørensen used the known generating characteristic of the 200 KW Gedser machine and known hourly windspeed data from the 56 meter meteorological mast at Risø, Denmark. By combining these, he was able to determine what fraction of the time a wind machine at Risø would be able to deliver at least its average power. With no storage, this fraction is approximately 0.42. With storage, the situation improves.

When output exceeds the average, the excess is assumed to go into the storage to be withdrawn when needed in order to keep the combined wind generation and storage output at the average power. Using hourly data for an entire year, it was found that ten hours of storage would improve the fraction of time the plant can deliver at least its average power to 0.62; twenty-four hours of storage raises it to 0.73.

The PCF (plant capacity factor) of a nuclear or fossil fuel base load plant which is controlled by scheduled and unscheduled maintenance downtime is not a great deal more. In fact, the industry-wide average for nuclear plants is in the range of 0.5 to 0.6. Since sometimes the nuclear plant operates at reduced capacity, this corresponds to a fraction of time that the plant delivers average power of 0.6 to 0.7. The PCF of a windgenerator is controlled by the wind statistics, so the non-generating time cannot be scheduled, though to some extent it may be predicted.

On the other hand, 1000 MW of wind capacity will never be shut down without warning for unscheduled maintenance, since the wind capacity consists of many hundreds of individual units which can hardly all fail at once. Weight may also be given to the fact that the 'fuel' for the windgenerators cannot be interrupted by embargo or strikes. It is apparent that the wind system has elements of reliability that no fossil- or uranium-fueled system can have.

In any case, the reliability of a wind system can certainly be improved to be comparable to that of any other power plant if storage is used. The amount of storage is not excessive. From ten to one hundred hours is enough, depending on requirements and local wind characteristics.

The technology and cost of the storage is, at this point, not clear, and the best trade-off between storage cost and increased worth of the wind energy resulting from better PCF is also not clear. The cost of pumped hydraulic storage -- the only on-line large-scale technology -- is at present $150 to $300/KW. The cost of short-term electrochemical (battery) storage on a power system scale has been estimated by the Lockheed group at $15/KWH plus $48/KW rating for batteries which last ten years. This amounts to $200/KW for a system to store 1000 MW for ten hours. Battery storage for dispersed mode (small scale) applications is currently in use: it costs \$50 to \$70/KWH.

If the hundreds of wind generating stations making up the 1000 MW of wind generating capacity are sufficiently dispersed geographically, somewhat less storage than would otherwise be necessary will suffice to achieve a given PCF. The magnitude of this effect and the extent of geographic dispersion necessary are not well known at present.

The worth of windpower in a utility system with a mix of generating sources has been discussed by Putnam. The situation is very complicated and depends a great deal on the nature of the other generating sources in the system.

Sometimes storage will be necessary even to obtain the fuel-saving value of wind-generated energy. For example, the wind energy may be available at a time of low demand (middle of the night) when the only other plants operating in the power system are large, high capital cost, low fuel cost, nuclear, or fossil fuel stations. It may be impossible to economically turn these large plants off and on to accommodate changing wind.

A few systems run diesel generators and/or gas turbines a large fraction of the time, though these are normally intended to be used for peaking power. Some systems have hydro capacity, which amounts to easily controlled zero cost storage. The water is simply held behind the dam when the windpower is available -- a concept we call "displacement storage". Sometimes (as in run-of-river plants), displacement storage is limited because of limited reservoir size or need for the water downstream.

In general, however, systems with hydro or systems which run diesel or gas turbine generators most of the time will be able to make full use of wind energy without building separate storage facilities. The utility systems with large base load stations requiring perhaps thirty minutes to turn on or turn off, supplemented by infrequently operating peaking sources (one or two hours per day, for example) and not having access to hydro will have difficulty making economic use of windpower unless storage is provided. Interties with other systems, in some cases, can relieve the need for storage.

Utility systems having good wind sites, where output from windgenerators can be expected to be available most of the time it is needed, can save money by replacing base load capacity with wind capacity in parallel with dedicated oil-fired peaking capacity (e.g., gas turbines). This is because base load capacity costs four to five times as much as peaking capacity. Of course the economies disappear if the peaking capacity, which consumes lots of expensive fuel, has to run too often.

An ideal use of wind energy is to serve an interruptible load -- one which does not require a constant flow of power. Examples are: pumping water (crop irrigation, animal or human domestic supply, pumping from hydro powerhouse afterbays into upper reservoirs, et cetera), heating water (with immersed resistor or with mechanical friction), making ice by vapor compression refrigeration, cooling a large building or refrigerated warehouse, making hydrogen or anhydrous ammonia, and many others. Some of these interruptible loads are well suited to large-scale wind systems; some are suited to dispersed applications.

The creation of a new class of 'truly interruptible' utility service with supply reliability 50 percent or less and very low rates would be a creative way to stimulate this type of load.

The preceding are some of the considerations bearing on the question of the extent to which windgenerators can displace capacity in the electric power networks and in dispersed uses, and the extent to which they can be effective as fuel savers in networks with fossil fuel generating stations.

Unfortunately, appreciation of the various considerations does not lead to an answer for the question. To answer the question requires that the amount of storage provided be specified in each application and also requires that the other generating capacity in each system for which wind generation capacity is proposed be fully characterized, even down to such details as part load efficiencies, start-up and shut-down time profiles and the like for each generator, boiler, or nuclear reactor. Also, the wind profile at the wind sites to be used must be characterized. Use of national averages for some of this information will give wrong answers for national fuel saving or capacity displacement by wind.

I have prepared the estimates of Task I by supposing that capacity displacement by wind will be negligible to the year 2000, but that all the wind-generated energy available may be used to save fuel.

Essential Element 5: Amount of Wind Energy Available

There is an unfortunate tendency to think of wind as an energy source comparable to, say, natural gas, and then to try to specify the amount available in the same way one might try to specify the amount of natural gas reserves.

Wind is an energy source, and it is appropriate to discuss the magnitude of the resource, but the comparison to reserves of a fossil fuel is inappropriate. The fossil fuels are highly concentrated energy -- sufficiently concentrated so that when found, they are quite likely to be worth extracting. The problem is finding the resource. Economically extracting it and converting it to electricity or heat is usually not the problem.

With wind energy, the problem of extracting, converting, and transporting the energy in an economical manner becomes dominant. Though there is indeed a problem in locating the regions of very high wind energy density, wind energy, in fact, is widely distributed. The problem becomes more one of economics than of prospecting.

The total amount of wind energy circulating over the world, or over the United States, is very large and not very relevant. We are certainly not likely to be able ever to economically tap more than the lowest 200 meters or so, and then only in selected locations.

Considering now the electric utility applications, energy in the wind will never show up as useful energy in the powerline unless the installation and operating of wind turbines can be demonstrated to be an economically rational activity for the electric utility companies or federal agencies or other users who will have to invest the capital and make use of the power.

The cost of wind-produced electricity depends on many things, as earlier noted. Windspeed is one of them. Studies presently indicate that the Texas High Plains are windy enough to make installation of wind turbines a paying proposition now for a private utility in Texas, and that Minnesota is not. Thus, the wind over Minnesota is presently not a usable resource, whereas the wind over Texas is. In the future, the situation could change. The size of the wind energy resource depends on the price of oil.

Power in the wind increases with the cube of windspeed, so it is important to locate sites having high average windspeed. If a large number of such sites exist in regions which are not hopelessly isolated, then it is possible to estimate a large total amount of potentially available wind energy. There are two major difficulties in attempting to form such an estimate with any accuracy.

The first is that stations which have been set up to measure windspeed have been established for some reason other than wind energy study. Thus, they are not located in high wind places. The usual locations are airports and city centers: both airplanes and humans prefer to congregate in places which are not excessively windy. If the several dozen wind-monitoring stations in Nevada, for example, show an overall average annual windspeed of 12 mph, it does not mean that a reasonable average windspeed for all the land area where windmills might be sited in the state is 12 mph. In fact, there are probably many sites -- perhaps more than half the land area of the state -- with annual average windspeeds of 15 mph or even more.

The second of the major difficulties is that what wind data there are usually are taken at 10 meters (33 feet) height above the ground. Large wind machines would use the wind in a strip from a little above ground level to perhaps 90 meters height, depending on the rotor diameter. Windspeed increases with height above ground; the question is how much. As already mentioned, the height dependence is usually expressed as a power law: $\frac{V_H}{V_{10}} = \left(\frac{H}{10}\right)^a$, where V_H is the unknown windspeed at height H; V_{10} is the windspeed at 10 meters; and a is an empirically determined coefficient.

The most commonly cited value of a is 0.14. This is based on data from anemometers at different heights on a few television towers. Justus, after extensive analysis, concluded 0.23 was the best choice for a. If H is 50 meters, the two choices give 1.45 and 1.25 for the velocity ratio. Cubing the ratio, the available windpower estimated if the 0.23 number is used is 1.56 times that estimated if the 0.14 number is used, so it makes a difference.

There is good evidence that a varies from place to place and even at different times during the day in any one place, and the variations are not small. Thus, wind data extrapolated from 10 meters height upwards to wind machine height lose most of their reliability.

Because of the preceding two difficulties, windpower estimates based on contour maps with contours of constant windspeed (isovents) are not very accurate. However, they do suffice to show that there is probably plenty of wind energy available and that considerations other than the quantity of windpower in the air will limit wind energy utilization.

The Lockheed group used a somewhat more detailed method to estimate the land area having high mean windspeeds. They found the mean annual windspeed for all stations having ten years or more of good data -- over 700 in the United States. Then they determined the percentage of these having mean windspeeds of more than 7 m/s (15.7 mph). (This was chosen because it was thought to be the lowest windspeed economically utilizable today.) The result was a small percentage -- about 2 percent.

It was then hypothesized that the same percentage of the total land area had mean windspeeds over 7 m/s. From the total land area, they subtracted the highways, military bases, national parks, urban areas, et cetera, and supposed that 2 percent of the remainder would be the usable wind locations having mean windspeed, at 10 meters height, of over 7 m/s. Then an assumption was made about the increase with height and about the allowable machine spacing, and the machine characteristics were factored in.

The result was that 10^{12} KWH annually could be obtained from the land area of the United States. 10^{12} KWH is a lot: U.S. consumption of electricity in 1977 will be about 2 times 10^{12} KWH. Incidentally, only a tiny part of the land area is used by the machines themselves; most is required to avoid wake interference. Because of the conservative way the uncertainties were handled and the fact that offshore areas were not included, it could be argued that the correct number should be two or three times 10^{12} KWH/year.

The conclusion from all analyses is that the amount of wind energy potentially available for generating electricity in the United States is very substantial on the scale of present electricity use. Since less than 10 percent of U.S. energy use is in electrical form, this does not necessarily mean that the amount of wind energy is large on the scale of total U.S. energy consumption -- especially if this consumption figure is projected twenty-five years into the future, increasing a few percent each year compounded.

The accuracy with which the amount of potential wind energy available is known is not good at all. A careful program of wind measurement might show that the actual amount is three times -- or perhaps only one-third -- what we now think it is. "What we now think" depends on whom you ask. I would say 10^{12} KWH/year from an installed capacity of about 300,000 MW.

All the preceding has been for the case where the wind energy is used to make electricity to go into regular transmission lines operated by public utility companies. There is a potential for dispersed applications, small machines near the point of use providing energy for electricity, hot water, or space heat, or for agricultural and industrial purposes. Dispersed use would show up in the national energy accounts as a reduction in demand.

Since the value of electricity at the point of use is greater than it is when put into the power company's transmission system (commercial tariff in the Northern California area in late 1977 was 4.7¢/KWH versus a cost to the power company at the source of about half that), lower windspeeds can economically be used. Moreover, the independence or partial independence from the main power grid could become important as future supply becomes insufficient and load-shedding becomes common.

Use of wind energy as heat eliminates the storage-intermittency problem, as does interfacing at-home wind-electric systems with commercial power. Dispersed applications are not economically viable now because the small machines are too expensive.

Studies of the potential wind energy available for dispersed applications have not been made. To make a rough estimate, let us suppose that there are ten million dwelling units which could make use of wind machines rated at 30 KW. Using an average PCF of 0.35 for the machines gives 300,000 MW installed and about 10^{12} KWH/year, the same as the centralized applications. Whether the amount of dispersed capacity which will be installed will turn out to be comparable to the centralized wind electricity capacity is another matter.

In any case, the amount of energy in the winds of the United States seems large enough so that it is not likely to limit wind energy utilization in this country for some time.

Essential Element 6: Physical Constraints on the Utilization of Wind Energy

Consider a flat plain with a high average windspeed. Suppose the windspeed is everywhere the same over this hypothetical flat plain, though it may vary with time. How much wind energy may be extracted?

This turns out to be not such a simple question. There are two physical limitations on how closely wind machines may be spaced. One is wake interference. Downwind of a large operating wind machine is a wake, where the wind is altered in form (made more turbulent) and reduced in magnitude (energy has been removed from it). If a second machine is located in the wake interference region, it will not deliver as much energy as it would if the first machine were absent.

The other physical limitation is overall depletion of the wind energy in the lowest 100 meters or so of the atmosphere, which is the layer the wind machines extract energy from. If the whole plain is covered with large wind machines, those in the central portion of the array and on the downwind edge will not be able to deliver as much energy as those on the upwind edge unless the machines are spaced far enough apart to correspond to the rate at which energy is coupled into the lowest layer of the atmosphere from the winds above.

The first of these problems, wake interference, has been investigated with model wind turbines in a wind tunnel and also by field measurements behind the NASA-ERDA 100 KW Sandusky, Ohio machine. More work remains to be done, but the problem is reasonably well under control. It appears that a spacing of 5 rotor diameters is adequate to avoid excessive wake interference, provided only that the wind turbines are not laid out in straight rows.

The second problem is not completely understood. At present, the only approach is through calculation. The calculations become quite involved and depend on models of the terrain and the atmosphere which may or may not correspond to the actual situation.

Railly has estimated that the allowable density of wind machines on a large flat plain in order that the undisturbed windspeed be available to all the machines is in the neighborhood of 1500 m^2 of wind turbine area per km^2 of land. For machines with 200 feet (61 m) in diameter rotors, that density is only 0.5 machine per km^2 -- a separation of thirty-five rotor diameters. This is much greater than the wake interference limit, and, if true, says that available wind energy is likely to be limited by the ability of the winds at greater heights to couple energy into the layer of moving air next to the ground.

Environmental constraints seem unlikely to limit the use of wind energy. Large wind turbines do not make much noise. According to earwitness reports, the operating noise of the 100 KW Sandusky unit cannot be heard over the general wind noise. Bird kills, insect kills, or other direct interference with fauna of the region are expected to be negligible. In fact, there is every expectation that land beneath and close by operating aerogenerators will be usable for agriculture.

Some interference with human activity or aesthetics may occur (for example, interference with television reception up to a distance of about a mile), but these seem likely to be minor. Visual impact is cited sometimes as a possible negative factor, but it seems unlikely, judging from past experience with tall buildings, TV towers, and transmission lines, that this will seriously constrain wind machine deployment.

It is possible to imagine a situation where a site which would appear very promising on the basis of high average windspeed is in fact not promising because of an unfortunate windspeed-time characteristic. For example, if the diurnal pattern were such that the wind usually blew at high speed in the middle of the night when demand was low and the energy had low value, and at very low speed other times, then economic viability of the site for wind energy would be less than one would at first have thought.

Another bad situation would be if the ten-year expected maximum wind was so high that survivial of the wind machine was doubtful. Other bad situations are imaginable. It seems doubtful to me that any unfavorable windspeed-time situations are likely to occur with sufficient frequency to cause a downward revision in the estimates of windpower availability.

Essential Element 7: Cost of Conventional Power Plants

The cost of coal base load capacity today is about $500/KW, oil slightly less -- perhaps $450 -- and nuclear somewhat more, perhaps $850. Hydro and geothermal are highly site dependent and are usually not possible anyhow. Oil-fired peaking capacity costs only $150-$300/KW. The tendency is to compare the (uncertainly known) cost of wind power plants with these numbers.

However, a straightforward comparison is simplistic. Variations in supply reliability, fuel requirements, future fuel supply uncertainties, environmental impact, construction lead time, political opposition, and many other factors make the inter-comparison a vastly more complicated process than simply comparing the apparent first cost. Even on a first cost basis the comparison is misleading, because a wind station started now will be working in two or three years, whereas a nuclear station started now will be working in eight or ten years. A comparison of today's prices is not appropriate in a world of changing costs.

There is an even more fundamental difficulty. Comparing alternatives in terms of money costs makes sense if a number of alternatives are available and only one is to be purchased. We seem to be moving toward an energy supply situation where this is not the case. It may well be that a perceived shortage of supply sources will motivate the procurement of at least some wind energy conversion equipment because it does not depend on a fuel which could become unavailable and because it can be procured with certainty.

Essential Element 8: ERDA Wind Energy Program

The extent to which wind energy is used in the United States between now and the year 2000 depends a great deal on the vigor and effectiveness of the federal wind energy program. It is difficult to imagine a private firm taking the full risks associated with a completely new product of this magnitude.

Unfortunately, the federal government has never brought a new technology into being with federal R&D money and subsidy when cost effectiveness was important. The principal contractors in the ERDA large wind turbine program have a long and successful history of accomplishment which does not include effective cost control.

If a number of "demonstration" windgenerators are installed and only serve to demonstrate economic infeasibility, wind energy utilization will be delayed. If the wind program concentrates exclusively on R&D of new types of machines, the prospect of large cost reduction through production of established types will disappear.

It appears to me that the ERDA Wind Energy Branch is proceeding in a coherent and effective manner at present. The guiding philosophy is concerned with reduction of risk by reducing uncertainties -- uncertainties in machine performance, in machine cost, in knowledge of the wind resource, in systems application.

At present, ERDA itself is the customer for all the large wind machines produced. When the time comes to move from engineering experimentation to commercialization, it will become necessary for ERDA to take some action to reduce financial and business risk to the first manufacturers and operators. This action will have to be production-oriented, not R&D-oriented, which is an unfamiliar stance for government.

In making the estimates of Task 1, I have supposed that the federal wind energy program will continue to be effective. As noted, the "accelerated case" involves substantial incentives and/or major eventualities.

Essential Element 9: Cost of Fossil Fuels and Uranium to the Year 2000

This is a subject which has been reviewed by many economists, energy specialists, and general prognosticators at great length. Past predictions have not proved notably accurate. Major determinants of fuel prices are not subject to numerical analysis or quantitative extrapolation, being political or monopolistic in nature. Fuel prices are not determined by cost of production in a fuel-short world.

Some predict that fuel prices will rise no more rapidly than general inflation, or at most, 5 percent or so more rapidly than general inflation. In fact, this sort of future view is often regarded as the only responsible one by corporate or governmental planners. On this basis, there is certainly a place for wind energy, but not as large a place as if a more rapid escalation of fuel prices is assumed.

My judgment is that fuel prices will rise in an erratic and irregular pattern between now and the year 2000, and that the overall rate of rise will be substantially greater than 5 percent above general inflation when averaged over the whole time interval. The rate of increase of energy costs will contribute substantially to inflation and will lead the way. Labor costs in the United States will decline relative to energy costs, which means that the competitive position of wind and solar technologies will improve.

The basis for my belief in future substantial fuel price rises is geologic and political. I believe that oil and gas supplies world-wide will be noticeably depleted by the year 2000, though far from exhausted, and that the countries with small populations and large fuel reserves (e.g., Saudi Arabia) will have the strength and control to limit production when it is in their own interest to do so.

I am less certain about the future of uranium prices than I am about oil prices, but I believe the same considerations apply. In any case, uranium will remain a less important fuel than oil. Development or non-development of the breeder reactor is unimportant in this context.

Essential Element 10: Availability Constraints on Fuels to the Year 2000

Governments in the fuel-consuming countries, such as the United States, are likely to intervene in the market to limit price rises initiated abroad, especially during periods of rapid price increase. Failure to let the market do the rationing will certainly result in availability constraints. Such availability constraints, which could be considerably more severe than the natural gas shortage in the Eastern United States in the winter of 1976-'77, will have a stimulative effect upon the introduction and use of the inexhaustible sources, including wind.

Essential Element 11: Probability of Low Cost Solar Energy

This is an important consideration in assessing the market penetration of wind energy. The solar resource is widely distributed, and the availability does not vary as much from site to site as for wind. Arizona has typically 250 watts/m^2 (year-long average, including night hours), and New York has typically 150, leading to the conclusion that a solar technology which is economically successful in Arizona is already at least marginal in New York.

Low cost electric energy from solar-photothermal or solar-photovoltaic or solar-OTEC or solar-biomass or any other solar technology would raise a serious issue as to whether wind energy was worth pursuing with a major effort. Not only centralized wind energy exploitation would be affected, but also decentralized applications, at least those where it is planned to use the output of the wind machine as heat. However, it is unlikely that the wind program would be as seriously set back by progress in the heating and cooling of buildings program as it would be by major cost reductions in the cost of solar-generated electricity.

In my mind there is little doubt that wind-generated electricity will be substantially less expensive than solar-generated electricity for many years to come. Official ERDA predictions have recently been heard to the effect that the cost of photo-voltaics will drop to $1/watt within two years.

Even if this should be true (and I do not believe it), the number is \$1/peak watt, corresponding to \$5000/average KW: not competitive with wind machines. Solar power tower is likely to prove an expensive white elephant, and OTEC may not even work in an engineering sense. (Of course the proponents of these schemes do not see it quite this way!) Solar-biomass is the least known, though possibly the most promising solar route to low cost electricity.

I do not expect that low cost solar electricity will limit the application of windpower before the year 2000. If it does, so much the better for all of us.

TASK 3. REVIEW OF OTHER PREDICTIONS AND METHODOLOGIES

First, before discussing methodologies, we summarize some of the projections published by reputable and knowledgeable people in recent years:

1. E. Wendell Hewson, Oregon State University — Bull. Am. Meteorological Society 56 (7), July 1975, pp. 660-675.

   Windpower available to man over the whole earth: 10^{12} watts.

   Windpower is capable of supplying at least 10 percent of the nation's electrical energy requirements by the 1990s, at a cost which will be competitive with conventional power sources.

2. Jack W. Reed, Sandia Laboratories — "Wind Power Climatology", Weatherwise 27 (6) 236-242 (1974).

   Several times the national electricity consumption could be extracted from the winds in the High Plains of the U.S.

3. William Heronemus, University of Massachusetts — cited in SCIENCE 184 1055-58 (1974).

   By the year 2000, windmills could be supplying 1.5×10^{12} KWH/year of electricity to national power grids.

4. NSF/NASA Solar Energy Panel — "An Assessment of Solar Energy as a National Energy Resource", p. 69, (1972). (cited by LeBoff, ref. below).

   A reasonable value of expected power (note: must mean "energy") from the wind by the year 2000 is about 1.5×10^{12} KWH/year; this is about 8 percent of the projected total U.S. energy demand in the year 2000.

5. J. Peter LeBoff, Resources for the Future, Inc. — "Windpower Feasibility", Energy Sources 2 (4) 361-376 (1976).

Windpower is non-competitive with other energy sources at the present time, and so no appreciable contribution by wind energy to national energy supply is to be expected for the forseeable future.

6. Ugo Coty, Lockheed-California Company, Burbank, California — "Wind Energy Mission Analysis" Report LR 27611, Oct. 1976, Executive Summary

If fuel prices rise as much a 7 per cent above annual inflation rates, wind turbines could furnish 1.21 trillion KWH/year (=1.2 x 10^{12} KWH/year), about 19 per cent of U.S. consumption forecast for 1995. If oil, gas, coal do not escalate in price above inflation trends, as much as 4.8 per cent of 1995 national electrical demand can be furnished by wind turbines at a price less than the equivalent fuel cost.

Wind energy that can be extracted over coterminus U.S. exceeds 48 trillion KWH/year or over seven times the high forecast electrical demand for 1995. Over open range land, more than 15 trillion KWH/year can be generated.

7. John A. Garate, General Electric, Space Division — "Wind Energy Mission Analysis" Report C00/2578-1/1, Executive Summary

There is sufficient wind energy available in the United States to provide over a trillion KWH/year of electricity (10^{12} KWH/year), which is equivalent to 13.6 percent of the projected energy demand in the year 2000. This estimate is conservative. It is unlikely that all the available wind energy will be utilized in the year 2000. A more realistic estimate of the energy contribution from wind in that year is 0.5 to 7 percent of the energy demand (=0.04 to 0.5 x 10^{12} KWH/year).

The potential for decentralized electricity uses is about a fourth of that for centralized electricity generation.

Comparing these, we note several things:

a) Two of the estimates, #6 and #7, are based on a great deal more work and analysis than are the others, and consequently should be weighted more if we are to engage in an exercise of seeking truth by consensus.

b) Bearing in mind that the national consumption of electricity in 1977 is about 2 x 10^{12} KWH/year, we note that #1, #2, #3, #4, and #6 are in general agreement about the magnitude of the possible future contribution of wind energy to national electricity requirements. The estimate of source #7 is somewhat lower, and that of source #5 is very much lower -- approaching zero, in fact.

c) None of the sources feel that the amount of wind energy utilized will be limited by the amount of wind. There is plenty of wind.

d) Most of the sources stress the application of wind energy to producing electricity for centralized grids, though some consideration of decentralized uses is given by #7 and #6. In other more recent work, the author of #3 has become a promotor of decentralized use for heating.

Next, discussing the various methodologies:

#2, Jack Reed's remark, need not be considered further, since it is entirely climatological in nature and does not relate to the question of how much of the available energy actually will be used.

#1, #3, and #4, which are all in agreement, cannot be discussed further because no details of the methodology used were given in the papers I looked at. In some cases, there probably was not much methodology.

#5, LeBoff's analysis, is clear and to the point. He concludes that windpower is not a feasible proposition because it's too expensive, so there's no point in worrying about how much is there. Being too expensive now doesn't guarantee it will be so in the future -- if fuel costs escalate sufficiently, anything can work out -- but to postulate a substantial escalation is not a sound basis for planning, Mr. LeBoff apparently feels. We now explain and criticize his argument.

According to LeBoff, the key is to write the busbar cost of electricity as a function of the various elements which contribute to it, as follows:

$$BBC = \frac{(CC)(FCR) + (FC) + (OC) + (MC)}{(PR)(LF)(HPY)}$$

BBC = busbar cost (¢/KWH)
CC = capital cost
FCR = fixed charge rate
FC = fuel cost
OC = operating cost
MC = maintenance cost
PR = plant rating (KW)
LF = load factor
HPY = hours per year (8766)

For wind, FC = 0 and OC and MC are expected to be small. CC is of major importance. Also of major importance is LF, which is equivalent in this analysis to PCF, which we defined earlier.

For CC, LeBoff considered various values mostly in the $500-$1000/KW range, considering especially the $700/KW which was Hewson's update of Putman's analysis. As an FCR he took 0.17. As an LF, he considered a range from 0.30 down to 0.10.

Since the Hewson $700/KW was in 1971 dollars, LeBoff compared the resulting BBCs with actual BBCs from conventional power plants in 1971 -- these are published numbers. Under the most optimistic LF assumption, he found the cost of wind-produced electricity to be five times the BBC of conventionally produced electricity and thus infeasible.

In my opinion, there are serious errors in the LeBoff analysis, though the method is fundamentally sound. The most glaring is that the crucial comparison was made on the basis of 1971 conventional BBCs when the nation's power stations were running on pre-embargo oil and cheap natural gas (a later comparison in his paper used 1974 costs). Another problem was the use of an LF range from 0.10 to 0.30, whereas I would have used 0.25 to 0.45, and Justus has pointed out that the NASA-ERDA Mod-0 machine would run at more than 0.6 in some locations (though the Smith-Putnam machine would not).

Another criticism of LeBoff's analysis lies in his comparison of average BBCs from national utility industry statistical information. It is to be expected that the utilities presently having low BBCs will not be very interested in windpower utilization, and that windpower will be used first by those utilities and companies having high BBCs.

I believe Mr. LeBoff is correct, however, in that there is no reason to seriously consider wind energy if it can be assumed that fossil fuels will indefinitely remain available in any desired amount at a price which, when corrected for inflation, will not increase over today's price. Although LeBoff did not explicitly state that these were his assumptions, it seems to be implicit in his work that in fact they were.

We now move on to consider #6 and #7. To discuss the methodologies of these two large Mission Analysis studies seems rather presumptuous. In both cases the methodology of analysis was a central task, and a great deal of thought was given to it. Each study was something like ten professional man-years in extent. We can, however, make some comments.

The Lockheed study (#6) estimated the number of high wind sites by considering the fraction of all weather stations showing high wind and assuming the land area fraction to be the same. This seems sound to me and even conservative, but of course it is basically an unvalidated procedure.

The GE study (#7) drew contour lines on a map to delineate high, moderate, and low wind regions, and then supposed the number of acceptable sites could be derived by combining land use maps with these contour maps. I believe the GE method is less reliable than the Lockheed method. The packing density used by Lockheed (2.7 units per square mile) was approximately twice that used by GE for the same size rotor machine. At present, no one knows the allowable packing density. This subject has been discussed under Task 2. The amount of harvestable wind energy is certainly affected by whatever is assumed.

The assumptions of the two studies regarding cost-production volume relationships have already been discussed under Task 1. I have no reason to dispute either one. They are in reasonable agreement.

Both studies correctly consider that the utilization of wind energy will be limited by cost effectiveness of the wind machines, not by availability of wind or limitations of as yet undeveloped technology. They suppose that the fuel against which the wind machines will mainly have to compete will be imported oil -- a supposition with which I concur. However, for some of the special applications, particularly the forest products industry, biomass not presently utilized may cover most energy requirements in a world of higher oil prices.

A fault I find with both studies is their blind acceptance of projections for U.S. electricity demand and energy demand. These projections are based on extrapolation of the past twenty-five years in order to predict the next twenty-five -- a procedure I believe to be basically unwarranted. The argument "Well, what else is to be done?" is no argument at all. The proper way to deal with uncertainty here, it seems to me, is to run scenarios with drastically different rates of growth.

Another fault -- and one which I do not know how to avoid myself -- is to use a standard inflation correction to convert costs from 1975, say, to 1985. To characterize inflation by a single number is wrong. In this case it is a central problem, since the whole analysis depends on projected costs.

Another difficulty is that no quantitative cost allowance is made for the environmental benefit of windpower versus fossil fuel or nuclear, except insofar as it is assumed that the environmental costs of the latter will be increasingly internalized. Also, no cost allowance is made on the prowind side for its better international-geopolitical and national security aspects.

In general, however, I think the methodology of both studies was well thought out and is effective in bringing coherence to a difficult and multifaceted analysis.

TASK 4: COMMENTS AND PERSPECTIVES

1. Quantity of Energy Derivable From Wind

The numbers in this regard are very uncertain. They're hardly more than a reasonable expectation in the "base case" instance and a reasonable upper limit in the "accelerated case". They are not to be regarded as the results of any kind of exact calculation, and they cannot be justified rigorously.

Still, they are quite useful. For example, most of the numbers are quite small in comparison to total U.S. energy consumption (75 Quads in 1976). This means that zealots who see salvation from wind alone should not be taken seriously. It is extremely unlikely that wind will ever provide as much as half or even one-fourth of total U.S. energy, so long as consumption of energy continues at anything like present levels. However, that does not mean that wind energy is quantitatively unimportant in the U.S. energy picture. It is only the zealots who see it as the total solution who should not be taken seriously. Proponents who argue that wind energy can be part of the solution -- important, though not dominant -- in the mix of U.S. energy sources should be listened to.

It is entirely possible, for example, that the quantity of energy provided by wind in the United States could come to surpass that provided by hydro well before the year 2000. Wind is also likely to surpass geothermal energy and energy recovered from burning trash. Solar energy for the heating and cooling of buildings is currently regarded as very promising, and indeed, I believe that it is.

However, as of the beginning of 1977, statistics for the total square feet of solar collectors sold indicated, in the units of Table 1, total solar energy provided of 0.003 Quads. The wind contribution is likely to reach this order of magnitude before too long.

2. Compatibility with Existing Economic Institutions

One of the difficulties in implementing sources is that they do not fit in well with our existing economic system. In some cases (conservation), there are not many companies and organizations effectively selling it, because it is difficult to arrange things so that an acceptable profit can be made. In other cases (solar industrial heat), one of the big problems is that the return which industries normally require on their investments is greater than the return which would be considered satisfactory from the overall socio-economic viewpoint.

Wind suffers somewhat from these difficulties, but not completely. A major part of the installed capacity is expected to be owned by utilities, in individual units rated in the megawatt range. This kind of equipment resembles, in some operational and business aspects, the small unattended hydro stations which many utilities now operate.

No other solar-electric technology is as close to realization or as likely to operate in a trouble-free manner. Most utilities are under public pressure to show activity in the solar-renewable resources area: wind capacity is an opportunity to do this which is entirely consistent with normal business practice and could even be profitable.

3. Importance of Further R&D

Both the Lockheed and the GE Mission Analyses called for expansion of federally-funded R&D and stressed its importance as a way to lower costs. To a degree, I agree.

However, as discussed previously, engineering design is of minor importance compared to other factors in determining the cost of windpower. Thus, engineering research and development alone is of limited value in accelerating the implementation of wind energy as a U.S. energy source. Funding R&D is something the government is accustomed to doing. There is no reason to doubt that R&D funding in wind technology will continue and expand, and this is all to the good.

However, this is not the crucial element in accelerating wind utilization. To go to the moon or to build a ballistic missile required us to learn how to do a number of things which had never been done before. This is not the situation with wind energy.

In particular, exotic designs and schemes for wind devices and systems should be funded for study and analysis and for experiments when indicated, but commitments to develop such designs and schemes to full-scale implementation should not be made simply because they are new.

4. Wind in the U.S. Energy Future

The future, beginning in a very few years, will feature a much more diverse mix of energy sources than in the past. The commercial energy sector will have to operate with biomass burners, windmills, mini-hydro (under 10 MW), direct solar, and various other things, in addition to oil, gas, coal, nuclear, and big hydro (and geothermal where possible). In this increased diversity, which will come about because of the decline in availability of the major sources and which will be accompanied by higher costs, wind energy will play an important role.

DR. MERRIAM: Well, first I will say a few words about wind energy, and then I will say a few words about federal policy issues.

Wind energy seems unreal to most people who are concerned with energy questions, and it seems unreal, really, except in an historical sense, to most people. There's a feeling that it should be just not considered because it belongs to the time of Don Quixote and it is not worthy of consideration in our enlightened century, or that it shouldn't be seriously considered because it's not really a high technology kind of operation: it doesn't depend on mysterious and unseen forces.

But in fact, the flux of wind energy through a square meter maintained perpendicular to the wind direction, in many places in the United States, is as high as 400 watts per square meter, day and night average, and in many, many places exceeds 300 watts per square meter. The highest solar flux, in contrast, is perhaps 250 in the sunny Southwest.

So the flux of wind energy through a square meter of area is higher than the solar flux, and the wind energy is already in mechanical form. This means that if you want to make electricity out of it, you are much better off, and in fact, you can convert 25 to 35 percent of that wind energy into electricity on a realistic basis, whereas you can convert a much smaller fraction of the solar flux into electricity.

The technology for making electricity out of wind energy is certainly known, although it's certainly in need of improvement. Large wind-generating machines have operated long before ERDA and DOE ever existed. In fact, there is one machine which operated for nine years, connected to a power grid, as a regular operating part of an electric power system.

Now, let me just detail some things which are true about wind energy in the United States or anywhere. Wind generation of electricity is one of the very few ways to produce electricity which does not require any water at all. That is a matter of great importance in many parts of this country and especially in the High Plains area of the Southwest, which is one of our wind resource areas.

Wind generation produces no pollutants at all. Wind generation has essentially zero environmental impact, according to me.

[Audience Laughter]

DR. MERRIAM: There are many people who feel that nothing has zero environmental impact; however, I am deliberately not counting the question of visual pollution of the landscape, which some people speak of -- the aesthetics of large numbers of machines -- and I'm not counting TV interference, because I do not think they are environmental impacts. They are effects upon human amenity, but they do not affect human health, and they do not affect the health of any animal or plant species.

Furthermore, I think they are often not real, either. I have looked at more large windgenerators, probably, than anybody in this room. I think the aesthetic issue is entirely a false issue. However, that is to be resolved in other ways.

Wind generation is marginally cost-effective today in high fuel cost situations, of which there are quite a few. Basically, when you have a diesel generator providing electric in a region where the average windspeed is high, then it would not be correct to say that wind generation is certainly cost-effective in those situations, but it's marginal already, and that makes wind generation way ahead economically of any other solar electric conversion scheme. There's no other solar electric conversion scheme that shows any promise of being anything near as cost-effective as wind generation does.

Wind electric capacity will necessarily be dispersed in many units. If you want a thousand megawatts of wind capacity, you have got to settle for a thousand units of one megawatt each -- or maybe five hundred units of two megawatts, but not many fewer than that.

Now, many people feel that's another reason to reject it outright. It just seems so preposterous to have large numbers of individual units. However, there are great advantages in having it so modular: you never have the thousand megawatts fail; you'll only have one or two units fail at a time, so the whole plant does not go down. That leads to improved system stability.

It is also true that it's possible to implement it in a modular manner. Today, if you're building a thousand megawatt generating plant of any type, you cannot get any value for all your money spent until the last bolt's in place and the thing is turned on, and that is not the case with wind generation.

Wind generation will never be the backbone of U.S. energy supply, but it could certainly be significant. The potential in the United States is very difficult to estimate with accuracy, but probably we're talking about producing something like 1 to 10 percent of U.S. energy needs. The estimate I made in the FEA paper, and which is consistent with other people's estimates, is about 10^{12} KWH/year. That is half the electricity used in the United States last year, but of course it's much less than half of the total energy.

So we're talking about something comparable to hydro, and hydro is certainly an important energy source. No one would deny that.

The major determinants of the cost of wind energy are, in order of importance: first, the fixed charge rate -- whether you are a public utility or a private utility or a government utility and so what the interest charges that are relevant to you are and the taxes and so on. That has nothing to do with the wind, but that's the first thing that determines the cost of wind electricity.

The second thing is the scale of production of wind machines -- whether you make ten of them or a hundred of them or a thousand of them, because these are mechanical devices. The complexity is not greater than that of an automobile, and there is, in fact, a mass production economy possible if many alike are produced. So the second most important issue is the scale of production.

The third most important determinant in the cost of wind energy appears to be the mean windspeed at various sites. You have to find the places where the wind is. The power in the wind depends on the cube of the wind velocity.

The fourth most important is probably the type of technology and the efficiency of the machine. That fourth issue is the one to which most of our federal funding has been addressed so far.

Now I will pass to the federal policy issues. First, there is an environmental policy issue. It would help windpower economics a lot if the EPA or some other appropriate branch of the federal government, after due study and careful consideration, could produce a number that represented the worth -- the additional worth -- of a non-polluting electric power source. Is it worth one cent per kilowatt hour to have zero pollutants emitted? Or is it worth a half a cent or two cents per kilowatt hour? But if there is some definite credit, which could be written down, that reflected the fact that the generation does not require any water and does not emit any pollutants, that would be a desirable thing.

I think it's also a legitimate policy issue to ask whether wind power plants could perhaps be categorically exempted from a large number of the usual certification procedures which are designed to protect the environment. That would, in fact, make it possible to build them rather quickly and improve their appeal to electric utility companies.

One of the features of wind generating plants is that, as far as the physical considerations go, they can be implemented very quickly. There is no reason why you cannot produce quite a number in a very few years of lead time.

Another thing is that today environmental regulators are often in a position of having to approve something bad because it's the best of a number of bad choices. If wind energy were promoted and nurtured to the status of what was widely seen as a viable alternative, then regulators would have a basis for saying no to many of the other bad choices because there would be at least one viable alternative that wasn't bad.

As an example of this kind of thinking, I saw a position paper by the staff of the California State Energy Commission called "Wind Energy: Alternative to Sun Desert" -- Sun Desert being a nuclear power plant proposed in Southern California.

The nature of the government stimulation of the market or intervention in the market for best results in promoting wind energy I don't want to discuss in detail; it's a complicated question and it's a DOE problem. I do think the budget for wind energy should be a lot higher. I cannot see the rationale, for example, for having the budget for magnetic fusion ten times as high as the budget for wind energy, when magnetic fusion does not work and may never work, and wind energy certainly does work and is marginally cost-effective right now. It just doesn't employ any physicists and it doesn't have a heavy R&D component.

[Audience Laughter]

DR. MERRIAM: I, by the way, am trained as a physicist; I think I understand that.

There are some R&D questions, but let me not go into that, since my time is up. I will just summarize by pointing out again that wind energy is a major resource comparable to hydro; it's already very close to cost-effectiveness and can likely be made cost-effective without new inventions or new breakthroughs. No other solar electric technology is in that position. Wind energy is generated without any pollution and without requiring any water.

I will close with a case point illustrating that the environmental impact of wind energy is not only negligible, it may even by positive. When I recently visited the demonstration windgenerator at Clayton, New Mexico, one of the local people, a rancher there, said that if one could put a battery of such wind machines in front of the town -- upwind of the town -- with the result of slowing down the wind going through the town -- with the result of slowing down the wind going through the town, people would be willing to pay for that -- that wind breaks had a positive economic value.

Thank you.

DR. REZNEK: Thank you. I was surprised to learn of another one of the benefits of wind energy, and that's television interference.

[Audience Laughter]

DR. MERRIAM: Right.

DR. REZNEK: Does the Panel have any questions?

QUESTIONS AND REMARKS

MR. GAMSE: What is your estimate of the current costs and do you have an estimate of how much further they might be brought down?

DR. MERRIAM: Well, as to the current costs, the Canadian installation on the Magdalen Islands is supposed to be able to produce electricity, if it lasts twenty years, for three cents per kilowatt hour, and that is equal to the fuel cost that they are currently paying at that place at today's oil price. That's the first unit, and it was stated by the manufacturer who produced that unit that the second unit would cost something like 65 per cent as much as the first one, and after that there would be some further reduction with production scale. Of course that's a high fuel cost area.

DR. MACKENZIE: Why aren't the utilities beating the door down to get to it? What are the principal barriers to the introduction of it?

DR. MERRIAM: Well, I think one is the feeling that the whole idea is preposterous. Another is that our program -- our federal program -- has demonstrated high costs, because of the nature of the way we buy and demonstrate things.

The utilities -- and fortunately so, I might say I feel, are conservative people, and they want to make sure that they see something working for quite awhile before rushing after it. The large windgenerator in Denmark, which ran for nine years, was eventually shut down by the utility that was operating it because the maintenance cost exceeded the value of the electricity produced. Now, it is felt that that's not a fundamental problem and that that wouldn't occur today, but that's not certain.

MR. OUTWATER: You said it has no environmental impact. Being a little defensive -- I don't want you to put me out of work -- there must be a noise problem associated with these, isn't there, and also a non-ionizing radiation problem, and I would presume also an entrainment/impingement as far as insects, birds, and that sort of thing is concerned.

DR. MERRIAM. Okay. Now, the noise problem I don't think is there. I have stood next to the large generator at Gedser when it was operated, and as soon as you are two or three rotor diameters away, you cannot hear the blades over the wind noise. According to testimony from other people who have stood next to many other large machines when they were operating, that is also true.

It is possible, of course, to do it wrong and have a lot of gear noise or something like that.

Now, as far as the birds and insects go, there has been an exhaustive environmental study by Battelle-Columbus, under DOE sponsorship, focusing mostly on the test machine at Plumbrook, and they find no evidence of bird kills or insect kills, and especially no evidence of bird kills or insect kills exceeding those expected of a stationary object of a similar size.

I have seen a few birds killed by Darrieus rotor in Bushland, Texas, but again, I don't think they probably exceed those of a similar-sized object that was stationary.

Now, the other one you mentioned, non-ionizing radiation --

MR. OUTWATER: That would just be for transportation of electricity. There would be a certain effect depending on the size of it.

DR. MERRIAM: Well, yes. There are environmental impacts associated with the non-windmill aspects of it, and of course there's production of the steel and building roads and so on, but as to the specific part that's wind, I am unable to find any real environmental impact.

DR. MACKENZIE: Could you give me your guesstimate as to what the installed capacity might be by the end of the century or how many kilowatt hours might be available by the end of the century? If we get into a vigorous installation program.

DR. MERRIAM: Yes. They could be, based on plausibility of manufacturing rates and things of that sort, centainly.

DR. MACKENZIE: Is that in your paper?

DR. MERRIAM. Yes, that's in my paper, and there are several different scenarios, but it's on the order of 1 to 10 Quads of energy, or --

DR. MACKENZIE: Ten Quads would be the full trillion kilowatt hours?

DR. MERRIAM: Yes, 10 Quads is the full trillion kilowatt hours.

DR. MACKENZIE: Do you think we might get there if we worked on it?

DR. MERRIAM: Well, I think at present there is great deal of uncertainty in the knowledge of the wind resource, and that is unquestionably something that must be resolved by direct and primary measurements. No further amount of studies will resolve that; the primary data are not there at the moment.

By the end of the century, the optimistic numbers call for an installed capacity of 330,000 megawatts in electric utility systems and another 65,000 megawatts in dispersed modes, which I didn't speak about very much here, but it's quite possible to have windgenerators on peoples' farms with the wind electricity being sold into a utility grid as an additional cash crop.

The economics are unclear. It's being done in Denmark; I visited some installations where the men were hopeful about the economics already.

MR. LEE: I have just two quick questions. In the paper, you cite the price of 25¢/KWH for small wind generation. That's a very pessimistic price from what I've seen coming out of any research that we've seen in the New England area, where the price we're looking at is closer to 12¢/KWH -- it's still higher than conventional electricity. How did you arrive at that 25¢ figure?

The second question is: how important is the whole R&D effort to do with storage batteries in this, to the wind area?

DR. MERRIAM: Your first question about the price -- the 25¢ is pessimistic. It was supposed to represent what I thought was reality right now, today, considering the mix of customers who normally buy the products of the existing windgenerator industry, which is not only a small industry, it's microscopic. There is no economy of distribution of anything, and the customers are those in remote locations almost completely. So I would think that probably the difference between the 25¢ and the 12¢ can be explained rationally on that basis.

The question as to how important is research in batteries and other storage devices -- I do not feel that's crucial. It is very important for the present windgenerator industry, because they sell to people who are not connected to power grids. I look for a big contribution to the U.S. energy picture from windgenerators connected to power grids, and consequently, the storage is in the grid; basically it's in unburnt fuel elsewhere in the system.

DR. REZNEK: If I read you correctly, you don't see capital investment in wind power as displacing any of the capital investment in conventional generation capacity, and furthermore, that the economic viability of wind power depends only on the cost of fuel for conventional systems. Is this correct?

DR. MERRIAM: That is a subject of continuing research and great controversy. The studies -- tremendous controversy in it depends entirely on whom you read, but there is certainly going to be some capital displacement possible. It might be as little as 1 or as much as 30 per cent of the installed wind capacity.

I have trouble worrying about that at the moment, because certainly until we get something up -- you know, until the wind becomes a half of 1 per cent or something like that of the installed capacity, no one is going to give it any capacity credit. But that will affect the economics; you're quite right.

MR. OUTWATER: Dr. Merriam, I'm not quite sure I understood geographically what parts of the country should be considered for windgenerators.

DR. MERRIAM: Well, some of the regions which are known to have high wind energy potential are the Southwestern High Plains, which is a large area geographically; the coasts in the Northeast and Northwest; the mountains in the West; and probably some strips along the Northern border of the country as well, and there may be other places, too. There are maps which indicate wind potential; they are based on very sketchy data.

Furthermore, you may have a generally low wind region, but because of some funneling effect of the terrain, there is a high wind pocket. That represents a resource. It cannot be treated like solar energy, where you can make fairly reliable maps and integrate the area on the maps. There is great uncertainty about the total available supply.

MR. GAMSE: You alluded to an unfortunate experience with federal R&D already in this area. Do you have advice as to how the federal government can make positive contributions of a stronger nature?

DR. MERRIAM: Well, yes. I don't want to be in the position of saying that the DOE effort in wind energy is misguided and fruitless; that is not at all the case. However, it is true that they have some pretty high cost installations.

Yes, I would personally like to see the federal subsidy -- the federal money -- spent in such a way that it directly rewards performance, rather than buying R&D or paying part of the capital cost.

In particular, wind energy, unlike solar energy, has the unique feature that it can be directly metered. The output is practically always electricity, and you can meter electricity cheaply and easily. I would like to see a direct subsidy of, say, two cents per kilowatt hour in the 1980s for every kilowatt hour of wind energy produced by whosever machine, under whatever conditions, with the subsidy being reduced in future years.

This would, I feel, foster the greater diversity of manufacture and of marketing which our country has historically excelled at. I would rather see that than see a great expansion of the totally federally-funded demonstration projects.

MR. GAMSE: Why has the federal project been so expensive?

DR. MERRIAM: Well, we have two completely different groups of industry in this country: one type which sells mainly to the federal government, and one type which avoids selling to the federal government -- or at least doesn't participate in the contract-RFP-PERDA game -- and their costs are greatly different. I don't see anything conspiratorial or bad about this, but in fact, if you buy things from that high-cost, high-performance-oriented type of industry, you're going to get high cost products. That's one major reason, I think.

I don't say that it would have been easy to do it differently at this beginning stage, but that's one thing I see. It's General Electric Space Product Division that's building a MOD-1 machine, it's not GE Washing Machine Company that knows something about mass production.

[Audience Laughter]

DR. REZNEK: One of the aspects of wind power that has always been difficult for me to accept is the small scale and thus the large number of towers you need. The number that would be needed for the ultimate wind potential is so large that it means the landscape will be covered with them. You will be able to see from one wind tower to the next no matter where you are in the country. Is this right?

DR. MERRIAM: Oh, no. Only in the high wind regions, I would say. In the Southwestern High Plains it might be true that you would see almost as many as you see transmission towers today. I think that's quite possible.

[Audience Laughter and Applause]

DR. REZNEK: Only if you look towards California.

DR. MERRIAM: I must say that in Denmark, I made a special effort to interview people who had been concerned with, for a long time, the Gedser wind machine, which was built in 1957 and operated until 1967, and has stood there unoperating until now, and now it's operating again, and no one knew of any case where anyone had complained about the appearence, and that is only two kilometers from a substantial town and within easy sight of the highway and railway.

DR. REZNEK: Where is it?

DR. MERRIAM: It's in a southernmost town in Denmark, facing the --

DR. REZNEK: Obenroll? Never mind.

DR. MERRIAM: No, it's on the island of Falster, facing East Germany across the Baltic.

MR. OUTWATER: Let me ask a question. Do you have a windgenerator on your own home?

DR. MERRIAM: No, I have no wind. I do not live in a --

MR. OUTWATER: I thought you lived on the Coast.

[Audience Laughter]

DR. MERRIAM: I live in Berkeley, California, but that is certainly not a high wind region, and most people do not live in high wind regions. If the wind is not strong enough to make you miserable, it is not a good place.

[Audience Laughter]

DR. MERRIAM: That's a very rough statement. That's why you look to these fairly small fractions of the country that do have high mean windspeeds and probably must also not have high frequency of terrible storms, because that could destroy the machines. The top of Mt. Washington has high mean windspeed, but it's probably not a super wind site because of the extreme speeds.

MR. LEE: There is a windmill on top of Mt. Washington.

DR. MERRIAM: But I imagine that it may have a limited life. I don't know.

DR. REZNEK: Is there a safety problem when their life comes to an end?

DR. MERRIAM: Well, the safety question, I feel, is very real and is soluble. However, I feel the great majority of machines will be far from human dwellings. That is something which must be worked out.

DR. REZNEK: Any further questions? Thank you.

DR. MERRIAM: Thank you.

DR. REZNEK: We'll break for lunch and return at quarter past 1:00.

AFTERNOON SESSION

DR. REZNEK: We can reconvene. Our next witness is Vic Russo of the Ad Hoc Committee on Thermionic Energy Conversion.

STATEMENT OF DR. VIC F. RUSSO
ACCOMPANIED BY MR. GARY O. FITZPATRICK AND
PROFESSOR DEAN L. JACOBSON
THE AD HOC COMMITTEE ON THERMIONIC ENERGY CONVERSION

DR. RUSSO: Mr. Chairman and members of the Panel, I am Vic Russo, Director of New Technology Development at Rasor Associates. With me is Gary Fitzpatrick, Manager of the Thermionic Energy Conversion Program at Rasor Associates, and Professor Dean Jacobson of Arizona State University.

We are here today on behalf of the Ad Hoc Committee on Thermionic Energy Conversion, which is a group of fourteen individuals from the industrial, university, and national laboratory engineering community. A list of the members of the Ad Hoc Committee on Thermionic Energy Conversion and their professional affiliation is attached to my statement.

We appreciate this opportunity to appear before you today to discuss the Department of Energy Thermionic Energy Conversion Program. We would like to present some facts about the thermionic energy conversion process and its potential for fossil fuel conservation and make some general comments concerning the program priority relative to other coal-fired advanced power systems presently under development.

Most of the technologies which are being developed to reduce the environmental impact of central station power plants exact an energy penalty and directly increase plant capital costs. As a result, the cost of electricity goes up, as does fuel use, waste heat and water use. We are here today to discuss a technology which reduces emission, reduces thermal pollution and water use, and at the same time has the potential to decrease the cost of electricity, all while decreasing the fuel use.

It should be mentioned that in contrast to the usual conservation measures, which require either changes in lifestyle or restrictions on economic growth, the program to increase power plant conversion efficiency will not change the way people live in any way, and could free billions of dollars per year of capital for more economically productive activities, such as providing jobs.

As I'm sure the members of the Panel are aware, the United States Department of Energy is developing a number of advanced coal-fired power systems to increase the conversion efficiency of central station power plants from the present 36 percent to over 50 percent. As shown in our first figure, the comprehensive program of the Department of Energy, Power System Division of the Office of Fossil Energy, could potentially conserve as much as 30 percent of the total energy consumed in this country, and at the same time reduce environmental degradation significantly.

We have prepared a list of figures, and I'm referring right now to the first figure which is entitled "Thermionic Energy Conversion Development Payoff". It is, of course, true that the same benefits would accrue from developing any of the advanced power systems which will increase the power plant efficiency from 36 to over 50 percent.

I might mention that the 3 billion barrel equivalence of fuel savings is equivalent to approximately $45 billion of fuel at current prices. The fuel savings resulting in the reductions in pollution which are indicated on that chart result solely from the ability to extract more energy from the fuel, and consequently produce more electricity while utilizing less fuel.

You'll note that the figures listed for the sulfur dioxide, nitrogen oxides, and particulate reductions correspond to approximately a 30 per cent reduction in atmospheric emissions from central station power plants. Relative to the water use, that figure represents a 50 per cent reduction in water use, since the 50 per cent figure is appropriate for reductions in thermal discharges from power plants.

The energy conversion community in general, and our Ad Hoc Committee on Thermionic Energy Conversion in particular, believe that the DOE Power Systems Division can provide this needed improvement in conversion efficiency if the federal government will increase the priority attached to this advanced energy conversion program.

As an example of the need for increased priority, we would like to cite specifically the example of thermionic energy conversion. Thermionics is a well-established, internationally recognized technology for converting heat directly to electricity, and the schematic for a thermionic converter is on the second page of that handout.

The thermionic converter consists of two plates, one of which is heated hot enough to boil off electrons; the electrons cross a narrow interelectrode gap, and condense on a cooler electrode. This process sets up an electric current which delivers power to an electric load. In effect, the temperature difference is driving electrons through a load. There are no moving parts; that's all there is to this converter.

These converters have thus far operated for up to five years without any degradation, and at levels high enough to save 25 per cent of the waste heat presently wasted in power plants, if they could be used economically in power plants. Unfortunately, the present converters cannot be, and there is an active program supported by DOE, NSF, and NASA to reduce the costs of thermionic converters.

These converters have a number of attractive features, including a modular nature and operation at extremely high power density levels. The feature responsible for DOE interest in the technology in the power plant application results from the fact that the cooler electrode, which is indicated in that figure, is still at a high enough temperature to generate high quality steam. So this unit is well-suited to use as a topping system in a fossil power plant.

The next figure indicates how this might be accomplished. In this figure, there is a comparison made of a conventional steam power plant and a thermionic power plant. In the conventional plant, fossil fuels are burned at approximately 3500 degrees Fahrenheit, and that heat is utilized at about 1000 degrees Fahrenheit by the conventional steam system to raise steam.

The thermodynamic availability of the heat in the range between those two temperatures is completely lost in the conventional power plant. The thermionic module operates in precisely this temperature interval and, as indicated in the bottom figure, the inclusion by either retrofit or design of a new power plant from the ground up could, in effect, extract energy from that thermal stream twice.

The thermionic module could accept the heat at 3500 degrees and reject it at 1000 degrees at sufficiently high temperature to go directly into the steam system and continue to operate the conventional plant.

The Power Systems Division of DOE has prepared plans calling for increased priority for each of the advanced power systems presently under development. In the case of thermionic energy conversion, these plans call for the development of the technology, and the objective of the plan is to begin a retrofit demonstration program in 1984. So it does qualify as a near-term energy technology, according to President Carter's definition.

However, budgetary restrictions have not allowed the implementation of the DOE plans in this area. The present situation, as shown on the last page of that group of figures, shows the first two columns representing the results of studies which have been done on three of the different energy conversion systems, related to the cost of electricity and the potential improvement in conversion efficiencies.

You'll note that all of the advanced energy systems presently under development would reduce environmental degradation significantly, by virtue of the fact that a significant reduction would occur in fuel use, reducing all of the pollutants that I have previously mentioned.

Really, the need for increased priority in this important area is evidenced in the second-to-last column, which shows the present funding situation in these programs.

In summary, in consideration of the potential for significant fossil fuel conservation with concomitant reduction in environmental degradation which would accrue from commercial utilization of these advanced power systems, the Ad Hoc Committee on Thermionic Energy Conversion would recommed that the federal priority attached to these programs be increased to allow implementation of DOE operational plans, particularly in the case of thermionic energy conversion.

Mr. Chairman, that concludes our presentation.

PREPARED STATEMENT

Thermionic energy conversion is a well-established non-mechanical method of producing electric power directly from heat. A thermionic converter consists of a hot electrode (called the "emitter") facing a cooler electrode (called the "collector"). The region between the two electrodes contains a highly conducting plasma at low pressure. Electrons are evaporated from the hot emitter and flow across the inter-electrode gap to the cooler collector, where they condense and return to the emitter through the electrical load. In effect, the emitter-to-collector temperature difference drives the electrons through the load.

The thermionic cycle therefore employs a basic process similar to that occurring in the conventional electron tube which is widely used in industrial, military, and consumer products. Due to their modular nature, thermionic converters can efficiently produce electric power from a few watts up to the multi-megawatt levels of modern central station power plants. The U.S. successfully developed thermionic nuclear fuel elements for space power application, and a thermionic space reactor system has been operated for several years in the U.S.S.R.

DOE studies have now shown that thermionic technology offers the potential for increasing fossil fuel power plant conversion efficiencies to 50 per cent or more, as compared to the conventional steam plant efficiency of approximately 36 percent. The efficiency projections for thermionic central station topping systems are supported by studies carried out in the U.S.S.R., which has a thermionic development program over ten times larger than that of the U.S. As the members of this Panel are aware, such an improvement in central station power system efficiency could result in an energy conservation equivalent to about three billion barrels of oil annually.

Thermionic converters have thus far demonstrated efficiency of greater than 15 percent -- a level high enough to save 25 percent of the heat currently wasted by power plants, if they can be used economically in power plants. Thermionic converters can have extremely long operating lifetimes, since they are no moving parts to wear out. For example, converters have operated continuously up to five years without any degradation of performance.

Studies show that if converter efficiency can be increased to 25 percent, thermionic topping of central station power plants could reduce the cost of electric power. Achievement of this increased efficiency is an objective of the current U.S. Thermionic Energy Conversion R&D Program.

The U.S. program is jointly supported by DOE, NASA, and NSF. The DOE thermionic fossil energy program has in the past been supported jointly by its Office of Nuclear Energy and the Office of Fossil Energy through a memorandum of understanding between these two divisions. Nuclear support for this fossil application resulted from the historical interest in and development of the technology for use in space nuclear power systems.

In mid-January 1978, the entire DOE thermionic program was transferred to Fossil Energy. The current FY 1978 funding level for the thermionic program is presently uncertain because of the transfer, but it is likely to be significantly less than the $1.7 million called for in the DOE program plan.

The primary objective of the DOE thermionic program plan is to demonstrate the commercial viability of thermionic topping of central station power plants by 1987. The plan includes two near-term tasks: first, a Thermionic Materials Research and Technology Task will improve converter efficiency and demonstrate long-term materials compatibility. Technical approaches have been formulated to increase converter efficiency as well as demonstrate materials with long lifetimes in the combustion environment.

For example, materials already have been operated for over 15,000 hours (two years) under simulated conditions for coal-fired heating of thermionic converters, and these tests are continuing. Significant reduction in plasma and electrode energy losses have been demonstrated in laboratory converters both here and in the U.S.S.R. This has resulted in a significant improvement in converter performance over that of the converters developed for the space program. These demonstrated basic advances must now be consolidated for subsequent reduction to engineering practice in the power plant topping application.

The other near-term task of the program plan involves evaluation of specific thermionic power modules for fossil-fueled power plant topping. This Thermionic Power Modules Evaluation Task will take three years. After selection of module designs, the technology will be reduced to engineering practice and prototypes demonstrated by retrofitting the thermionic modules into existing power plants between 1984 and 1987. The use of existing plants as test beds for the modules greatly reduces the development time and cost. At the end of the retrofit period, that is by 1987, there should be sufficient operating experience to justify commercial use.

Perhaps the best way to gain a perspective of the potential of thermionic energy conversion relative to its current funding level of less than $1.7 million, is to compare it with two other advanced conversion methods being developed for advanced electric power plants: MHD and fuel cells.

These are quite different technologies, but they both can also potentially convert coal to electric power at efficiencies of 50 percent or more. The MHD system has the advantage that it can operate by direct combustion of coal. However, high efficiency is obtained only in very large MHD units of 100 megawatts or more.

Fuel cells have the advantage of efficient electro-chemical operation at relatively low temperatures and the great advantage of modular development and construction. However, they require preprocessing of the coal into clean fuels, which imposes additional costs, inefficiencies, and environmental impacts.

The thermionic system combines the advantages of both of these other systems, in that it can operate efficiently at high temperatures using the direct combustion of coal, and has, in addition, the advantage of modular development and construction. System studies show that all three systems -- MHD, thermionics, and fuel cells -- have about the same overall efficiencies and approximately the same total costs of generated electricity.

However, because of their modular nature, thermionic and fuel cell systems can be developed more rapidly and with a much lower investment than the MHD system. It is projected that about $150 million will be required for the commercial demonstration of prototype thermionic and fuel cell power plants, compared with the $600 million projected for MHD commercial demonstration. FY 1978 federal expenditures of less than $1.7 million for thermionic technology should be compared with the approximately $36 million and $65 million expenditures for fuel cells and MHD respectively.

From an environmental standpoint, thermionic topping appears to be substantially superior to other advanced power systems. The increase in efficiency resulting from use of any of the advanced power systems would reduce NO_x, SO_x, particulate and thermal discharges by an amount equivalent to the additional electric power generated.

As recently pointed out in work supported by the EPA, the alkali metal seed material utilized in MHD generators represents a potential adverse environmental impact which requires recovery of the seed material. The same work also points out potential leachate and sludge disposal problems requiring solution before large-scale use of fuel cell technology is achieved.

On the other hand, thermionics is a static technology utilizing heat only. The only impact associated with the use of thermionic topping units is a reduction in the environmental factors associated with coal combustion. It should be mentioned that fugitive emissions associated with the mining, transportation, and storage of coal for use in central station power plants have not been addressed as yet.

The Ad Hoc Committee on Thermionic Energy Conversion believes that it is essential that the federal government increase the priority given to the development of thermionic central station topping units. Considering only the potential waste of national resources, each year of delay in achieving commercial use of efficient thermionic power plants can result in the waste of energy resources corresponding to billions of dollars, as compared to the small investment required to buy a year of progress now.

There is an even more important reason to increase the priority of the thermionic development program. A decision on the demonstration of advanced power systems must be made at some stage. Due to the great cost involved in demonstration, it is likely that only one or possibly two systems will be chosen. This decision will be based on the existing technical data base at the time of decision.

Although thermionic technology was developed to a high level in the space program, it is only recently that studies have shown the potential for thermionic energy conservation in coal-fired power plants. Other advanced systems were not seriously considered for the space application and have been devoted to the power plant application for a longer period. Consequently, these other systems have had more time to build the technical data base needed for an informed choice of the best approach to be commercialized at great subsequent cost.

Because we believe such a choice will be made in the early 1980s, a delay in carrying out the DOE thermionic program plan may result in insufficient time to build this required data base. Therefore, it may be necessary at the time of decision to pass over the thermionic system for lack of a sufficient power plant data base in spite of its promising potential. This situation must be avoided if meaningful and cost-effective decisions on the demonstration of any of the advanced power systems are to be made in the early 1980s.

END OF PREPARED STATEMENT

DR. REZNEK: Thank you. Does the Panel have any questions?

DR. REZNEK: Thank you.

DR. RUSSO: Thank you.

DR. REZNEK: We'll go on to the next witness, who is Ted Taylor from Princeton University.

STATEMENT OF DR. THEODORE B. TAYLOR
INDEPENDENT CONSULTANT AND VISITING LECTURER
PRINCETON UNIVERSITY

DR. TAYLOR: I am convinced that the prospects for wide-scale use of solar energy in the United States and the rest of the world are much brighter than presented in most recent overviews of the energy situation for the following reasons.

First, public opinion appears overwhelmingly to favor solar energy over the other major long-range alternatives -- that is, coal and nuclear energy -- if it can be provided at the same or perhaps somewhat higher costs. This preference is largely based on much lower perceived environmental, safety, and national security risks associated with solar energy than with the use of coal or nuclear energy.

Second, new ways to collect and use solar energy can often be conceived, designed, and demonstrated with small resources, sometimes by one individual.

Three, solar energy is available everywhere on earth. Even at very high latitudes there are ways to store energy collected when solar energy is abundant -- as during the summer -- for use in the winter or during extended periods of cloudy weather.

Four, solar radiation, unlike any alternative large sources of energy found in nature on earth, is pure energy. It is not mixed with any material when it arrives at the earth's surface. The amounts and kinds of waste products associated with its manipulation can be controlled. This is in sharp contrast with the absolute necessity of producing waste products from the combustion of coal or the fission of nuclei.

Five, we are in the midst of a sudden, world-wide surge of new concepts and new combinations of old concepts for collecting and storing solar energy and converting it to distributable heat, chemical fuels, electric power, and heat sinks for cooling and refrigeration at reasonable costs.

A few specific examples are the following: architectural concepts, some of which come to us from ancient times, for rejecting solar energy in summer and absorbing and storing it in winter, to reduce needs for air conditioning and heating; so-called "biogas" generators for converting energy in animal and crop wastes to methane and for producing high grade fertilizers. More than four million very low cost biodigesters are reported to have been built in the People's Republic of China since 1972.

Sugar cane, casaba, and other types of potential fuel so-called "plantations" such as those now being developed in Brazil for example, for producing such fuels as alcohol for motor vehicles; integrated, small scale energy, food production, and water management systems, such as those now being developed at the New Alchemy Institute in Massachusetts; collectors made of air-inflated plastics, sand, or other low-cost materials for production of hot water below its boiling point at very low costs; hot water ponds covered with insulating, air-inflated plastic pads for storage of heat from summer to winter, with small heat losses, if large enough to meet the energy demands of several dozen or more houses.

Engines that use the expansion of low boiling point liquids, such as Freon, to convert thermal energy in hot water below the boiling point to electricity, with overall efficiency of about 10 percent; for places with cold winters, such as right here in Washington, ice ponds for making and storing ice reservoirs several meters thick to serve as heat sinks for refrigeration or air conditioning of clusters of houses or large buildings in the summer.

Major advances in the configurations and production techniques for solar cells, based on the photo-voltaic effect, now look likely to do better than meet the Department of Energy goal of $500 per peak kilowatt by 1985. Meeting or exceeding this goal, coupled with the use of present or improved batteries for overnight storage, could make this type of solar electric power economically competitive with alternatives in areas without large seasonal fluctuations in solar insulation, as in most parts of the developing countries.

I am also convinced that more attention should be given to systems for using solar energy to provide for all energy needs for small communities and large urban areas than to active heating or cooling systems for individual houses or to large solar electric power systems designed to substitute for very large fossil-fueled or nuclear generating plants.

Solar energy systems look best when they are adapted to local settings. In rural and many urban fringe areas, solar energy systems can be coupled to food production and water management systems in ways that make multiple use of the components of each.

For example, water collected as runoff from solar collectors can be first used for storage and distribution of heat, and then for irrigation, making double or sometimes triple use of collectors, storage reservoirs, and water distribution systems.

My main suggestions for modifications of the present Department of Energy solar energy program are the following: first, give more emphasis to concepts that offer the possibility of major reductions in the costs of collectors, energy storage, and energy conversion to electricity, chemical fuels, and distributed heat.

Two, establish a few long-range programs under the same management for carrying out research, systems analysis and assessment, development, field demonstration, and stimulation of wide-scale diffusion of selected approaches to using solar energy to meet major fractions of local and regional energy demands. Assessment of the environmental, economic, social, and political impact of the selected technological approaches should commence at the beginning of such programs and provide feedback to their subsequent design and implementation.

Three, allocate substantial funds for the support of novel and promising research and development programs proposed directly to the Department of Energy, in addition to funds for programs selected on the basis of competitive bidding.

Four, establish solar technology assessment programs that include a wide range of assumptions concerning future energy demands, by type of end-use and form of end-use energy, giving special attention to opportunities for major increases in end-use efficiency.

Five, perform assessments of opportunities for constructive coupling of solar energy, food production, and water management systems on regional bases for the entire nation.

Six, select and establish specific programs designed to be of major assistance to the developing countries in their efforts to make greater and more effective use of solar energy.

And finally, do not carry out demonstration programs related to solar energy technologies that, in their demonstrated form, are not economically attractive ways to meet a significant fraction of national energy demands or for which the environmental impact of wide-scale use has not been assessed.

This concludes my prepared testimony. I'd be glad to try to answer your questions.

QUESTIONS AND REMARKS

DR. REZNEK: Thank you. I was interested in your remarks about water management. If I understood you right, you're proposing using the solar panels to collect rainwater?

DR. TAYLOR: That's one use. Any form of solar energy is going to require a lot of area to be covered with collectors. In cases where one is supplying essentially all of the local energy, in a high energy consumption society like ours, the areas that are involved are quite large.

It turns out, for example, that the rainfall on a collection system needed to support all the energy needs of a set of households is about equal to the average amount of municipal water those households use now. There are other examples of catchment basins that would go beyond the collectors themselves but would make use of land prepared for solar energy application.

MR. LEE: I just wanted to ask a question. Am I correct in -- as I listen to you, you are putting more emphasis on community use of solar energy technologies than individual use of solar energy technologies. The example you gave, I think, is demonstrative of the type of community-based technologies, and while a great many of the programs that have been put forth up to now have been either very large-scale solar electric, like the tower of power concept, and then very small-scale collectors on individuals' homes, you're sort of saying more emphasis should be on a more sort of middle area, where you could use it for community-based systems.

DR. TAYLOR: Exactly. If I had to characterize my main criticism of the present federal program, it is that it's left out that middle part.

I might add though, because I don't want to be misunderstood, that there are situations -- as in the New York metropolitan area and much of the area around here -- where there just isn't enough land to do this -- at least land at anything approaching acceptable cost. Under those conditions, one is going to have to move out into the fringe areas at least, and perhaps further out than that, to have enough land to put out collectors and storage ponds and so on.

But still, the guiding principle is, I think, generally, to collect the solar energy as close to the consumers as possible, but don't go to such a small scale that each householder has to look after the whole system and protect himself against big trees being grown next door and that sort of thing.

There are also economies of scale, which, as far as we can tell, top out somewhere around a few dozen houses.

DR. REZNEK: Do you envision solar systems replacing conventional heating and cooling systems of existing residences, or will most solar systems be installed in new buildings?

DR. TAYLOR: Well, I can see it penetrating existing -- being used in existing houses, particularly those houses that are now hooked up to district heating systems. There's a surprisingly large number of such houses in the United States; although district heating is not extremely common, it is the main way in which most clusters of houses at universities, faculty housing, many types of new developments are actually heated.

So there is an immediate possibility for plugging in, if you will, to hot water district heating systems that now exist. I think that I don't want to make too much of a claim that single-family house solar energy systems are not worth it. I believe I said that house designs, which can even be retrofits of old designs, of existing houses that tend to absorb energy in the winter and reject it in the summer are possible with most houses today that aren't properly designed.

So I think there can be a major commercial activity on the solar energy front, making use of these examples that already exist, of cases where even community-scale solar energy systems could be plugged in. Eventually, I think, attention to the scale appropriate for solar energy would make it look best if it were put into the original plans for new developments.

MR. OUTWATER: On number seven on the last page, there, where you talk about demonstration programs that don't seem to meet the significant fraction of the national energy demand, I presume you're talking about some that are now in existence, is that right?

DR. TAYLOR: Yes. I'm thinking particularly of a large fraction of the solar heating and cooling demonstration programs in which it's evident on the face of it that that particular system that's being demonstrated is not going to make it economically, except under very unusual cases, such that when all added up, they amount to a tiny fraction of the total energy demand of the United States.

Some of the demonstration programs are simply uneconomical on the face of it for any application. I see no excuse for that.

DR. REZNEK: Perhaps the most important barrier to multi-unit demonstrations is the documented short discount rate in new housing. The up-front costs and financing are much more important to the developer than to the individuals who would invest in their own solar system. A developer having twelve houses, for instance, has to find twelve people who are willing to extend their discount rate from the usual three-year return obtainable in the housing market. This might well be difficult. I wouldn't envision a penetration of a multi-house market without some sort of low interest bonding. Don't you agree?

DR. TAYLOR: I agree with that. I think the mechanism for doing that is to try to put these first costs into the same tax category as such things as the underground water systems that feed houses now with municipal water, the sewage systems, and so on, that are, in effect, paid for when one buys a house but through an effective charge for the so-called "improved" land, I don't think it's too far out to consider possibly a role even for municipal utilities to play, which is similar to what they play now with respect to supplying other services to houses in a conventional way.

That is, if a development is modified or a development is built which has, for example, a district heating system using solar energy, I don't see any fundamental reason why that could't be paid for in the same way that people pay for underground sewage pipes.

DR. REZNEK: Any further questions?

DR. REZNEK: Thank you.

DR. TAYLOR: Thank you.

DR. REZNEK: Our next witness is Dr. Thomas Sladek, Senior Project Engineer, Energy Division, Colorado School of Mines.

STATEMENT OF DR. THOMAS SLADEK, SENIOR PROJECT ENGINEER
ENERGY DIVISION
COLORADO SCHOOL OF MINES RESEARCH INSTITUTE

DR. SLADEK: Thank you, Mr. Chairman. I have a prepared statement which I'd like to read. Unfortunately, I did not bring along enough copies for you to have individual ones. I'll read through it verbatim, and I guess it will be gathered into the Record of the proceedings.

I'm a Chemical Engineer. I'm employed in the Energy Division of the Colorado School of Mines Research Institute, which is a not-for-profit contract research corporation somewhat tied to the School of Mines.

I have been involved in fuels research and development for about ten years, and most of my work has been focused on alternative energy sources, which I will define as anything except the conventional petroleum and natural gas which currently dominate the U.S. energy supply picture.

Included in this category of alternate energy sources are oil shale, coal processing, and conversion of coal to liquid and gaseous fuels, tar sands, utilization of carbonaceous waste materials, and biomass conversion.

The subject of my talk today is the latter item, biomass energy, and in particular the production of ethyl alcohol motor fuel from agricultural commodities. I will concentrate on ethanol gasoline motor fuel blends, the substance that the Nebraska Agricultural Products Industrial Utilization Committee has called "gasohol".

I notice from the program that Mr. Dick Merritt was one of your speakers yesterday, and I assume that he at least introduced this subject to you. It was mentioned briefly by the previous speaker also.

My most recent involvement with gasohol dates back to last November, when my company was hired by the Colorado Gasohol Task Force to assist in the preparation of a proposal to the U.S. Department of Agriculture. The proposal is to be in response to a USDA solicitation regarding guaranteed loans for construction of "pilot projects" to manufacture alcohol and industrial hydrocarbons from agricultural commodities and forest products.

This program is outside of the DOE Energy Development Program, but there are some good opportunities for interface with the Department of Energy research programs.

Since November, my activities in this project have been rather intense, because the time frame was perhaps not what might be desired. I expect that they will continue to be so until the final project proposal is delivered to the USDA sometime in October of this year.

The people of Colorado are very interested in the creation of a fuel alcohol industry in the state, and this interest is particularly noticeable in Colorado's extensive agricultural community. The farmers in Colorado are currently economically depressed, and they view fuel alcohol as an opportunity to improve their income, to improve the quality of life in Colorado's urban and rural regions, and in addition, to contribute to a resolution of the nation's energy problems.

I'm personally very excited about fuel alcohol development in Colorado. My excitement may be a reflection of my ignorance of the technical and economic problems which restrict utilization of alcohol fuels. I know quite a bit about other potential sources of synfuels, and I'm certainly not as excited about them as I am about this particular topic.

It may also be that after devoting much feverish activity to preparing a proposal for a Colorado alcohol project, I've come to the point where I'm beginning to sort of metabolize my own nonsense. It may also be -- and I hope that this is the case -- that there are really some advantages to the alcohol fuel concept, and that it does represent a potentially viable alternative source of liquid fuels for the transportation sector.

Certainly the alcohol project has been unique in my experience, because unlike potential projects to recover energy from coal or oil shale, the gasohol project has the enthusiastic support of a great diversity of people, including our federal legislators, our state governor, the Colorado State Assembly, the farm community, the academic community, and, with some degree of caution and reservation, the media and the environmental sector.

I have never encountered another situation in which the energy developer and the environmentalist can agree that perhaps this concept is worthy of some consideration after all, and that perhaps energy can be extracted from this resource without doing permanent damage to the delicate eco-system.

The Colorado Gasohol Project is such a concept, and therefore I believe that it's appropriate to discuss it at this vital hearing.

Fuel alcohol has many advantages, which I will enumerate now, and several disadvantages, which I will discuss subsequently. The first advantage is that it can be obtained from a renewable resource called biomass, a non-fossil fuel which is generated by the sun and soil with considerable help from the farmer.

In Colorado's situation, the biomass type which has received the greatest attention is agricultural produce, such as wheat, corn, grain sorghum, sugar beets, root potatoes, and other commodities. Alcohol may also be obtained from trees, from field residue such as cornstalks, and from other cellulosic commodities.

The biomass resource is vast and it is renewable. In Colorado, enough wheat, corn, sorghum, sugar beets, and potatoes are produced under normal conditions to generate over 430 million gallons of absolute ethanol each year. If blended with gasoline at the 10 percent level to produce what is commonly known as gasohol, this quantity of alcohol would supply three times as much motor fuel as is now consumed in the state in the form of gasoline.

About 10 percent of the agricultural production of these five major crops would supply enough gasohol to replace all of the gasoline which is currently consumed in the Denver metropolitan region.

A second major advantage of fuel ethanol is economic, and relates to the creation of a new market for farm produce. Colorado farmers and farmers in most other states are in an economically depressed condition, due to a current oversupply of food in the world market. The American farmer is perhaps too efficient and too hard-working for his own good. He has managed to produce more crops than the market can absorb, and he is now faced with surplus capacity, over-production, and market prices which do not even cover the costs of production.

If a reasonable portion of farm production capacity could be diverted to fuel, the increase in demand should have decidedly favorable effects on the farmer's income and lifestyle.

The third advantage of alcohol fuels is related to societal benefits and to national security. If a barrel of motor fuel is produced from biomass, then it does not have to be obtained from petroleum. The oil does not have to be imported, or alternatively, it does not have to be obtained from our increasingly scarce domestic reserves.

As indicated earlier, sufficient agricultural capacity does exist to provide a considerable quantity of fuel alcohol. Furthermore, alcohol fuels can be obtained from diseased or distressed commodities, from residues, and from other wastes which are otherwise unfit for consumption by human or animal. If these commodities are utilized for alcohol production, fuels can be provided to the transportation sector without reducing the net food supply.

The fourth advantage, and the last one I will discuss today, is environmental, and is responsible for much of the enthusiasm in Colorado for fuel alcohol. The air in Colorado's urban corridor is heavily polluted by what we residents call the "brown cloud" -- a dome of airborne sewage which extends for about fifty miles along the front range of the Rockies during the winter months, when we experience one of our frequent thermal inversions.

I'm sure you have all seen similar phenomena in the Los Angeles basin, over industrial cities in the Midwest, and even over Washington. The principal constituents of this brown cloud are nitrogen oxides, carbon monoxide, unburnt hydrocarbons, ozone, particulates, and sulfates. Over 60 percent of this air pollution has been related to automotive emissions.

This component results from the inability of conventional internal combustion engines to burn gasoline efficiently.

As part of my work for the Colorado Gasohol Task Force, I have been able to review several publications which indicate that automotive emissions can be reduced substantially if gasohol is substituted for gasoline. One example of this is the results of the two million mile fleet test, which was recently completed by the State of Nebraska. Mr. Merritt may have mentioned this yesterday.

The results show typical reductions of approximately 30 percent in carbon monoxide emissions when gasohol is substituted for unleaded regular gas. The study did not reveal any significant changes in nitrogen oxide emissions, nor in release of unburned hydrocarbons. The Nebraska study involved cars and light trucks which had been tuned for maximum performance with gasoline, and which were not retuned for gasohol.

In contrast, a 1975 study reported to the Society of Automotive Engineers that gasoline-powered cars and gasohol-powered cars emit similar levels of carbon monoxide and hydrocarbons when they are tuned to equivalent air-to-fuel ratios. However, the same study showed reductions in nitrogen oxide emissions of up to 20 percent for gasohol-fueled engines, when operated under the same conditions.

Unfortunately, these prior studies were conducted at much lower elevations than are common in Colorado. Our elevations range typically from about 5000 feet to a maximum of about 14,000 feet, with most of the people in the state living at elevations of about one mile. Most of the studies reported on previously have been performed at or quite close to sea level, and of course the change in elevation and the change in air density does affect the way that automobiles operate.

Colorado is presently initiating an emission study to determine if the residents of Colorado will realize the same benefits noted in the other locations. This work is critical to continued public support of the Colorado Gasohol Project.

If we are patient, it is likely that much of the brown cloud will go away, as our older cars are replaced by the new models, which are equipped with catalytic converters and other environmental controls. This gradual attrition process will take many years, because, like California, the benign climate in Denver's urban corridor results in very long automobile service lives.

It is difficult for the people of Colorado, and particularly those in the Denver area to be patient with this advice during the periods of health alerts, and it would be preferable to do something about the air pollution problem before it becomes so serious that the public health is threatened on a regular basis.

It appears, from what we've been able to obtain from the literature, that alcohol fuels may offer at least a temporary solution to a portion of the problem.

Coincidentally, addition of ethanol to a low octane gasoline blending base produces a high octane fuel, which is very suitable for older, high compression engines. These engines are not commonly equipped with catalytic converters, exhaust gas recirculators, or fuel injection, and these engines which are most in need of help, from an environmental viewpoint, are most benefited by the use of gasohol as a motor fuel.

In essence, the use of gasohol in these old engines produces a fuel retrofit. It does not require any modifications to the engine or drive train itself. Although emissions from gasohol-powered vehicles, particularly the older ones that have no emission control devices on them, would still not be within current EPA specifications, the reductions may be very significant and could help alleviate much of the air pollution problem in Denver.

As mentioned earlier, these potential benefits still need to be verified for the Colorado situation, but steps are being taken to see that this objective is accomplished.

On the negative side, fuel alcohol is expensive, and fuel alcohol manufacturing is energy-intensive. Fermentation ethanol is presently at least twice as expensive as refinery gasoline, and the pump price of gasohol would be from four to nine cents more per gallon than unleaded regular. This cost differential could be reduced substantially through innovative manufacturing techniques and through use of feedstocks which have no other marketing opportunity.

Alternatively, if the public decides that potential societal benefits, such as farm stabilization, pollution abatement, and reduced fossil fuel requirements, outweigh the factors of conventional economics, gasohol production could be incentivized through excise tax relief, through favorable tax accounting procedures and tax credits, or through other government subsidies.

Energy requirements for alcohol production can also be reduced through good engineering practices and with innovative processing techniques. Our preliminary studies of state of the art European fermentation plants indicate that fuel ethanol can be produced with a net gain in process energy. The energy balance becomes less favorable if the energy consumed in farming is included, but this problem can be resolved by using as fuels the field residues which are generated as co-products of farming operations.

In summary, ethanol motor fuels from biomass fermentation are technically feasible sources of liquid energy for the transportation sector. The processing technology is currently available, and it is very likely that significant process improvements can be achieved with relatively little supporting research and development.

The benefits which would be accrued by society due to use of fuel ethanol would include farm stabilization, reduced reliance on scarce fossil fuels, utilization of solar energy through a renewable resource, and possible reductions in air pollution from automobile engines. These potential benefits, I think, warrant your consideration, and I hope you will give them the attention they deserve.

Thank you for your attention. I'd be pleased to answer any questions that you might have.

DR. REZNEK: Thank you. Any questions?

QUESTIONS AND REMARKS

MR. GAMSE: What do you think the federal R&D program should be like in this area? Are there specific needs that the federal government should emphasize or incentives that need to be set up for the private sector, or what?

DR. SLADEK: DOE does have quite an active program in obtaining energy from biomass resources. A lot of the research and development that's currently being funded by DOE in this area is pretty long-range and would require, perhaps, five to ten years to commercialize the technology that is currently being developed. I believe that there are process improvements that could be implemented in the industry in a very short period of time without a great deal of R&D. I think these should be directed towards reducing the energy requirements for alcohol manufacturing and towards utilizing food residues such as cornstalks and other types of grain stover as fuels either in the plants themselves or in other, let's say, power-generated stations.

This is commonly done in the sugar refining industry in other countries, particularly in countries which obtain sugar from sugar cane. The sugar refining plants will use the solid component of the cane, called bagasse, to generate process steam and electricity for use in the plant. There's generally so much of this material available that they produce a surplus of power, which can then be sold into the power grid that also provides the plant.

I think the USDA program is quite a bit ahead of what DOE is presently contemplating. It is really designed to commercialize an alcohol industry within a very short period of time -- within the next, say, two to three years. People in Colorado, particularly the farmers, are doing everything they can to see that this industry gets started in Colorado.

DOE's goals are much more long-range than that. I think there needs to be some work in the middle ground on improving existing technology to make it more energy-efficient and less costly.

MR. LEE: I just have one question. You're dealing with a technology or a solution that still depends on nine parts gasoline to one part ethanol. The fact that you need the nine parts gasoline as we now know it -- is that an inhibiting factor when you take a look at projected oil supplies into the latter part of the 1990s and into the twenty-first century?

DR. SLADEK: Well, it is true that some gasoline is going to be required for use of the material called gasohol. I think that a 10 percent reduction in that supply is significant. That amounts to something like 700,000 barrels of fuel oil each day that would not have to be consumed for this purpose.

Alcohol itself is quite a good motor fuel, and it's possible to visualize the transformation away from gasoline and towards a pure alcohol fuel economy.

MR. LEE: Do you think more research should be done on that?

DR. SLADEK: Well, the combustion properties of alcohol are pretty well known. The problems that are created when you try to put alcohol through an engine designed for gasoline are pretty well known and quite easy to solve, although it does require some engine modification.

I think the research that would be directed towards producing alcohol for gasohol would be directly applicable to producing alcohol for use as a fuel by itself. So I don't really see any need for any shift in emphasis.

DR. REZNEK: What's the price of alcohol as a pure fuel?

DR. SLADEK: The current production cost of alcohol ranges anywhere from $.80 to about $1.20, depending on the type of process used and the cost of the feedstock consumed in the plant. It is possible to purchase ethyl alcohol made from converted wood sugar out of the Georgia Pacific Plant in Bellingham, Washington for $1.22 per gallon. Our estimates indicate that to produce absolute alcohol in Colorado would entail a market price of about $1.00 per gallon, which is about twice to two-and-a-half times the current price of refinery gasoline, so it's considerably more expensive.

DR. REZNEK: If you bring about an alcohol market, do you anticipate the displacement in agricultural production of foodstuffs?

DR. SLADEK: Well, one of the most interesting things about the alcohol production technique is that the fermentation by which the sugar in the commodity is converted to alcohol acts only upon the sugar in the plant; it does not affect the protein that's available in the plant, nor does if affect the cellulose. It's possible to process grain through the plant, recover a protein-rich concentrate, which is then available for use as a cattle feed for example, and if used as a cattle feed, would displace the corn which is normally consumed in the feed lot. That corn could be made available for human consumption, or alternatively, the acreage that produced that corn could be diverted into other food crops.

It's also possible to extract the protein from the grain before it's processed to alcohol to produce a protein isolate, which can then be used for human consumption.

It appears, from the limited statistics that I've been able to gather, that about 25 percent of our farm acreage is currently held in set-aside acres. In other words, it's not used for food production because there's just too much food available, at least in the domestic market.

If this acreage could be converted to producing commodities for alcohol production, certainly the amount of food available to the world would not be affected whatsoever.

DR. REZNEK: Have you done studies on the energy input, fertilizer, and that type of material necessary to produce an energy crop?

DR. SLADEK: I have not done studies personally; quite a bit of work has been done on this subject by the University of Nebraska and by the University of Illinois. The energy balance figures are not favorable, if you go back to the farm and look at the amount of energy that has to be put in, in terms of fertilizers prepared from natural gas, pesticides, and so forth.

There is a way around this, and I mentioned using the field residues as fuels. There is much more energy contained in the field residues than is contained in the food component of the agricultural commodity, but these things are currently simply plowed back into the soil and the energy is wasted totally.

There is another area of research that I did not mention, and it's a little difficult to relate this to DOE's prime function, but it would be developing crops which are ideal alcohol feedstocks, but which do not require as much farming energy as is currently employed for grain and sugar beet production.

DR REZNEK: When you plow the remaining material back into the field, you waste its energy value, but you return its nutrients and soil conditioning value, don't you?

DR. SLADEK: You return a portion of the nutrients to the soil. Some work that Nebraska has done indicates that you actually only have to return about 25 percent of the residue back to the soil to keep the nutrient level up to where it should be for further crop production.

DR. REZNEK: That's with no other artificial fertilizer additives?

DR. SLADEK: Well, no. I'm not being clear, I guess. If you don't put back 25 percent of the residue regardless of what else you're doing in terms of fertilizing and enriching the soil, you get into trouble. You interfere with the ability of the soil to produce. If you do put back 25 percent, then you're all right, provided that you carry on as you did before.

So according to Nebraska anyway, you can remove 75 percent of the residues and use them for other purposes -- the soil doesn't need them.

DR. REZNEK: If you do remove 75 percent, you'll increase the requirement for fertilizer and therefore energy input.

DR. SLADEK: I haven't examined that question in detail, but I believe that the University of Nebraska's findings indicated that you would not have to increase the amount of fertilizer.

DR. REZNEK: Thank you. Any other questions?

MR. OUTWATER: Yes. Is the capital investment to produce a gallon of this about the same as for a gallon of gasoline?

DR. SLADEK: The capital investment is about a dollar per gallon of annual capacity, so a 20 million gallon a year plant would require a capital investment of roughly 20 million dollars.

MR. OUTWATER: What is it in the oil industry?

DR. SLADEK: It's comparable; I think slightly larger, but on the same general order of magnitude.

MR. OUTWATER: Would you perceive, then, that the oil industry would pick this up as a portion of their production as their own reserves started to diminish? Is that where the scenario would go?

DR. SLADEK: I would think that would be extremely logical -- that they would get on to this as another potential source of raw material.

MR. OUTWATER: Is any portion of a refinery now utilizable in terms of this material -- for producing this material?

DR. SLADEK: Well, not unless you considered the utilities that go into a refinery. Producing alcohol from grain requires steam and electricity just as a refinery does. The alcohol, being a biological product, is quite different to obtain than, say, straight run gasoline or diesel fuel, so the processing equipment would be quite dissimilar.

Once you have the alcohol, all you have to do to prepare gasohol from it is to mix one part with nine parts of gasoline. That can be done in an oil drum or in the tank of the car.

DR. REZNEK. Any further questions?

Thank you.

DR. SLADEK: Thank you.

DR. REZNEK: The next witness is Mr. John Abbotts of the Public Interest Research Group.

STATEMENT OF MR. JOHN ABBOTTS
PUBLIC INTEREST RESEARCH GROUP

MR. ABBOTTS: Mr. Chairman and members of the Panel, thank you for the opportunity to testify. I am a Staff Member of the Public Interest Research Group (PIRG), an organization founded by Ralph Nader in 1970. PIRG's energy activities have included reports and testimony on nuclear and non-nuclear programs of the Energy Research and Development Administration (ERDA). PIRG representatives also testified at the 1975 and 1976 hearings held by the Council on Environmental Quality, on ERDA's non-nuclear energy programs.

My comments generally cover the Department of Energy 1979. The DOE budget suffers from the major defect of ERDA budgets -- the bias toward nuclear options at the expense of non-nuclear energy sources. I will also comment on an ERDA memo prepared for the Carter transition team, which indicates that the DOE budget slights solar energy.

DOE BUDGET

It is not possible to discuss non-nuclear energy programs without discussing nuclear programs: tilting toward one category will cause the other to suffer. DOE's fiscal year 1979 (FY '79) budget, like previous Energy Research and Development Administration budgets, contained a heavy and unjustified bias to nuclear programs.

Charts A and B, attached, compare the funding for FY '78 and FY '79 for programs which ERDA listed in its "Energy Research, Development, and Demonstration" category for fiscal year 1978. As the charts indicate, some of the nuclear programs are hidden in the DOE budget under new categories; they have been included in Charts A and B for a consistent comparison with last year's budget.

FUNDING SUMMARY - CHARTS A & B

Category	Budget Authority FY '78	Percent	FY '79	Percent
Conservation	307	9.4	407	12.5
Fossil	684	21.0	724	22.2
Geothermal	106	3.2	130	3.9
Solar	411	12.6	400	12.3
Non-Nuclear Total	1508	46.2	1661	50.9
Fusion	455	14.0	460	14.1
Nuclear Fuel Cycle and Safeguards	521		485	
Breeder	517		367	
Other Fission	260		291	
Fission Total	1298	39.8	1143	35.0
Nuclear-Fission and Fusion Total	1753	53.8	1603	49.1
Energy Budget Total	3261		3264	

This budget, to be sure, does represent a milestone: it is the first federal energy budget which gives less than half its funding to nuclear energy, although just barely so. So while credit must be given where it is due, DOE can only be credited with continuing the snail's-pace reallocation of funds from nuclear to non-nuclear programs.

The difference in the nuclear power budget from FY '78 to FY '79 is exactly the reduction in funding for the breeder reactor. The Department has yet to present a balanced energy research program which is either free from bias or justified by the potential of technologies to deliver energy. One is left with no other conclusion than that the only justification for this DOE budget is historical inertia, with a grudging reduction of the nuclear budget.

SOLAR BUDGET

The solar energy budget, moreover, has been reduced both in absolute dollars and percentage of the energy budget. Despite this reduction, there are clear indications that DOE can usefully spend more money on solar power. I wish to insert for the record the attached memo, titled "Realistic Maximum and Minimum Solar Energy Programs." This document was prepared by the Energy Research and Development Administration for the incoming Carter transition team. The Public Interest Research Group obtained this memo in July 1977 through a Freedom of Information Act request.

As a baseline program for fiscal year 1979, the memo suggested a budget of $520 million. This figure is in good agreement with a recent General Accounting Office report, which concluded that the solar program directors in the Department of Energy would be able to spend $555 million in fiscal year 1979, if they had the money.

But beyond the baseline budget, the memo notes that an additional $190 million could be spent on a "maximum realistic" program, taking the total funding for solar to $710 million. Most of this additional funding could go to distributed solar systems, to provide power for irrigation, houses, communities, and other on-site applications.

As the memo notes, many of these applications are presently served by liquid and gas fossil fuel, which the Administration increasingly is recognizing will not be displaced quickly by greater electrification.

Lastly, the memo to the transition team established a "minimum realistic" program. By reducing or eliminating demonstration projects from the baseline program, the minimum program would spend only $440 million for FY '79. As the memo notes, "the present public attitude would very likely be strongly opposed to a minimum solar R&D program so that option would be exceedingly difficult to implement without a sound rationale, which cannot be constructed at this time".

The Carter Administration's total solar budget of $400 million is $40 million below the "minimum realistic" budget, and Administration officials have not been able to develop a sound rationale for this miserly funding level. Officials have defended the solar budget by noting that, except for the cuts in the solar heating and cooling demonstration program, this year's budget is similar to last year's.

For example, the White House press office, responding to a question from a Washington Post reporter, noted that the bulk of the budget reduction had been in the heating and cooling area, and the reduction was justified by increases in other areas totaling $18 million. Simple arithmetic, however, shows that an $18 million increase does not offset a $23 million decrease in the heating and cooling budget.

Thus, the best that can be said of the Department's treatment of solar energy is that it reduced the heating and cooling demonstration program, but did nothing to compensate for that cutback. In short, DOE has little imagination or creativity in the solar area. While the Department attempts to keep nuclear projects at their present funding levels, in spite of growing disenchantment with the nuclear option, DOE fails to come up with new solar programs.

DOE should dramatically increase its solar funding and decrease its nuclear funding, if for no other reason than to come closer to the balanced energy research program that the Atomic Energy Commission and the Energy Research and Development Administration never had.

LACK OF PROGRESS IN ENERGY BUDGETS

It is frustrating to be giving this testimony before EPA. That is not because I expect little from EPA: the Council on Environmental Quality, as a result of its hearings on non-nuclear energy research, provided valuable recommendations for redirecting ERDA programs, and I have faith that EPA can follow that CEQ precedent.

But it is frustrating that public input to the Department of Energy must come from this roundabout route. Although ERDA did hold regional hearings on its national plans (ERDA-48 and ERDA 76-1), the Agency never held hearings in Washington, D.C., where the persons most familiar with the Agency's defects could present their comments directly to ERDA.

I suggest that one of EPA's recommendations to the Department of Energy be that DOE hold its own hearings, regionally and in the district, so criticism may be directly presented to Department officials.

I also recognize that this week's hearings will have little effect on the DOE budget for fiscal year 1979. That budget is already well on its way through Congress, and I can only hope that these comments will induce DOE to reform its budget next year. But we have already seen several years of hoping that next year the AEC or ERDA budget would become more balanced, and each year little progress has been seen.

I suspect that my frustration may be shared by such agencies as the Council on Environmental Quality (CEQ) and the Office of Technology Assessment (OTA). These offices no doubt hoped that their valuable suggestions for reforming the ERDA budget would be reflected in the following year's programs. Unfortunately, their criticisms remain valid for this year's DOE budget.

In 1975, for example, the Office of Technology Assessment found that "ERDA's program overemphasizes energy supply technology" relative to energy conservation. In 1976, OTA noted that ERDA had recognized conservation as an area for priority, but that its budget for conservation remained small. That criticism is still valid for the FY '79 DOE energy research budget.

In 1975, OTA noted that "The ERDA Plan appears to overemphasize electrification", and commented in 1976 that "Non-electric energy technology development is still underemphasized." Those remarks are still valid for the DOE budget.

OTA also noted both years that this overemphasis on electrical options extended to the Agency's solar programs. That comment also remains valid: DOE's budget gives $250 million, or 62 percent, of its solar budget to electrical applications, and the solar electric percentage is slightly higher than for the FY '78 budget. OTA also noted in 1975 that "The ERDA Plan relies on assumptions which appear to bias its priorities toward high technology, capital-intensive energy supply alternatives." DOE programs still suffer from an overemphasis on high technology projects, such as synthetic fuels, fission, and fusion.

The Council on Environmental Quality, in its September 1976 report, noted that ERDA needed to perform comparisons of different energy options so that the options could be ranked and priorities established rationally. CEQ noted that a sensible energy research, development, and demonstration (RD&D) program would require:" a process for deciding what RD&D should be done, based upon ongoing comparisons of all potential RD&D options whether they are supply- or conservation-oriented; comparisons based on comprehensive assessment of the energy, economic, environmental, and social impacts of the options."

ERDA never did perform such a side-by-side comparison to establish priorities among energy technologies. The Department of Energy has no intent of performing such a comparison in its National Energy Supply Strategy (NESS) analysis, and there are indications that the NESS might not even rank options merely by the amount of energy they can supply in the near- and long-term. Even performing this analysis would provide some rationality to DOE's research budget.

For example, ERDA, in 1975, established five scenarios as part of its National Plan for Energy RD&D. In the "No New Initiatives" scenario, solar energy, the breeder, fusion, and biomass all would provide no energy by the year 2000. In all other scenarios, solar -- including biomass -- was projected to provide more energy than the breeder and fusion combined.

Since 1975, the breeder's prospects have dimmed considerably, while even pro-nuclear officials in DOE are more optimistic about solar energy. Yet FY '79 will be the first federal budget which gives less money to the breeder than the entire solar program, and fusion still receives more money than solar. There is little to justify this state of affairs besides the inertia of historical biases.

In summary, this DOE budget is a business-as-usual budget, reflecting neither imagination nor the reform that is long past due.

In 1975, ERDA defended a miserly non-nuclear budget by noting that it was a new agency established with the funding imbalance of the Atomic Energy Commission. ERDA also denigrated the idea that funds to nuclear programs would detract from non-nuclear programs: the Agency promised to boost funding for all energy options and pursue each aggressively.

In 1976, ERDA asked observers not to judge the Agency's priorities by its funding levels: ERDA announced that conservation would be a high-priority item, but the budget for conservation changed little because existing programs -- chiefly nuclear power projects -- had an inertia which made their funding levels larger than higher priority programs. If that was the case, then there is all the more reason to cut back drastically on programs whose only rationale is history.

Finally, DOE has presented a budget which suffers from the same defects as ERDA budgets: although the numbers have changed somewhat, the overall flavor of the energy research program has not. It is still biased toward nuclear over non-nuclear options, energy supply over conservation options, and high technology, centralized projects over distributed energy options. One can also see that ERDA's previous statements about non-competition between energy sources were misleading: this DOE energy budget is almost exactly at the same level as last year's, and non-nuclear funding has grown only as nuclear funding has diminished.

Citizens have already waited too long for "next year's" budget to show the balanced energy program that the Atomic Energy Commission, ERDA, and now DOE have failed to produce, and it is long past time for a rational energy research program. DOE should conduct a side-by-side comparison to rank energy technologies; it should explain the rationale for its ranking; and it should adjust its budget to reflect that ranking. I urge EPA to make just such recommendations to the Department of Energy.

CHART A: NON-NUCLEAR ENERGY

Budget Authority, ERDA, and DOE budgets, Fiscal Years '78 and '79

(All figures rounded to millions of dollars)

Conservation	FY '78	FY '79
Electric Energy Systems	40	40
Energy Storage Systems	50	58
Industrial Energy Conservation	30	49
Buildings and Community Systems	55	59
Transportation	65	98
Improved Conversion Efficiency	59	78
Energy Extension	8	25
Conservation - Total	307	407

Fossil	FY '78	FY '79
Coal	579	618
Petroleum	74	80
Natural Gas	31	26
Fossil - Total	684	724
Geothermal - Total	106	130

Solar	FY '78	FY '79
Solar Heating	87	64
Solar Electric and Other	303	309
Biomass	21	27
Solar - Total	411	400

CHART B: NUCLEAR ENERGY

Budget Authority, ERDA and DOE Budgets, Fiscal Years '78 and '79

(All figures rounded to millions of dollars)

Fusion (a)	FY '78	FY '79
Magnetic Fusion (c)	325	334
Laser Fusion (d)	130	126
Fusion - Total	455	460

Nuclear Fuel Cycle and Safeguards (a)	FY '78	FY '79
Fuel Cycle (c)	285	247
U-235 Process Development	130	100
Uranium Resource Assessment (b)	65	95
Nuclear Material Security and Safeguards (d)	41	43
Nuclear Fuel Cycle - Total	521	485
Breeder - Total (c)	517	367

Other Fission (a)	FY '78	FY '79
Nuclear Research and Applications (c)	227	278
LWR Facilities (c)	28	10
Fuel Storage (c)	5	3
Other Fission - Total	260	291

Charts A and B Notes:

(a) Categories are taken from Statistical Highlights, U.S. Energy Research and Development Administration, Amended FY 1978 Budget to Congress, May 1977, pp. 6-14.

(b) Figures for FY '78 and FY '79 come from Budget Highlights, U.S. Department of Energy, FY 1979 Budget to Congress, January 1978, Energy Supply-Production, Demonstration, and Distribution, pp. 38-40.

(c) Figures for FY '78 and FY '79 come from Ibid., Energy Supply-Research and Technology Development, pp. 33-37.

(d) Figures for FY '78 and FY'79 come from Ibid., Atomic Energy Defense Activities, pp. 50-51.

ATTACHED MEMO

REALISTIC MAXIMUM AND MINIMUM SOLAR ENERGY PROGRAMS

I. ISSUE

Define options for realistic maximum and minimum programs, including justification for each and proper program mix within each. Include accelerated efforts in industrial process heat in the maximum case.

II. BACKGROUND

The federal solar energy program comprises varying amounts of research, development, and demonstration in each of seven major solar technology and end-use areas. These programs are aimed at bringing concepts to the point where demonstration projects can show technological and economic feasibility to potential customers, such as private homeowners, process industries, and electric utilities. Two solar technologies have potential to have significant near-to-mid-term impact.

The first technology is based on the direct use of solar energy for heating and cooling of buildings and for process heat in agricultural and industrial applications. This technology is relatively simple, and it is close to or actually economically competitive in several regions of the U.S. today. An industry is developing that can be the nucleus of the large industrial base needed to meet the goals of the program. To speed this development, ERDA is involved in research and development for product improvement and cost reduction, in demonstration programs, information dissemination, the development of standards, and in the identification of incentives.

The second near-to-mid-term technology is based on the conversion of biomass (e.g., cornhusks, wood chips, peanut shells, etc.) into gas and liquid fuels through various chemical or biological processes or by direct burning. The technology already exists to convert biomass on a relatively small scale, and R&D on technology improvement and larger scale process development is beginning. The efficient growth of trees and/or plants for later use in biomass applications is another key element of this technology. At present, biomass, mainly through burning of wood and wood residues, provides nearly one percent of the U.S. energy supply.

Solar electric power generation technologies include the following: the concentration of solar energy to produce steam to drive steam turbines or irrigation pumps; the employment of ocean temperature differences to drive heat engines that in turn generate electric power; wind energy; and the direct generation of electric power through the use of solar cells. All solar electric programs have demonstrated technical feasibility, but their economics are not yet competitive with alternate energy sources.

Wind technology is closest to being economically competitive. It needs a factor of 2-3 cost improvement; OTEC needs a factor of 3-5; thermal power, 20-30; and photo-voltaics, 30-50. The primary emphasis of the solar electric programs is on cost reduction through R&D and process engineering. If successful, this could lead to successive demonstrations of the economic feasibility of each technology in the 1982-to-1995 time frame.

Of the four solar electric technologies, only the OTEC program seems to have the potential of providing base load electric power capacity. The other solar electric technologies will have their most immediate applications as fuel savers used in conjunction with intermediate load plants, and, in limited situations, will result in capacity replacement of intermediate oil-burning systems. A cost breakthrough in energy storage could permit applications of these technologies to stand alone, distributed or base load capacity systems.

The present allocation of funds to the various solar technologies is the result of balancing a complex set of variables, including potential short-term and long-term impact of the technology, market readiness, technology readiness and complexity, degree of industrial capability, social and economic impact, and non-technical/non-economic barriers. No single factor can justify the mix and the present allocation is somewhat arbitrary, having been determined by management perceptions of the relative impact of the variables and the requirements needed to overcome existing problems.

Recently, the Assistant Administrator for Solar, Geothermal, and Advanced Energy Systems requested that the ERDA General Advisory Committee undertake an in-depth analysis of the present balance of the solar program in view of the ultimate promise of each technology, because there is reason to question the present distribution of effort.

It should be noted that solar heating and cooling of buildings, agricultural and industrial process heat, wind, and some elements of biomass are close to economic viability, while the solar thermal, photo-voltaic, and OTEC options require significant R&D before proceeding to market-oriented demonstrations.

III. STRATEGY OPTIONS FOR SOLAR ENERGY DEVELOPMENT

The development of any new product within the framework of the free enterprise system proceeds through three distinct phases. The first, often called the "create phase", consists of the research and development needed to establish the potential competitive position of any new concept in the marketplace.

The create phase is followed by manufacturing and market phases that are usually carried forward concurrently. A number of different options are possible in each phase. The choice depends on a number of factors, and, depending on which option is chosen in each phase, the product will advance more or less quickly into the marketplace.

The strategy of the present solar energy program consists of pursuing an agressive, sequential, primarily federally-funded research and development program in the create phase, followed by a program that relies on private industry to shoulder the responsibility in the manufacturing phase, and finally, a strong consumer-oriented incentives program to stimulate market growth in the marketplace. Strategies for pursuing maximum and minimum programs are shown and brief rationales for the paths chosen are included in the discussion of each option.

IV. OPTIONS

A. Realistic Maximum Program

It must be recognized at the outset that a detailed program plan or benefit-cost analysis for a realistic maximum program has not been carried out. This Issue Paper thus represents preliminary views on necessary associated new initiatives and provides preliminary estimates of the resources required to carry out a program where the private sector can fully exploit the results of the federal effort with minimum risk.

In contrast to the present program, a realistic maximum program would focus on a strong federal role in each of the create, manufacture, and market phases. The program strategy would involve a maximum effective federally-sponsored effort in the create phase by paralleling, to the maximum extent possible, research and development programs. In the manufacturing phase, federal funding or subsidization of manufacturing facilities to assure a strong manufacturing base would be undertaken.

In the marketplace, maximum incentives for buyers or users would be provided by the government. New federal initiatives in each of the phases would build on the current program to increase the probability of wide-scale deployment and commercialization and accelerate the acceptance of solar technologies.

Initiative No. 1 - Assure a Total Manufacturing and Delivery Capability by 1981-82 by Increasing Number of Solar Heating and Cooling Demonstrations

The present program plan calls for the demonstration of 3000-4000 units to address most technical system options, regional differences, key building types, and economics. In spite of this large demonstration, large-volume automated collector manufacturing lines will probably not be in place at the end of the demonstration period (1980). In order to assure a total manufacturing and delivery capability, this initiative would increase by a factor of four the federally-sponsored demonstrations on both private and federal buildings, and increase the industrial process heat demonstrations from 20 to 200. The additional funding required for this initiative is approximately as follows:

	FY'78	FY'79	FY'80	FY'81	FY'82
Additional Cost ($ million BA)	30	50	55	40	25

In order to have the desired impact by 1985, this initiative would have to begin immediately and build rapidly to a maximum by 1980. All elements of the demonstration program would be underway by 1978 and would be complete by 1982. Only modest follow-on costs would be expected beyond 1982.

Initiative No. 2 - Increase Development and Demonstration of Systems that Permit Distribution Use of Solar Energy

Distributed solar systems may have a number of attractive applications. At present, many of these applications are served by conventional energy sources, such as propane and natural gas, which are costly and susceptible to curtailment. A rough distribution of resources allocated in the present program to central power applications, as opposed to distributed power applications, is as follows:

	PROGRAM ELEMENT		
	Heating & Cooling	Solar Electric	Biomass
Central Power Application	0%	95%	10%
Distributed Power Application	100%	5%	90%
TOTAL	100%	100%	100%

The heating and cooling options are intrinsically distributed applications; no central utility is envisioned. Solar electric options are now heavily oriented toward central utility applications. Biomass can have central power applications as well as be a distributed source and produce transportable fuels. A realistic maximum program would support an aggressive effort to emphasize distributed solar use for irrigation, houses, communities, and other on-site applications. The additional cost of the initiative is shown below:

	FY'78	FY'79	FY'80	FY'81	FY'82
Additional Cost ($ million BA)	50	75	95	105	110

This level of effort will permit a great many more distributed use systems to be designed, tested, and demonstrated. If successful, this initiative could stimulate commercial use of such systems by 1985 and increase the impact of solar energy in the 1990-2000 period.

Initiative No. 3 - Parallel Research and Development Paths

This initiative takes advantage of the opportunity to increase the pace of research and development by paralleling those activites that are being funded sequentially in the present program. In addition, the initiative could encourage the investment in high-risk, high-payoff concepts that would not otherwise be supported.

The major elements of the initiative include research and development for air conditioning systems, retrofit components for solar heating and cooling systems, photo-voltaic processes for the direct production of electricity, high temperature collectors, and storage. The additional cost of the initiative is shown below:

	FY '78	FY '79	FY '80	FY '81	FY '82
Cost ($ million BA)	35	65	70	90	90

Primary R&D emphasis in the '78-'79 time frame would be on air conditioning systems and high temperature collectors, with later funding emphasizing the development of solar storage and retrofit systems. Throughout the period, a significant effort would be devoted to investigating cost reduction concepts related to solar cell systems.

Initiative No. 4 - Parallel Demonstration of Solar Electric Systems for Utility Application

The present plan allows for a limited number of utility-oriented solar electric systems. This initiative would allow for the concurrent demonstration of additional systems meeting different end-user requirements. Through these additional demonstrations, we could increase the probability that the configurations chosen would more nearly match varying utility market requirements. The additional funds required for this initiative in the next five years are shown below:

	FY '78	FY '79	FY '80	FY '81	FY '82
Cost ($ million BA)	0	0	30	50	100

Funds are not requested in FY 1978 and FY 1979 because this initiative assumes parallel demonstration of the electric options on initially the same scale as the present program. However, major capital investments would be required in the period beyond 1982 to complete this initiative.

Funding Summary for Key Initiatives

Funds to be added to the present plan for the realistic maximum program initiative are shown below. The four major new initiatives are estimated to cost two billion dollars above presently projected program costs over the next decade.

The program resulting from these increased funds would assure meeting present goals and would, through the first two initiatives, make possible a far greater impact for solar energy in the near term (1985).

TOTAL FUNDING INCREASE REQUIRED IN ADDITION TO PRESENT PLAN FOR REALISTIC MAXIMUM PROGRAM

INITIATIVE	'78	'79	'80	'81	'82
Accelerate SHACOB & AIPH	30	50	55	40	25
Increase Distributed R&D	50	75	95	105	110
Increase Parallel R&D	35	65	70	90	90
Central Utility Demos	-	-	30	50	100
	115	190	250	285	325
Present Program	415	520	550	595	660
TOTAL FUNDING	530	710	800	880	985

B. Minimum Realistic Program

The minimum realistic program consists of a sequential research and development option in the create phase of the solar energy development program. The R&D effort would be followed by a manufacturing phase in which incentives would be applied to encourage a reasonable entry of large industrial firms into the solar market. Such a program would rely on normal market forces to commercialize solar energy systems.

The additional assumptions needed to develop this minimum plan are that the federal research and development program would proceed with minimum parallel technical development; that development of solar technologies by the federal government would not go beyond minimum size, pilot plant demonstrations; that national policy would provide the fewest incentives necessary to entice industry to invest risk capital; and that the government would not be utilized as the first market to show economic viability. The change from the presently projected program to a minimum realistic effort would reduce expenditures over the next decade by about one billion dollars.

The reductions in the projected budget that might be made under this program result, almost entirely, from elimination of demonstration facilities. The solar heating and cooling of buildings demonstration program would be reduced to a minimum level consistent with the intent of the Solar Heating and Cooling Demonstration Act of 1974. Other demonstration programs would be highly selective. Each solar electric technology would be limited to a single demonstration project at the 10 MW pilot plant level, as opposed to the currently planned 100 MW levels. In the research phase, reliance on sequential activities would be mandated.

The minimum realistic program would be success-oriented -- i.e., the risk of failure would be greater than in the current program, but the program goals could still be met if major technical barriers do not arise in the research and development program; if all the objectives are met on schedule; and if the postulated manufacturing incentives successfully stimulate consumer demand and sustain market growth.

V. CONCLUDING REMARKS

There is a great public interest in solar technologies because of their attractive environmental and safety characteristics and because solar energy is free and available to all. As yet the public does not understand the very difficult cost barriers that must be overcome to make solar technologies competitive with alternate energy forms. Nevertheless, the present public attitude would very likely be strongly opposed to a minimum solar R&D program, and so that option would be exceedingly difficult to implement without a sound rationale, which cannot be constructed at this time.

END - ATTACHED MEMO

MR. ABBOTTS: That completes my prepared testimony.

DR. REZNEK: Thank you. Any comments?

QUESTIONS AND REMARKS

MR. GAMSE: We heard this morning that some of the environmental groups and other public interest groups, while advocating increased spending in areas such as solar energy, didn't have the technical basis for suggesting specific programs.

I'm not familiar with the ERDA memo that you have attached here, but I'm wondering if that provides some of the specifics of the experts that might be helpful with this problem.

MR. ABBOTTS: The memo is fairly general, but it does mention a couple of areas. The memo describes areas where ERDA could have gone from the baseline budget to a maximum realistic budget, and the additional funding there is, $190 million, and most of the applications would be distributed applications.

One area was an expanded heating and cooling demonstration program. I think, although the memo doesn't mention it, one of the areas that has been lacking in the heating and cooling demo program is the passive program. I think passive is being much more favorably viewed, particularly in the past few years, in the architectural community as probably the most cost-effective way for solar home heating.

If that's the case, I think that you'd want to -- If you want to encourage people to put solar units on their homes, one of the things you'd want to do is to make them aware of the option that's probably most cost-effective. So I think there's a potential for using heating and cooling demo funds for passive.

The second area that's identified in the memo refers to an "aggressive effort to emphasize distributed solar use for irrigation, houses, communities, and other on-site applications." And the third area that's identified is an area called parallel research and development paths, and the memo says: "The major elements of the initiative include research and development for air conditioning systems, retrofit components for solar heating and cooling systems, photo-voltaic processes for the direct production of electricity, high temperature collectors, and storage."

In terms of where DOE can spend the money, the General Accounting Office report that I referred to identified the different solar technologies and also identified where the money could be put, if the Program Directors had additional money.

MR. LEE: I'm just sort of curious about one thing. You talk about the need to rank -- and I agree with you on that -- and you talk a lot about the importance of stressing the solar budget over the nuclear budget. Do you believe that solar is really the top-ranked thing rather than conservation research and development at this time? Do you think that's where we ought to put the emphasis, or do you think we ought to do parallels in both conservation and solar?

MR. ABBOTTS: Well, I think that solar and conservation are areas that interact. Take the home heating area as one example: a solar home basically has to be -- a new solar home has to be designed from the ground up, and as part of the design you start with a very energy-efficient home.

In terms of ranking for energy R&D, I guess I would put solar ahead of conservation, because I feel that there are many conservation applications that are cost-effective right now.

DR. REZNEK: In designing an energy technology research program, two things are important. One is the promised net energy return. The other is the expected return on the research investment, which is to say, the extent to which research can help realize this promise. There can be great benefits to the society or to the nation of adopting an energy technology. Yet the utility of Federal investment in research in that area may be very limited. Some new technologies are technically fairly mature. Marketing, rather than research, is needed to realize their promise.

One of the steps in plotting a research strategy is to lay out what you expect to be the return of a research investment. Have you had any thoughts on how to incorporate expected return from research investment into a strategy for research allocation?

MR. ABBOTTS: Let me answer the question in a second, but preface it with sort of a philosophical viewpoint.

I would guess that, from a philosophical basis, I would really like to see no government involved in any energy technology: ideally, they should all compete in a free market in the real world.

But I think the political reality is that that's not going to happen, and with regard to solar versus other energy technology, the political reality is that the other technologies have had thirty years or so at least of government assistance in one way or another. In terms of "Where do we go from here?", the political reality is that we try and balance -- bring solar up to speed with the others.

In terms of the question of what your return is on an investment for different levels of funding, I have not done that analysis. The General Accounting Office did make the recommendation in their report that that does need to be done for the solar program, and I would agree, but I would also add that it shouldn't stop with the solar program. That analysis needs to be done for the other energy alternatives.

So the answer to the question is no, I have not done the analysis, but yes, I certainly agree that it would be beneficial.

DR. REZNEK: One of the concerns that is reflected in the federal energy research strategy is the enormous decrease over the last ten years in energy options available to energy decisionmakers in, say, the electrical utility industry. At one time they could burn natural gas, petroleum, or coal. Now many, if not all, of these options are shutting down. Boiling water reactors are, in fact, shutting down.

One of the purposes of the Federal energy research program is to open up options for energy decisionmakers. The effectiveness of research resources in opening up conservation options seems to be limited, compared to opening up breeder reactor options or wind power options.

Can you comment on that perspective on research investments?

MR. ABBOTTS: I can very generally and sort of off the top of my head. The conservation option, to me, is not a one-time thing. In other words, there are conservation options that right now are cost-effective, but that doesn't preclude new processes from being developed in the future -- and I guess that particularly would be in the industrial area.

In the area of building design and probably insulation, it may be true that while architects know how to build buildings that use half the energy of buildings that were built five years ago, there may not be that much more of a reduction. I really don't know.

But I would expect that, particularly in the industrial area, there is really a potential for advanced conservation technology.

DR. REZNEK: Any other questions?

Thank you.

MR. ABBOTTS: Thank you.

DR. REZNEK: Our next witness is Mr. DeLoss, the Washington Representative of the Environmental Policy Center.

STATEMENT OF MR. GARRY DELOSS
WASHINGTON REPRESENTATIVE,
ENVIRONMENTAL POLICY CENTER

MR. DELOSS: I apologize for not having more copies of my statement, but I'll leave it with you for the Record. Unfortunately, I just got done writing it this morning; our copy machine's broken.

Basically I've narrowed my comments down to one point. I'm here to explain why I believe that the Department of Energy's decision to reduce spending on its solar heating demonstrations is wrong, and why, instead, spending on demonstrations of solar heating and energy conservation in buildings should be increased.

In the proposed fiscal year 1979 budget for the Department of Energy which President Carter sent to Congress, the spending for the solar heating and cooling of buildings demonstration program was reduced by $28 million, from $64.4 million in fiscal year 1978 to $36 million in fiscal year 1979.

Critics of this decision have received a two-part rationalization for the cut in funds: first, that solar heating has been proven to be technically and economically feasible and its further development should be left largely to the forces of the private market; and second, that the prospect of federal tax credit for solar energy investments will more than offset the cut in funding for the demonstration program. Both these explanations are inadequate.

Let us examine first the argument that since the technical and economic feasibility of solar heating has been adequately demonstrated, government-funded demonstrations should be cut back in favor of allowing market forces to take over. There are two flaws in this argument.

First, the economic feasibility of solar heating has not been adequately demonstrated due to weaknesses in the federal demonstration program, including failure to promote development and demonstration of low-cost solar heating systems, and failure to collect sufficient cost data on solar heating demonstrations that are funded.

The failure to promote low-cost solar heating demonstrations is illustrated by the past failure to promote demonstration of passive solar heating designs. Only recently has DOE begun to think seriously about promoting passive solar systems. I might interject that even in the area of active solar systems, if you look at some of their contract fundings, you have to really search hard to find any kind of a contract in a research and development or demonstration program that specifically tries to elicit low-cost collector systems.

The failure to collect adequate cost data is a result of DOE's predeliction for collecting too much data. According to one expert observer whom I consulted on this point, only 1 to 2 percent of the present demonstrations are being instrumented to collect performance data that will disclose the dollars per Btu cost of energy from the solar systems. His view is that it would be better to develop a less sophisticated and less expensive means of collecting performance data and apply it to about 20 percent of the demonstration projects instead of the 1 to 2 percent I noted.

He believes that rough cost data, with an error range of plus or minus 15 to 20 percent, on a large sample of projects would provide the information needed by potential investors.

Even if the technical and economic feasibility of solar heating had been demonstrated, there would be a second flaw in the argument that government funding of solar heating demonstration should be ended. It is well understood that there are many barriers to the use of solar heating beyond technical and economic feasibility. These non-technical and non-economic barriers are generally characterized as institutional barriers to the development of solar heating.

A major institutional barrier that government-funded demonstrations can reduce is the reluctance of consumers and builders to invest in an unfamiliar technology. The building construction industry is notoriously slow to adopt new technologies, largely due to its extreme fragmentation. There are 300,000 firms in the building industry, and 90 percent of them produce fewer than 100 units per year.

Turning now to the argument that a prospective federal tax credit for solar energy investments will make up for the reduced funding of solar heating demonstrations, one must ask how many more people would respond to the tax credit incentives if they could see a nearby demonstration project. Rather than being viewed as mutually exclusive, government promotions of solar heating, the demonstrations and the tax credits should be viewed as mutually reinforcing programs.

The more widespread our government-funded demonstrations, the more potential investors in solar heating will gain a first-hand familiarity with nearby solar demonstrations and hence be moved to take advantage of the tax credit.

There are other basic problems from relying too much on the tax credit as a means of stimulating use of solar heating. One problem is that 40 percent of the housing in this country is rental housing. Renters won't install solar heating systems in a landlord's building, and landlords won't make the investment because they don't pay the utility bills and because they can't find a way to bill their renters for solar energy.

Some novel demonstration projects are needed to cope with this problem. Perhaps a demonstration of a solar heating system for a multi-family dwelling could be designed to permit landlords to collect a return on their investment in the solar heating system.

Another problem with the tax credit is that its incentive effect is primarily on the consumer who orders a custom-built home, rather than on the developer who builds dozens of homes on speculation. The mass builder, who is gambling large amounts of money on a housing development, is very skeptical about something as new and untried as solar heating, even when tax incentives are offered. More solar heating demonstrations are needed to convince builders and their sources of financing that solar heating is a good risk.

Perhaps the case where government-funded solar heating demonstrations are most needed is for passive solar heating systems. At least in the case of active solar heating systems, there is a developing industry of manufacturers and vendors of solar water heating systems and solar space heating systems who will work hard to promote their products to consumers and developers.

In the case of passive solar systems, however, there is no hardware industry of inventors, entrepreneurs, manufacturers, vendors, and installers knocking on the doors of consumers and building developers. Since private forces by themselves will be less likely to lead to consumer and builder acceptance of passive solar systems, as contrasted with active solar systems, more government demonstrations and other educational efforts are needed.

Ironically, then, the most economic systems for solar heating -- that is, the passive systems -- may require the most government intervention to achieve widespread public acceptance.

In summary, I believe that a good case can be made for expanding the federal funding of solar heating demonstrations rather than cutting back on that program.

Thank you.

DR. REZNEK: Thank you. Are there questions?

QUESTIONS AND REMARKS

MR. OUTWATER: Mr. DeLoss, what you're advocating is sort of a demonstration in every backyard?

MR. DELOSS: Sure, I'd be glad to say that. I think, for example, you could at least have one in every county seat in the United States. They're usually fairly centrally located; people go to and from them to market and to business with their local governmental entities.

MR. OUTWATER: You mean you really believe that the public still isn't particularly informed on solar energy and really wouldn't make the investment if the case were made clear that they would get some tax incentive and it would be really worth it? What we seem to have heard this afternoon is that there seems to be hardware around, but there seems to be a lack of good hardware and there seems to be a lack of certifying warranties to this; there seems to be a lack of people to install the stuff. In essence, there seems to be a lack of enough impetus in the industry to get behind this and get a good solid program going of making these units.

Just for the government to go out and start funding a whole bunch more of these things would be silly when we've had a number of witnesses who said "Let's not fund any more lousy demonstration projects".

DR. DELOSS: Well, let's just look at my point about passive systems for a minute. Let's say that you deal satisfactorily with all of the institutional barriers to the adoption of active solar systems that have been raised, including the standard-setting, the warranties -- you have the infrastructure in place, and so on. Those people are marketing active systems, and as I pointed out, they aren't out selling passive systems because there's not much hardware to sell. You know, what do you sell? The thermal fly-wheel? Some extra concrete blocks or water tanks to soak up the sun when it comes in the window? Or maybe some extra glass for the south side of the house?

Really, I would like to see especially a lot of passive systems demonstrated, because I think there is a growing awareness that there are some regional distinctions you want to make with passive systems. That's all the more reason not just to demonstrate them in New Mexico, for example, where they have a very interesting side-by-side demonstration of different passive systems in some dormitory buildings there.

I think that the need to convince consumers and builders who are going to make these investments applies still to active systems as well as passive ones, even after you solve all the institutional barriers, because one of the biggest institutional barriers is really consumer confidence -- investor confidence, and demonstrations are aimed at that.

MR. OUTWATER: I have one other problem, and that is with your number of renters. One of the places I think we seem to agree that solar energy doesn't have an immediate application is in congested urban areas where we don't have the room for the panels, and I would suppose that most of our renters are in urban areas, isn't that correct? Or is that incorrect?

MR. DELOSS: Well, I come from -- my home originally and which I return to frequently is a small town in Iowa of about 10,000, and there are a lot of renters in a town like that, especially since it's growing and there's a transient population.

I have some personal familiarity with the landlord problem, because my mother and my brother are both landlords, and when I go home and talk to them about solar energy, they're very interested and curious, but they won't make investments in it.

However, I think that on high-rise buildings, you can make investments, as well as in the smaller single home rental and, let's say, a four-, six-, or eight-unit apartment building. Even in a large high-rise building you could make investments in solar water heating. Space heating requirements, after all, in a building like that are lower than in the smaller units anyhow, and so what you might really want to focus on is solar hot water heating.

But again, the landlord has a problem in seeing how he's going to recoup his investment, and I don't think this has been addressed, frankly. I spoke with Alan Hirshberg about this yesterday, and he was Product Manager for Project SAGE in California, which was a demonstration program involving multi-family housing, but I don't believe that they focused on the problem --you know, took it another step further.

They were looking at technical and economic feasibility, but they weren't looking at this question of making it an attractive investment for the building owner. I don't think that was part of what they were looking at, and somebody should be thinking about this.

There must be ways to do this. Now, the one way that I've heard of that's been talked about, and which is going to be the subject of a workshop here in Washington tonight and tomorrow, is getting utilities involved, and to a certain extent, that addresses the rental housing issue, because then the utility would be charging the renter some kind of a fee for the use of a solar system.

Now, maybe landlords could find a way to do that. But it has to be addressed. In Washington, 65 percent of the housing is rental, and if you're talking about getting a very big market penetration in housing, you've got to address that. And don't forget that even in the owner-occupied housing, as I've pointed out, a lot of the so-called "incentives" really aren't going to operate very well, so you're really talking about more than 40 percent nationally and more than 65 percent in Washington, where things like the tax credit really don't work.

With the tax credit, you may only be talking about a price signal and an incentive that only reaches a very small fraction of the total housing in this country; it may be 25 percent or 20 -- I don't know. But it's much less than most of its advocates believe.

DR. REZNEK: Isn't it true that at current funding levels you could build a solar house in every county seat?

MR. DELOSS: Well, that may have something to do with this overly sophisticated instrumentation I was referring to.

DR. REZNEK: But the current funding is large enough to do that right now.

MR. DELOSS: You mean for solar demonstrations?

DR. REZNEK: Isn't it large enough?

MR. DELOSS: If you looked at -- what was the number for fiscal '79? It's going to be $36 million in fiscal '79.

DR. REZNEK: How many counties are there? There are 2200 or 3000. It seems to me you could put one in every county with one year's funding.

MR. DELOSS: Well, it's not being done that way.

DR. REZNEK: Well, perhaps its more efficient not to do it.

MR. DELOSS: I can go back and do some arithmetic and try to figure out roughly what it might cost to do this, but remember, if you're talking about demonstrating passive systems, you're talking about a different kind of demonstration program. In fact, in the passive plan that's being developed at

DOE -- I talked to people over there this week, and they are not talking about building buildings that are heated by passive systems. They're talking about a design award system to get architects to think about it.

What I'm talking about is actually putting one in -- building the structure that has these design elements in it. Now, that's maybe more expensive than the active system demonstration program, and so this same amount of money may not spread around as widely as if you were just demonstrating solar water heaters.

DR. REZNEK: Could you do that with next year's funding? I am perhaps being a trifle aggressive. My point is -- perhaps further demonstration is not necessary. What may be necessary is documentation of what has been achieved and dissemination of the information.

MR. DELOSS: Well, I'll be glad to respond; I'll be glad to try to figure out what I think, roughly speaking, it would take to create an adequate number of demonstrations -- let's just focus on one issue here -- of passive design systems, where you might want to have side-by-side demonstrations of two or three or four basic passive designs, regionally adapted, in a certain number of population centers around the country.

I didn't do anything that elaborate for this testimony, but I'd be very happy to try to respond to that in some detail. I think it's a very proper direction to think about.

DR. REZNEK: Thank you.

MR. LEE: I have one question I asked the preceding witness. You represent the Environmental Policy Center, and you spoke here today on solar energy, and as you know, any budget has certain limitations. There's a ceiling on how much money there can be in it, and it is our job really to allocate within certain bounds.

Why have you felt that solar should be the priority in the R&D budget over things like conservation or some of the other solar-related activities that we heard about today -- wind and biomass? Why do you put your priority on solar?

MR. DELOSS: Well, I wouldn't say I would put my priority on solar above conservation. Especially when you're talking about passive design factors, you're really talking about a building that is designed with conservation in mind and then passive solar gain in addition to that, so you have to start with conservation.

However, my primary concern for conservation in residental buildings, which is the topic I was addressing in the solar area, has to do with the government regulatory process and not R&D, because I'm very interested in mandatory retrofit of existing housing at the point of sale -- something that the State of Minnesota is already moving toward. So I really didn't address that issue.

With respect to the alternative investments in the solar area, I guess I can give at least a two-part answer. One is: I wouldn't accept the constraint on the solar budget that's presently placed around it and say we have to shift money around in the solar budget only. I would look for money outside of that and move it in.

Number two: after you decide how much you are going to have in the solar budget -- if you could add some from the outside, it would be great -- then I would try to establish some priorities that have to do with your payoff. I think one of the problems is that, in the past, in ERDA and now at DOE, there hasn't been enough concern for ranking priorities.

First it was not ranking priorities comparing solar to other investment opportunities in the RD&D area; they've specifically avoided that. I testified mostly on that point at the last hearing on the non-nuclear R&D budget. Since they have avoided it in general -- doing this kind of ranking -- that means they've ended up avoiding doing it specifically for solar as well as for everything else, and I think it's a long-neglected area that people should be working on.

I don't think that people on the outside such as myself have the capability to do it for them. Now, we have some very broad conceptual views on this, and there is some practical experience that would point people in the right direction, but the really tough work that should be done here has been neglected for years, and they really should be allocating a lot more of their resources in the direction of ranking so that they can come out with a budget that has the right priorities.

DR. REZNEK: Any further questions?

Thank you.

MR. DELOSS: Thank you.

DR. REZNEK: Our next witness is Dr. Donald Anderson, Director of the Mid-American Solar Energy Center.

STATEMENT OF DR. DONALD ANDERSON, DIRECTOR
MID-AMERICAN SOLAR ENERGY CENTER

DR. ANDERSON: In a sense, I appear here describing the results of the planning process funded by the Department of Energy, and of course also as a representative of an organization which was designated by the North Central states as one of the four groups planning for regional activities in commercialization of solar energy and related conservation activities.

More importantly, I am looking at the issues addressed at this session. I would like to, in a sense, act as a spokesman for some 852 experts in the twelve North Central states, who are participants in this planning process, and without going into any detail of the material that I've presented here as a written record, to attempt to summarize the intent of this planning process and some of the findings of the process.

The way in which the planning operation in the North Central states was accomplished under a planning grant from the Department of Energy -- originally ERDA -- between July and January in this last six months, was to ask the governors of the twelve states represented--basically the two North Central census districts--to designate their representative on an advisory council of states.

In turn, the planning team asked those designees the following question: would you please identify, in eighteen different areas of expert interest, those you would turn to first for advice in regard to solar commercialization?

These eighteen areas ranged from societal and institutional issues to those that were strictly technological. In this way we were able to gather a total group of some 852 North Central states' representatives, whose backgrounds ranged, for example, from finance through education through those involved in the legislative process both at the local and the state level and the like.

In turn, representatives from these groups were invited to attend topical planning conferences at which they themselves generated the elements of questionnnaires, which were mailed out to the entire group of experts, asking a series of questions in three different questionnaires, identifying a number of issues with regard to their perceived priorities for different solar commercialization activities, and equally importantly, their perceived relative significance of the performance of these priority activities at the national level, at the regional level, at the state, local, and finally in the private sector.

By going through this process -- for example, in the first questionnaire asking this panel of experts to respond to some 356 different question elements and then processing these -- I think we managed to obtain a good deal of information which is quite quantitative and specific as regards at least the interest of the twelve North Central states.

As I commented, we were one of four planning teams involved in performing activities of this sort for the fifty states. In comparing notes with those involved in planning in the other regions and looking at the nature of the responses to the questionnaires and participation in the planning process, I think that, in many cases, it's very much the case that this is fairly representative of the interests and concerns of the entire nation.

In the first of the three questionnaires which was presented, we asked a series of questions with regard to relative priorities of different actions that might be taken to assist in the development of viable solar alternatives as a meaningful part of the energy mix in the twelve state region, both with regard to the priority of the action itself and with regard to the relative importance of the different performers who might take part in such actions, ranging from national to private industry.

It turns out that, first of all, to that particular questionnaire, there was close to a 55 percent response on a questionnaire that took some hours to respond to per person, and there was a rather tight correlation and fairly good agreement among the participants in each of the twelve states and through the eighteen different interest areas.

I would like to read from page II-21 of that representation and the pages that follow those items that were identified as the ranked products, first of all, of maximum interest in general activities at the regional level, then going on through the ones that follow.

With regard to regional concern, seven different areas were identified as being of primary importance, both for being performed and for being performed on a regional level. In general, they have to do with disseminating information -- and if I can add, in a sense, an overview of the results of this full questionnaire process, the closest one can come to a consensus of this broad range is that of recognizing that the decisionmakers, in the process of commercializing as opposed to R&D, are spread through a broad spectrum of different interests, ranging, of course, from the energy users through those who would anticipate, in a sense, making a market or having a business part in the applications of solar energy, whether it's wind, biomass, or thermal applications, and including, then, those who are involved in the energy issues from a regulatory or legislative process as well.

In almost all areas, the general concern was that providing credible information pertinent to the particular application in a format that was appropriate to the user of that information -- which is obviously different, for example, for the person who would make a decision with regard to mortgage commitments on a passive solar home than it is for, say, an architect who would like to become much more competent in energy-efficient design -- is by far the highest priority level activity.

There are many of these things that are appropriate for regionally cooperative efforts, since they are frequently quite specific to climatic variables, to local building practices and the like, and to state involvement, since they're so heavily involved in the information delivery process known as education.

The specific activities felt to be most important in this regard had to do with collecting, disseminating, and exchanging solar energy information. The results of research specifically and quite highly placed those things that have to do with climate issues, and, in particular, a perceived concern that modeling of the resource available -- wind, solar, and the like -- as it pertains to a particular application, in a standard format, so that the designer of a particular application who is not promising different performance than a competitor, as a consequence of, for example, promising more sunshine, is a very important aspect.

Information regarding systems and hardware available; collecting, disseminating, and exchanging information on economic and financial issues are ranked very highly. In a very real sense, of course, many of the factors involving the decisionmaking process in the commercialization venture had to do with full insight, and in many cases, education concerning them -- life cycle cost payback issues and the like.

Interestingly enough, with very high correlation of those who participated in the process from the legislative group, there was a high priority on providing educational programs and energy-related information for legislative and regulatory bodies, who are very definitely recognizing their limitations on having, again, credible and unbiased information in an appropriate fashion -- an overtone, of course, as I mentioned before, of educational and instructional issues.

The questionnaire could be cross-sorted to identify those things that were pertinent to the involvement at the state level and at local levels, and finally, private responsibility.

Rather than going through all of these -- because this is much more than a ten-minute summary -- I would like to, in a sense, go to the opposite end of the spectrum and look at the concerns of this same group with regard to the highly-ranked private responsibility issues.

There was considerable concern on providing appropriate vehicles for, in a sense, the doing and performing of technology-related activities, involving the private sector as heavily as possible. Assistance to, for example, emerging industries and the small businesses who must be a part of making a market not only, for example, in manufacturing hardware, but in terms of design, installation, maintenance activities and the like -- these were ranked very highly by this grass roots set of sectors as things that have to occur before we can really have a commercial marketplace.

In the same sense, providing education programs for manufacturers themselves, for the installers and the like, was felt to be an appropriate and high priority for the private sector where the involvement did have to occur.

The general consensus within this twelve-state region, by the way, is quite favorably inclined to solar energy in the broad sense -- wind, biomass, and direct solar applications -- as having a good deal of promise in the future, and as being potentially cost-effective for many of the applications, if the full infrastructures develop so that all of the parts of the commercialization process are in place, and if sufficient activity can be developed.

In a general sense, those twelve states are at the end of the pipeline with regard to almost all forms of energy, and a rather surprising statistic is that if you look at the net energy imported into these heartland states from outside the boundaries of the twelve-state region, and compare that to the net energy imported into the United States in total, 126 percent of all energy imported into the United States is imported into that twelve-state region, much of it from Canada, and of course much of it by shipment and trans-shipment with other parts of the United States.

But we have a combination of a high base of agriculture, and, of course, related, a good deal of interest in biomass applications; a great deal of concern about the need for climate control, not as a comfort heating application but for sheer survival in a typical winter; and a favorable combination of climatic variables -- a long heating season and relatively high costs of the conventional forms of energy in the near future. So I think there's a good deal of promise for development of a significant total solar activity in these areas.

I report the results of these questionnaires to you primarily to provide a rather extensive series of prioritized activities and some fairly informed opinions with regard to the appropriate part in the puzzle for state activities, local activities, the private sector, and where national activities could take place.

I think that's enough to summarize, in a very broad sense, much more than I can go into in detail. Thank you.

DR. REZNEK: Thank you.

QUESTIONS AND REMARKS

DR. REZNEK: Just to nail it down firmly, I'd like to address your emphasis on disseminating technical information, making it available and putting it in a form that is usable by a spectrum of users. I take it, though you didn't say it as directly as maybe I would have, that you feel this good technical communication is not happening.

DR. ANDERSON: That's right. And knowing that within the computer system all things ever published are available is of no help to someone in many of the different sectors that we have available. It's not packaged appropriately, and they don't have the capability, in a sense, of also critically assessing conflicting claims and promises of performance from different kinds of alternative energy sources and projections made based on measurements or modeling done in different parts of the country, as it pertains to a particular application and location.

DR. REZNEK: There are several ways of getting that type of information and making it available to the public. A federal clearing-house would be one way. Another would be to foster an independent underwriters' laboratory to evaluate technical reports and documents. Perhaps such an underwriting establishment could be initiated with federal support, and as it matured, it would develop an adequate clientele and become self-supporting.

Have you looked into alternative mechanisms for making that kind of information available?

DR. ANDERSON: Rather extensively, and going along with the recommendations of this broad body of opinion. I think it is important to remember that as a viable industry develops, this might well be quite appropriate for the private sector itself to undertake, and it will do so, as for example the American Gas Association has done many activities in the past, very credibly and very reliably.

The primary problem is that of not saying that the federal government needs to intervene in order to make it happen. It's much more appropriate to say that by having intervention and support in the early stages, we can compress something that normally takes two or three decades into a much shorter period of time by having clearing-house kinds of activities -- unbiased advocates of the general alternative energy scheme, but not of the particular manufacturer or particular process, carefully assessing the claims and promises of different options for different applications and then making that information available -- packaging it, and letting it flow through a very extensive delivery mechanism, that already exists, of course, within the nation through the educational institutions and the like.

DR. REZNEK: I don't know if Panel members are supposed to say this, but I must say I certainly agree with you.

DR. ANDERSON: Thank you.

MR. LEE: I'd like to just ask you one question. Accepting that the information is collected, the information is obtained, and you're disseminating it, when you are setting up the discussions of the Mid-American Solar Energy Complex -- I guess you'd call yourselves --

DR. ANDERSON: Right.

MR. LEE: What role does the Complex play versus the role of state government, versus the role of local education and counties in disseminating that information? Have you developed a matrix of how that happens?

DR. ANDERSON: In a general sense, yes. In detail, obviously, this takes some time to flesh out, and I would like to do this by using an example -- and it's an example I've used many times.

In the absence of any regional activities or support from outside of the state matrix, you will find, without question -- and it's already occurring -- that, for example, a given educational institution, in looking at its continuing education programs, may well say, "Let's develop a program to retread architects." In other words, add to their total matrix skills the energy sensitivity in design features that was not a part of the curriculum of the average architect of even a few years ago.

Without other forms of support, you would find a given university, as a consequence, releasing a staff member for probably a summer to become an expert in solar energy and to write class notes. He would then pilot it with his first program and continue with this.

You can get a tremendous amount of overall improvement in the information package available and in their ability to deliver this, if you could just provide a vehicle for having, for example, twelve states with common regional concerns have a common workshop over the course of one summer to develop a total curriculum. Then each of them would take it back, pilot it in one particular program, perhaps refine that in the second summer -- to take the edges off it -- and have a set of information disseminated throughout the region that was much more extensive, in terms of looking at all of the options and weighing the different options, than if each of the twelve tried to do it separately.

To a large extent, it's trying to find ways to matchmake, to facilitate, and to link existing performers and existing information dissemination routes, rather than establishing new ones, that can give us a lot of impact in a hurry.

MR. OUTWATER: As long as you've got a questionnaire, I think it's interesting -- I'm sorry the rest of the people out here can't see it -- but, for instance, in a ranked national responsibility, it's interesting to see that demonstration projects are like seventeenth in there --

DR. ANDERSON: There were a number of surprises.

MR. OUTWATER: -- whereas right at the top is financial incentives.

DR. ANDERSON: Yes.

MR. OUTWATER. Higher than that, the first is, I guess you would say, promoting conservation, since it's promoting public awareness of the energy crisis. But your questionnaire seems to follow the general trend of the people that have been testifying this afternoon, when you get down to state responsibilities and some private; when you get to the training of operators, the warranties and equipment, and the sort of things that have come up occasionally this afternoon.

DR. ANDERSON: I think it was quite gratifying that, by taking this large a sample -- and far from a random sample, but rather a structured cross-section--through what are basically, in their own area, informed expert sources of opinion, which may or may not be, for example, education or finance -- there was as much consensus and strong correlation as we did find in this process.

DR. REZNEK: Any further questions?

Thank you.

DR. ANDERSON: Thank you.

DR. REZNEK: Our next witness is Mr. Norman Clapp, Vice President of Energy Development and Resources Corporation.

STATEMENT OF MR. NORMAN M. CLAPP, VICE PRESIDENT
ENERGY DEVELOPMENT AND RESOURCES CORPORATION

MR. CLAPP: Mr. Chairman and members of the Panel, first of all, perhaps I should identify myself and my role here. I am Vice President of the Energy Development and Resources Corporation, which I guess is perhaps better known by the name of its Chairman of the Board and Chief Executive Officer, Mr. David Lillienthal.

I'm here to work both sides of the street. You're interested in conservation and solar power; what I want to talk about today is properly classified in both categories, namely hydroelectric development and particularly the hydroelectric development that is available to us by the use of existing dam structures.

I know I do not need to refer you to the report of the Corps of Engineers, which came out of its ninety-day study directed by the President last year, dealing with the potential in this field.

Briefly, I'm here to urge upon this Panel, in its evaluation of the research, development, and demonstration programs of the Department of Energy, the importance of taking a very hard look at the urgency of developing this particular potential.

Briefly stated, the case simply goes this way. We do have an energy problem, and I think it's no exaggeration to say that it is an energy crisis. We are reliably informed that, within two to five years, at least certain sections of the United States will have their reserve capabilities for the supply of electrical energy well below the danger line. We are encountering various problems in the development of additional capacity to take care of that.

There are environmental concerns involved in the development of the major contributors to the energy needs. But herein, the potential of small -- it's sometimes referred to as "small", sometimes referred to as "low head" -- but whether it's small or low head or large, what we're really talking about is the utilization of the unused potential of existing dams.

The potential, as quantified by the Corps of Engineers, is at a maximum of 57,000 megawatts. This would almost double the current hydroelectric development in the dams of this country at the present time.

Now, this truly is a maximum figure; it's an outside figure, but it represents a significant potential, and the Corps goes on to report that if this potential were fully developed, this could offset the deferrment of some 16 or 17 percent of the projected fossil-fueled or steam capacity that is planned at the present time, through the period of 1979 to 1985.

I don't say that by way of recommending that we deliberately postpone that capacity, but we are already -- unwittingly or inevitably -- developing some lags in developing that capacity, and this represents a potential that is subject to relatively quick results.

Now, how does this get involved in the research, development, and demonstration program of the Department of Energy? It has come into the present program really as a result of some very substantial interest in the general public, as expressed through the Congress. I think ERDA was somewhat surprised that it inherited this sort of responsibility: it got placed in the Geothermal Division.

This year $10 million is being devoted to this program: $4 million of that is devoted to the technological type of research, which ERDA has been known for; $6 million has been budgeted for a general demonstration program, of which $2 million is earmarked for one project out in Idaho -- Idaho Falls. Of the remaining $4 million, $2-1/2 million is earmarked for funding an anticipated fifty feasibility studies on low head hydro sites, and the other million-and-a-half, it is expected, will be devoted to the development of two demonstration projects for which the specifications have not been announced.

I think the Department is certainly to be commended for moving ahead on this front, and I think the efforts are entirely in the right direction. We certainly would not want to be misunderstood on that score.

But developing the potential of small hydro at existing dams really requires a reversal of a general trend that has been taking place for the last fifteen to twenty years, in which the economies of scale have overshadowed the old historical patterns of electric generation. As a result, many of these projects have been abandoned in recent years, as part of that trend.

To turn that around requires overcoming a good deal of uneasiness and skepticism, particularly on the part of the industry, and to some extent, on the part of public decisionmakers. It also requires some actual experience in substantiating the economics involved and in working out the marketing patterns that will be necessary to integrate these smaller projects into the present electric systems.

This -- I don't want to get involved in a game of semantics here -- perhaps is the kind of demonstration that has not normally been regarded as a part of the demonstration program of a highly sophisticated agency such as the old ERDA organization is. Their emphasis has historically been on technology, on hardware -- the development of new kinds of hardware and the proving out of their mechanical and scientific feasibility.

Here the demonstration required is more in the application of technology that is pretty well established. Now, there probably are some refinements -- there are indeed some refinements that are being worked out on low head turbines, but essentially the demonstration that is required in this field is one of application and the proving of the economics by actual practice and the development of the marketing patterns that are necessary to fit this into our overall systems.

So I come back to my original point, and that is that I'm here today, really, to urge you gentlemen on this Panel, in your evaluation, to take a very hard look at the need for demonstrating this technology, which is more immediately and more readily available than many of the other soft technologies that are spoken of, and which will bring some rather immediate dividends in terms of power supply, at a time when power supply is going to be rather critical.

I might add one further point: That this is the kind of technology, when we're talking about using existing structures, where, it seems to me, happily, those who are concerned about power supply and energy needs can meet on common ground with people who are also concerned about environmental impacts, because with the existing structures -- although in certain circumstances, there no doubt are environmental impacts that have to be considered -- those impacts are minimized.

That's my testimony, Mr. Chairman.

DR. REZNEK: Thank you. Are there questions?

QUESTIONS AND REMARKS

MR. LEE: I have a question. In Massachusetts -- in New England -- we've been very concerned about this, and we think there's a lot of potential. We think sometimes the federal programs seem to be biased toward the Western dam situation, especially the FTC requirements.

But I think one of the problems we've encountered a great deal has been who's going to be able to finance these dams and the renovations, and this has been compounded lately by the Department of Interior requirement of fish ladders on all renovated dams, which has increased the expense considerably -- to the point where even some people who were willing to do it are now having second thoughts.

What recommendations would you make towards the Department of Energy, as to their budget and their allocation of resources, in attacking the financial problem of renovating existing dams?

MR. CLAPP: I think, Mr. Lee, that the approach that Senator Durkin from New Hampshire has taken, with substantial support from many parts of the country and certainly almost solid support from New England, is a very sound approach.

Again, there is really no way quite as effective to demonstrate the feasibility of this approach than by doing it. As you point out, in so many cases, these properties are in the hands of either agencies or individuals who are really not professionals in the electric generation business. They recognize the potential, they would like to do something with the property, but they do not have the professional expertise in-house or the financial resources to do it.

So, as I say, although I would certainly commend the Department for going in the right direction in doing what it is doing now, I think it is woefully underfinanced, and I would hope that an approach such as the Durkin Proposal, which offers loans to projects of this kind -- which can be forgiven if they prove to be unfeasible -- this is really a way of supplying front-end money -- would become part of the program of the federal government.

MR. LEE: Do you also have a concern about the Interior requirement of fish ladders and how that will affect the ability, especially in the area of -- we have a lot of anadromous fish that -- Do you have any opinion on that question?

MR. CLAPP: Well, this has come up. We have helped a number of applicants prepare their applications for these feasibility studies, and I understand I'm not to discuss individual projects here and I won't identify it specifically, but we have, in the process, become familiar with a project in Connecticut, and this is a site that is under the jurisdiction of the state Environmental Protection Agency.

They are putting in fish ladders in this particular dam. They have indicated their support for the development of hydroelectric power in that dam on the condition that any incremental expense in the fish ladders, as a result of the installation of turbines, would be met as a part of the cost of the power project.

So in answer to your question, I feel that there should be some funding available for the conservation aspects of the fish ladders. I think the power projects ought to stand whatever additional cost the power projects incur.

DR. REZNEK: Is your 50,000 megawatt estimate just physical generation capacity, or does it reflect the marginal cost price to some extent?

MR. CLAPP: That's physical.

DR. REZNEK: That's physical, okay. And presumably some fraction of that would then be cost-effective?

MR. CLAPP: Yes, and they, of course, point out in the report that this is subject to a number of constraints, and as I say, it's a maximum figure. I cite it simply to indicate that there is a substantial potential here.

I think no one can, at this moment, say exactly what the economics are of this type of development. Every project is going to have its own particular economics, but generally speaking, with the price of fuel going up -- that is, of fossil fuel, and for that matter, nuclear energy -- this has provided a whole new spectrum of costs against which you judge the economics of these smaller hydro projects.

I think we've seen enough of it to be pretty well satisfied that most of these projects can be developed economically and cost-effectively if we can work out the mechanics of fitting them into the marketing system.

DR. REZNEK. One of the problems is finding someone who either owns a dam or has an interest in it, who would also be interested in turning a profit -- using the electricity profitably, isn't it?

MR. CLAPP: There are those. We're working with some who have exactly that motivation. On the other hand, there are many -- it's a whole wide range of possible owners. We're familiar with one company that has water rights and the physical property of a dam adjacent to an industrial building which they are using to manufacture insulating material, and they propose to develop the power from this dam and use it in their manufacturing operation.

Public agencies are interested, either to generate electricity for the use of their own people or to sell or exchange as part of an arrangement with a neighboring utility.

Certainly we've seen enough interest, so that I think there is not a problem of locating developable sites with owners who are willing and ready to go, but as Mr. Lee points out, financing is one big stumbling block. I think that we need not expect that every dam in the country is going to have to have some financing provided by this program of the Department of Energy. It's a question of how you build the momentum for the thing to take off, and right now we're just beginning to taxi, and we need considerably more momentum than we have.

Once that momentum builds, then I think the financing will show up in a lot of quarters.

MR. OUTWATER. I'm not sure that federal non-nuclear energy research and development money should go into this type of program. As I look at it, there's no new technology here; it's a matter of stimulating a need for these things or a perception of the need for them. Wouldn't it be better for Mr. Lee to go back to Massachusetts and say to his Public Service Commission, "Look, I'm the energy man, and there's an energy potential out there, and I want you fellows to run a survey"?

Who can better finance these things than the utilities industry, where they have still bonding capacity. Isn't that where it should somehow lie -- folded into the existing energy framework, rather than start a whole new fresh set of entrepreneurs with little generators sitting on dams, hopefully looking for a customer?

MR. CLAPP: Well, in some instances, I think it probably will result in that. You have Niagara Mohawk in the State of New York, which has announced a general hydro program of some size that they're going to develop over the next ten years.

Other utilities don't have hydro sites. The hydro sites reside with somebody else. A lot of the hydro sites in New England, for instance, are parts of industrial properties. That's what produced the first industrialization in New England -- water power: water power used directly on the place where it fell for industrial production.

Certainly much can be done through the utilities, but again, I say that part of the problem is that, with the utilities, you're dealing with people who, at one time, used those sites in many cases, and then the economies of scale just got them completely oriented in the other direction.

MR. OUTWATER: We've got utilities making low-cost loans today for insulation in homes. Now, it doesn't seem to me to be too much different for a utility to go to an industrial user and say, "Look I'll give you a low-cost loan to develop the power potential on that dam."

MR. CLAPP: I'm not saying we shouldn't do it. I'm saying we ought to use every device we can. But I think the lead has been started here in this program -- and fortunately it has been started -- and I think it would be extremely important to put far greater emphasis on it than has been possible in this present year.

MR. LEE: Could I just add one thing? In terms of Massachusetts, we have talked to utilities, and you're talking around $10 million for some of these dam sites; we've identified seventeen sites that are under active consideration, in only one of which a utility is actively involved.

DR. REZNEK: Any further questions?

Thank you.

MR. CLAPP: Thank you very much.

DR. REZNEK: Our next witness is Mr. Jonathan Lash of the Natural Resources Defense Council.

STATEMENT OF MR. JONATHAN LASH
NATURAL RESOURCES DEFENSE COUNCIL

MR. LASH: Good afternoon. My name is Jonathan Lash. I'm an attorney with the Natural Resources Defense Council. I work in particular with the Clean Energy Project of NRDC, which may give you some idea as to the positions we take with respect to energy matters.

The Natural Resources Defense Council appreciates this opportunity to appear before this Panel and present its views on the federal Non-Nuclear Energy Research and Development Program. NRDC is a non-profit organization which, over the past seven years, has participated in administrative, legislative, and judicial proceedings involving a variety of environmental and conservation issues. The Clean Energy Project of NRDC participates in such proceedings to advocate policies which we believe will assure the nation a lasting and plentiful supply of energy without serious detriment to the environment.

Rather than discuss the merits of particular programs which have or have not been developed by the government, I would like to address an aspect of policy which is too often taken for granted: the tools by which it is carried out.

Whatever policy is pursued by the government -- and a little later in my testimony I'd like to pursue that question -- some determination must be made as to how to achieve it. Often that determination is made not in a conscious effort to match the methodology to the goals, but rather as a matter of political practicality, habit, or custom. There are certain types of programs that we're used to using to achieve particular types of goals.

If I might, for a moment, employ a metaphor: assuming that our national energy policy is a house -- a house which we desire to build so that it is as energy-efficient as possible, easy to maintain, cheap, and simple to construct, we still have to decide what kind of tools we're going to use to build it. If we don't tell the carpenter or the mason or the sheet metal worker what kind of tools to use, he will use those with which he is familiar. He will use those with which he has experience. He will use those that he has in his toolbox and doesn't have to run out and purchase.

At least in the course of the past three or four years, there's been some evidence that the Congress and the Department of Energy or its predecessors have utilized tools which are the most familiar and the least risky and require the least new investment of bureaucratic capital, in terms of personnel and development of new methods.

Let me first outline some of the available tools and then look at some of the ways they've been utilized in the course of the development of energy policy over the last four or five years. I'd rank them from most coercive or involving most governmental intervention to least coercive.

We have some examples of direct participation by the government in the function it wishes to have carried out. The Postal Service is an example of that: the government has set up a corporation which is essentially government-controlled which just does that. Military service is an example of that. In the field of atomic energy, the government has a long history of direct participation.

There are proposals now for the development of demonstration plants for synthetic fuel processes, to be constructed and paid for by the government -- or at least in part by the government. That would represent direct intervention.

Somewhat down the scale are mandatory programs -- the commands of law and regulation. Those may be civil commands or criminal commands; they may involve enforcement by the Department of Justice, a regulatory agency, or by private citizens -- private attorneys-general. They may involve injunctive relief, where the violator of a particular command is instructed not to do what he's been doing or to do something he hasn't been doing, or where he's penalized for conduct in violation of the command.

Commands are, by their nature, profound interferences in private decisionmaking. Commands are, by their nature, risky, in that they require certain conduct; they are not flexible; they don't permit adjustments when it turns out that some of the premises that underlay the development of the commands are faulty.

On the other hand, they're effective and they tend to work quickly. They tend to work even when there's significant public opposition or fear. The range of examples of mandatory programs is very wide. One example of a mandatory program used for energy conservation is the fleet gas mileage requirements, generally conceded to be an extremely effective method of conservation.

The Environmental Protection Agency, of course, has long and complex experience with mandatory systems for compliance. They lead to complex battles for enforcement.

Down the scale still further, in terms of the amount of interference in private decisionmaking, is the whole vast range of subsidy programs. Those may include grants -- familiar research and development grants; loans -- direct loans to entrepreneurs that we've heard some discussion about in the last several minutes, with regard to hydroelectric power; they may include loan guarantees, just to make the capital available; interest subsidies; they may include government purchases of a particular product or service at above market rate or simply to stimulate the market; they may include tax incentives, or, in a backwards way, tax disincentives. Tax disincentives, of course, subsidize all the alternatives which are not subject to the disincentives.

Subsidies, unlike commands or direct participation, leave freedom of choice to the potential recipient of the subsidy. He need not apply. He may make his own decision as to the viability of the program which the government desires to promote. He will be left considerable freedom in the method used to achieve a goal. If the goal is the development of solar technology, well, there will be a whole spectrum of experimental technologies which will be eligible for subsidy.

Subsidies, however, are expensive. No matter how you look at them -- whether in the forms of direct grants or even loan guarantees -- in the end, they involve government capital. They operate much more slowly in getting the desired effect, and they have very little impact where public resistance is not based on economic factors.

One example of this is a program which was initiated by EPA. In September of 1975, EPA issued regulations requiring the recycling of certain paper products in federal buildings with over 100 employees. I've spoken to the GSA officials responsible for the administration of that program in the Mid-Atlantic region -- five states are involved and some 320 buildings. It turns out that, by the end of this year, that program will involve the recycling of 1,700 tons of paper a month and a profit to the government of over $90,000 a month.

Now, those economics existed before EPA promulgated the recycling regulations; there's been no great leap in technology. The same impetus in economic terms existed for the government to undertake recycling, but nothing was done until the command to recycle was initiated by the EPA regulations.

Where the question is not an economic one, commands may be necessary. A subsidy would not have accomplished anything, with respect to recycling from federal buildings, because the question wasn't economic.

Another example is the approach that the Department of Energy has, at least up until this point, taken with respect to solar technologies. Almost all of the expenditures on solar technologies have involved what may be classed as subsidies, and the subsidies have been directed to research and development.

If the problems in the use of solar energy and the introduction of solar energy as a commercial alternative for home heating and building heating generally are technological, a subsidy program, which permits technological development with government grants, is useful. If the problems are not technological -- if the problems are economic -- then a subsidy program, which permits direct grants to consumers or to businessmen wishing to commercialize solar technologies, will be effective.

If the problems are neither technological nor economic but attitudinal -- that consumers simply regard solar technology as too far out, too unreliable -- then subsidy programs may simply not achieve the end of commercializing solar technology, and we may have to resort to some other form of governmental intervention if we wish to see solar technology commercialized.

A fourth form of governmental intervention -- that which is least coercive and, in many respects, least effective -- is persuasion. Presidents have, for generations, resorted to persuasion. Persuasion, of course, doesn't require prior legislative approval; persuasion doesn't involve the expenditure of any funds; persuasion is generally deemed to be a mark of leadership.

In the field of inflation, over the past ten years, we've repeatedly seen resorts to jawboning: wage-price guidelines, implicit threats by the White House.

But at the bottom line, persuasion always permits the target to ignore it. Another example of persuasion is something the Coast Guard does. When the water gets very rough and the wind begins to blow, they put up a little triangular red flag on the Coast Guard station to encourage yachtsmen not to go out because of the danger. Nothing happens to the boatman who ignores small craft warnings: if his boat begins to sink, the Coast Guard will still come and rescue him; if he's caught going out through the huge waves, nobody will hand him a citation, nobody will fine him, nobody will haul him into court.

Persuasion in that sense is purely informational. It's an effort to advise a particular segment of the population of a set of conditions which may persuade them to modify their conduct.

I would suggest that, over the past four or five years, almost all of the government's conservation programs have been on the level of persuasion, or in some cases, subsidy. We've heard a lot about riding the bus and "dialing down", but one can identify relatively few direct mandatory conservation programs.

I've discussed one of them -- that's the fleet gas mileage requirement. There are a few others.

In the proposed National Energy Act, the conservation program takes one step up and rises to the level of subsidy in the form of tax incentives. Tax incentives, I would note, are among the least coercive and least controlled of the subsidy tools available. They are so because, since the government is not contracting with the recipient of the benefit, the government's unable to attach conditions to the recipient of the benefit.

When you receive a federal grant, the grant is always hedged around with a great many requirements for conduct. Some of those are relevant to the purposes of the grant; some of those are totally irrelevant, but the grant is amenable to controls imposed with the design of furthering the purposes of the particular grant. Tax incentives and tax disincentives are non-amenable to that type of controls. One proposal, which does not appear in the Administration's proposed legislation but which has surfaced in the Congress nevertheless, is the solar development bank or the solar energy bank. That is a proposal for development of a new technology which is obviously pure subsidy. It proceeds on the assumption that if the economics of solar energy can be slightly adjusted, then solar energy will become feasible.

It is important, before choosing that alternative as a method of promoting solar energy, to make the decision as to what the obstacles are to development of solar energy.

Another example: testimony before the House Energy and Power Subcommittee of the Interstate Commerce Committee on conservation options -- a number of utility representatives testified about rather innovative programs that have been undertaken for conservation -- the use of utility capital as loan funds for the retrofit of homes; the development by the utilities of applicable technology.

Universally, a fear was expressed by the executives testifying that they would be subjected to disadvantages as a result of their active efforts to conserve. They expressed the fear, in the case of the gas companies, that if the amount of gas consumed by their customers was reduced, their allocations of gas would be reduced.

They expressed the fear that if the amount of gas their customers consumed was reduced, their profit margins would be reduced; their ability to undertake new technology would be reduced. And, most importantly, that financial institutions -- the business community, in looking at their behavior, would, because the demand was not growing, decide that they had a poor future. This despite the fact that they were undertaking among the most innovative programs to generate new supplies -- conservation programs -- among the cheapest programs to generate new supplies.

That kind of problem can only be resolved by action on a national level. It is non-amenable to subsidies. The questions are non-economic. The questions are those involving the regulatory schemes applied to the utilities and the attitudes of the people involved.

I'd like to discuss one final example that I think brings out another problem in the selection of tools. Several months ago when Secretary Schlesinger was testifying before the House Committee, he was pressed on the Administration's supply strategy, and he promised that within ninety days he would produce a National Energy Supply Strategy.

Indications are that that strategy will be based principally on the development of synthetic fuel alternatives, and that the synthetic fuel alternatives will be promoted by four measures. Number one: price guarantees. The fuels will be purchased at no less than the equivalent of $25.00 a barrel for oil.

Number two: subsidies for the development of the technology, but those subsidies are to take the form of the construction of demonstration plants, either solely by the Department of Energy, or by the Department in cooperation with some of the larger oil companies.

Number three: a roll-in requirement -- a requirement that at least a certain percentage of the products of each refiner or a certain percentage of his sales should be synthetic fuels. These measures will certainly help to promote the development of synthetic fuels. It's inevitable.

There was a fourth alternative, which involves a purchase by the Department of Defense of a substantial amount of shale oil. With that kind of subsidy and that kind of mandatory roll-in requirement and direct government intervention in the development of the technology, synthetic fuels will get a tremendous boost. But it has certain side effects.

It emphasizes certain of the synthetic fuels. Since some of the non-fossil synthetic fuels, while they may be subject to the price guarantees and may be available as roll-ins, will not receive the subsidy in the form of the direct government purchase and will not receive any benefit from the direct government participation in the development of the demonstration plants, they will almost inevitably be left behind.

Any effort to develop the non-fossil synthetic fuels will be virtually cancelled out by the fact that the major producers will have to rely on the technologies they've invested in so heavily in order to meet the roll-in requirements. There's no sense in making any investment in the non-fossil synthetic fuels if the other measures are going to be pursued, which will make the use of the synthetic fossil fuels inevitable.

Different tools act to reinforce one another or cancel one another out. It seems to me almost inevitable that, despite the turn of the country away from mandatory requirements and governmental restrictions, in energy policy we will have to increase our resort to mandatory requirements and to commands.

The time is short. The existing system represents a tremendous vested economic interest, one which will be difficult through subsidy programs to modify. Consumer attitudes can change only slowly, particularly where consumers are not yet convinced that there's any crisis, that there's any need to change, or that the new technologies are viable.

Where conservation requires some inconvenience and the failure to conserve only involves some expense, the evidence is that at least a substantial proportion of the population would avoid the inconvenience and undertake the expense.

If we concede that we are in a time where we have to act quickly, it seems inevitable that we can't tolerate the time involved in changing those attitudes through non-coercive, voluntary measures, and we must turn toward coercive measures.

I think that one of the factors which has skewed the selection of tools has been the fact that we are still arguing about values. We have no defined policy; we haven't decided what our priorities are. Since each new program involves a discussion of what our priorities are, there's little time left to discuss tools.

That completes my testimony, and I would be happy to answer any questions.

DR. REZNEK: Thank you.

QUESTIONS AND REMARKS

MR. LEE: I just have one question. Can you, in a couple of sentences, relate this discussion on tools to the problems this Panel has to wrestle with, which are the non-nuclear R&D and the solar conservation areas.

MR. LASH: Yes. I think that it is essential that, in determining in which areas we are going to expend limited funds for research and development, we focus on those areas in which research and development will meet the problem which is obstructing the development of those new sources of energy, and that we not simply use research and development as a safe way of saying "We're dealing with that area" and avoiding the crucial decision of whether we're going to take the risk of compelling the nation in some form to move into commercialization and utilization.

DR. REZNEK: Any further questions?

Thank you.

MR. LASH: Thank you for the opportunity to present our views.

DR. REZNEK: Our next witness is Mr. David O'Connor, Solar Project Director for the Center for Energy Policy.

STATEMENT OF MR. J. DAVID O'CONNOR
SOLAR PROJECT DIRECTOR
CENTER FOR ENERGY POLICY

MR. O'CONNOR: Good afternoon. My name is David O'Connor. I am Solar Project Director at the Center for Energy Policy in Boston, Massachusetts. I'd like to thank you very much for the opportunity to be here today to comment on the non-nuclear energy research and development budget, and in particular to mention a little bit about the views of the solar energy industry with regard to the problem of solar commercialization.

Before I begin, let me say that in my work, I receive a great deal of assistance from the Massachusetts Energy Policy Office and Mr. Lee, and I'd like to take the opportunity to thank him very much, personally and professionally, for all of his support. I am a go-between for the solar energy industry and the government. During the past year the Center for Energy Policy has been contractor to the Department of Energy on a study of solar commercialization in New England. Recently I authored a report for the Department entitled "Solar Energy Application Centers: A Strategy to Facilitate the Commercialization of Solar Energy". I am presently working for Booz, Allen and Hamilton, Inc. on a study of solar energy systems installed in the Northeast that have received no federal funding. We hope to compare costs and performance of these systems in relation to those that have received federal subsidies.

In short, I spend a great deal of time inspecting solar energy systems, talking with installers, distributors, and manufacturers of solar systems about their problems, and I try, to the best of my ability, to translate their needs into practical policy recommendations for the federal government. It is oftentimes difficult for either one to understand the other, and I'm afraid I spend too much time trying to justify the ways of one to the other and probably not enough time thinking about why they're wrong.

It seems to me that there are far too many activities undertaken by the federal government that foster a negative kind of environmental awareness. Bottles should be recycled because they are unsightly, air pollution should be eliminated or we will get chronic bronchitis, and so on. I'll surely not surprise anyone by mentioning nuclear power and the negative environmental awareness that that tends to engender.

Solar energy should be supported actively by those committed to the environment for two reasons. This is not so because it is theoretically a good thing, but because number one, it effectively displaces the use of alternative and limited fossil fuels, and number two, it encourages an individual, positive awareness of our environment.

I'd like to give you an example of the latter. Can you imagine a time in the future when most of the children in our country grow up in homes heated by solar energy? It is not as far off as you may think. You would probably not be surprised to learn that those children would grow up with a far better understanding of the causes of sunlight and cloudiness; of the consequences of daily and annual temperature averages; of the difficulties in storage and distribution of heat; and so on. In general, they will appreciate and understand the conservation of all natural resources because they appreciate and understand solar energy.

It seems to me significant for environmentalists to consider that and to understand that they have a vested interest in the rapid development of solar energy. If my thesis is correct, and if you find some merit in my recommendations, I suggest that the EPA should actively promote the use of solar energy. It seems to me essential that that kind of mutual interest be clearly understood.

During my time involved in solar energy, I've found that there is a great deal of resistance in the solar industry to government involvement in the commercialization of solar energy. Interestingly enough, there is also a great deal of concern among government officials about being involved in the commercialization of solar technology. Both seem to believe that solar energy is the one last frontier for pure capitalism in our society and ought to be left alone completely by the government if this is at all possible.

This seems to me to be a terribly mistaken attitude about the purpose and effect of free market capitalism and, more seriously, it simply is completely impractical, given the kind of obstacles that solar energy faces. It seems to me that a well-targeted government support program can really enhance the competitive nature of the industry rather than diminish it, yet I continually find that there is an all-consuming fear that the government will somehow eliminate competitiveness in the solar industry as soon as it becomes involved. That simply will not happen. In fact, competition will more likely decrease if the government does not get involved in the direct support of solar than if it does.

Let me try to explain why.

Imagine the situation today, of a person who is a distributor or a small manufacturer of solar energy systems. How can he market his product when all his customers are waiting for a decision on the National Energy Plan? This is extremely serious because it tends to cause a withering of interest and willingness to purchase solar energy systems. Many, many of the persons who are thinking seriously about solar energy, are waiting for the tax credit, and they are waiting to see what happens to the price of alternative fuels.

Therefore, those persons who are trying to stay alive in the solar energy industry are suffering terribly while the decision on the Energy Plan is delayed. It tends to drive out moderate-sized solar manufacturers, distributors and installers; they simply do not have the capital or the resources to maintain themselves during a slow down in the market such as this causes. If people expect the government to be involved and it does not act on its promise, what is the industry to do? Therefore it is absolutely essential that the National Energy Plan be passed as soon as possible. They simply cannot survive if it is not, and without them the industry will be left with less competition and innovation, I am sure.

One is left with a solar energy industry dominated by large corporations well capitalized from their dealings in other areas of the energy spectrum.

It seems clear that the National Energy Plan will cause increases in the price of fuels that compete with solar. Every study of solar energy commercialization points out that existing artificial supports for alternative fuels must be eliminated if solar energy is to become competitive in the marketplace. Present government subsidies for fuels other than solar effectively eliminate competition by the solar industry with established energy and fuel industries.

A more long-term problem is the one of a lack of venture capital for new solar businesses. I hear time and time again from new and potential solar manufacturers and distributors that there is simply no way that they can arrange to get funds to keep them alive.

I would suggest strongly that any programs to be undertaken by the Department of Energy in the area of solar commercialization look very, very seriously at the problem of a lack of venture capital and what it tends to do to the solar energy industry. I think it would be found that it, first of all, hurts it. Second of all, venture capital could be made available by the government at very, very low cost through loan guarantees for small businesses and a low-interest business loan program. I believe that these programs should be structured to weight "innovativeness" just as heavily as "reliability". It is obvious to me that in the midst of our energy problems a program could make wise use of tax revenues.

A lack of venture capital and a terrible cash flow situation caused by the failure to bring forth promised incentives creates a deadly problem within the industry. As moderate-sized manufacturers fight to survive, they encourage an attitude of "territorial exclusivity". Most solar manufacturers allow a distributor to represent their product alone. Distributors complain to me continually that this is really hurting the solar energy market because they need to have an array of systems and kinds of facilities to make available to buyers. It's extremely difficult for them to represent only one manufacturer but most are not willing to have their materials or systems displayed with those of five or six other manufacturers. They are just not willing to risk having a distributor selectively promote their system. It's a very, very serious problem for distributors and for the ultimate commercialization of the technology.

The other problem, I think, that's worth mentioning, with regard to the lack of venture capital and the ability of middle-and small-level manufacturers to stay alive, is the fact that it simply tends to keep production costs high, and therefore final retail costs are high -- much higher than they need be. If there were a capacity to produce in greater volume -- that I do not think needs to be encouraged through direct government funding of production but by providing these people with the capital that they need -- it would immediately work to reduce the retail cost of solar energy systems.

There are a great many forward-looking people building new homes and new businesses who are seeing the direct financial benefits of an investment in solar energy over the long term.

However, the fact of the matter is that many people who buy solar energy systems are doing it for much harder-to-predict reasons. They involve things like environmental awareness, a commitment to more natural life styles, and so on.

In fact, there is really an inadequate understanding of why people who buy homes buy solar energy systems.

Commercial and industrial purchasers of solar energy systems have available to them a number of incentives to buy solar. Namely, they have a capacity for rapid depreciation of the equipment; they have available capital to make the investment -- especially if they are building a new building, they can write this into the terms of the cost of the construction loan at a comparatively low interest rate; they understand the principle of life-cycle costing, and it works for them because they are going to be a stable facility. Businesses do not move as rapidly as homeowners and therefore, they can see the benefits of solar energy over the life of the building. Even if they move out, very often they continue to own the building and lease it. The benefits will accrue to them over its lifetime.

Perhaps the most significant reason for a business or a commercial industry to invest in solar is its advertising potential.

In any case, businesses have clear incentives. Residential homeowners and home buyers do not, and they have virtually none of the tools that I mentioned available to them now. (Clearly, these need to be made available and the most significant would be a tax credit.)

But an inadequate understanding of why and when consumers buy solar energy systems leads to a great deal of confusion on the part of manufacturers and distributors as to how to set up their wholesale and retail outlets: how to make their systems available, how to distribute them, where to market them and when, and also at what cost -- whether to take losses in certain areas at certain times. It seems to me that a great deal more work needs to be done, with assistance from the Department of Energy, to illuminate the market potential for solar. The industry is not yet able to handle this sizable task on its own.

So, in sum, let me run through a number of recommendations and then answer your questions.

The National Energy Plan must be passed immediately and the price of alternative fuels must be allowed to rise, however quickly or slowly it is politically feasible to allow, to their true marginal cost of replacement if solar is to become competitive.

Second, the Department of Energy Solar Commercialization Program, which, if you notice in your budget outlays, has a budget during the coming year of $2.7 million -- very small for the job at hand -- is simply unable to provide the kind of production incentives that I think are necessary: namely, support through loan guarantees and subsidies for venture capital and for other kinds of production incentives. This must be increased. There must be more venture capital made available.

Finally, it seems to me that there ought to be a significant increase in the number and kind of studies undertaken to determine who it is that is buying solar, when and how they buy it, and in particular, which fuels solar energy tends to displace. Whether it's oil, electric, or gas, with the installation of a solar energy system there is always going to be a displacement of alternative fuels. I think we have not yet discovered the many advantages in short that solar energy will provide us nor the ways in which the lack of government support for commercialization slows rather than speeds the realization of those advantages.

Thank you very much.

DR. REZNEK: Thank you. Are there comments from the Panel?

QUESTIONS AND REMARKS

MR. OUTWATER: Yes. I've got to say that at this time of the day your enthusiasm and eagerness on this subject is really impressive. I think it's just great. I'm just sorry you're not out selling conservation as well. I don't have a question to ask -- I thought what you said was very good.

MR. O'CONNOR: Don't misunderstand me. I'm a thorough conservation advocate and I am well aware of how closely they are related. Today I chose to focus on solar.

MR. OUTWATER: I admire you for your stamina and interest. It's just incredible.

DR. REZNEK: Any further questions?

Thank you.

EVENING SESSION

DR. REZNEK: Our next witness is Dr. William J. Lang, President of Strata Power.

STATEMENT OF DR. WILLIAM J. LANG
PRESIDENT, STRATA POWER

DR. LANG: My name is William J. Lang. I'm the President of Strata Power Company. This is a company that was originated for the purpose of developing underground compressed air energy storage about twelve years ago, and has been engaged more or less full-time in this for that full period of time.

PREPARED STATEMENT

INTRODUCTION AND OVERVIEW

Energy storage is the most direct and clear path to upgrade the entire national electrical system. While not as glamorous as replacing all of the older system with some new space age power systems, it offers major energy conservation benefits through efficiency upgrading of every existing base load power plant. Retrofitting or plant modernization is not required but merely improving load factors through auxiliary energy storage systems. The difference is analogous to the differences in fuel economy from one automobile driver to the next when one accelerates and stops erratically while the other drives smoothly. The electrical power industry operates currently like a drag strip hot rodder, but through energy storage could become like a skillful trucker who effectively transports large loads without extravagant fuel consumption.

The electrical power industry across the nation is faced with erratic loads which commonly vary as much as 250% over a 24-hour period. Well over 99% of this load is met by electricity generated the very instant it is used. The effect is high cost due to erratic system operation resulting from ineffective capital utilization and excessive fuel consumption. Differential between peak capacity and off-peak periods continues steadily increasing as it has over the last 40 years.

There are two short range and practical remedies to the erratic load problem. One, the nation, from the greatest industries to the smallest individual users, can be deprived of readily available electricity. Two, energy storage can accomplish the same results without disruption of our way of life. Further extensive development of major energy storage systems can provide the means for shifting large blocks of energy production away from oil or natural gas over to the more abundant coal or nuclear fuels. The shift is also away from low efficiency peak or midrange power plants to highly efficient base load systems while at the same time improving the latter. Effective energy storage is also a necessary adjunct to the harnessing of intermittent and variable sources of energy such as wind, solar and tides.

The estimated budget outlays in 1978 and 1979 for Energy Supply Research and Technology Development of DOE clearly shows their failure to discern the cost effectiveness, far reaching and short range potential benefits to the national electrical grid and excessive petroleum consumption. About 1½% of the budget is for electrical energy storage.

Fuel substitution, heat rate improvements and exotic power development are subjects finding much attention in government energy research, but another matter may override these concerns. A new word on the horizon is "energy famine". It seems not from new energy technology but the lack of it. The term refers simply to the shortage of electrical power generating capacity and distribution facilities. Warning of a coming national energy famine has been heralded only by few in the past but is now coming from numerous quarters. The imminent problem is not one of overall total capacity but temporary shortages during periods of hot weather or especially cold days. Electrical energy storage can offset this situation by increasing the total output of existing plants by levels as significant as 25 to 30%. It can be the quickest and least expensive means to increase the national electrical output.

The problem of short sighted budgeting of the federal electrical energy storage research is further aggravated by gross mismanagement of the funds which are expended. I would like to point out one such segment of this research as a specific example.

CAES, AN EMERGING ENERGY STORAGE TECHNOLOGY

Gas turbines are simply special types of air motors where air is compressed with turbocompressors, heated by burning fuel in it and expanded through expansion turbine blading. The surplus energy, after subtracting that used from driving the compressor is then used as a power supply. Gas turbines gained wide acceptance in the electrical power industry for driving generators because of their low capital cost, minimum installation requirements, low pollutant emissions, quick starting and flexible operating characteristics. After reaching about 17% of the nation's total power generating capacity in 1974, these systems fell rapidly out of favor because of two disadvantages. They burned only refined petroleum fuels or natural gas and furthermore did so with the lowest efficiency of any modern plants. The fuel crisis has caught up with this once thriving gas turbine industry and reduced it to a shadow of former years. A number of gas turbine manufacturers in the U.S. and abroad have ceased production and shelved the technology.

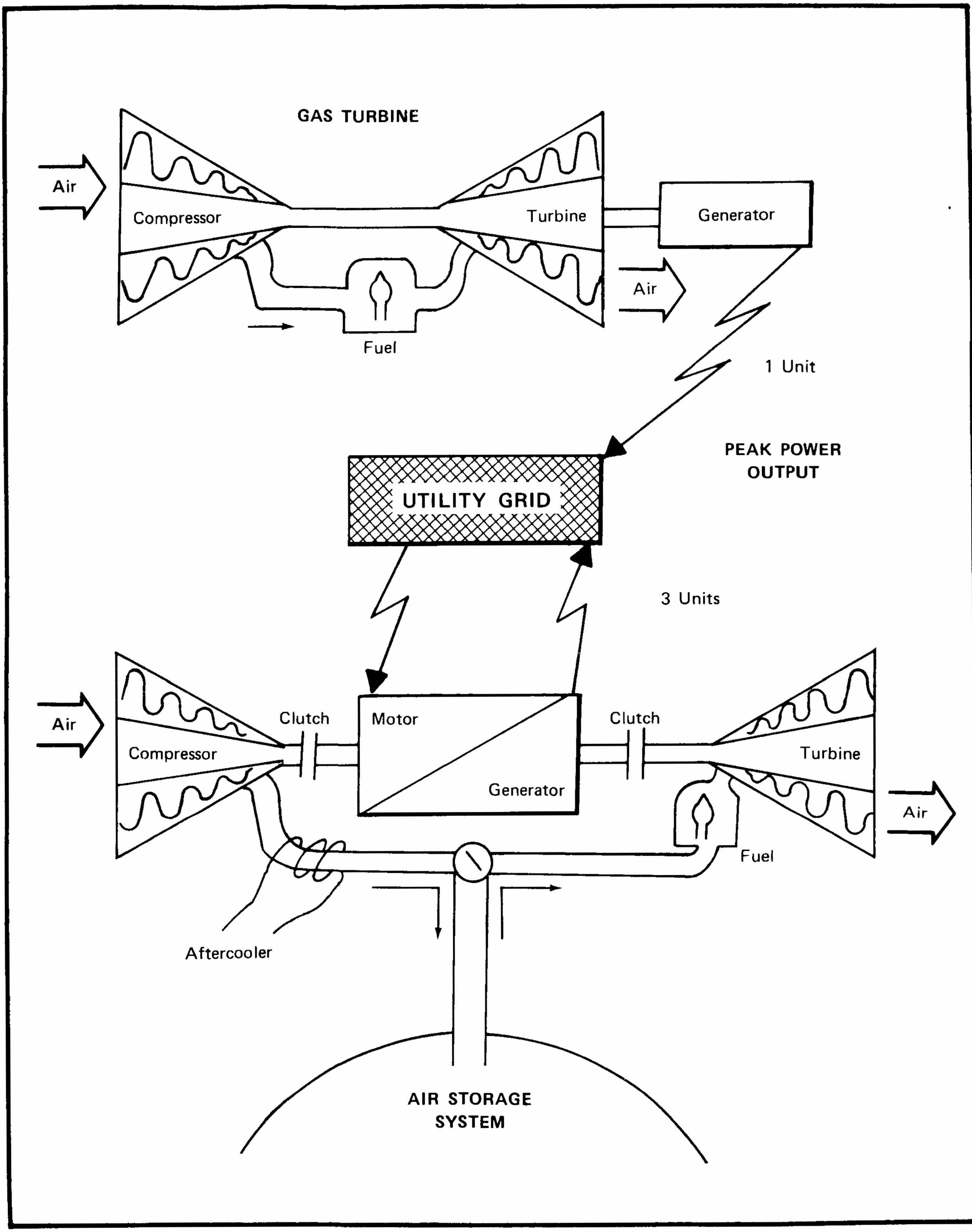

Figure 1: CAES and Gas Turbine Comparison

Another use of this technology which has been known for thirty years is that gas turbines can be separated into components and coupled with underground compressed air storage for electrical energy storage purposes. (Figure 1). Large scale energy storage has historically been only by means of pumped hydro systems. This practice has been found to be a desirable adjunct to generation systems in about 40 locations around the country. Pumped hydro is restricted to hilly or mountainous areas. Also, site selections involve a low power density of .015 Kw/Ft^2 and modify the environment or recreational areas to such an extent that bitter litigation almost always ensues and few sites, even where conditions are favorable, have more than a remote chance of success. By contrast, CAES involves minimal surface disruption with power density of .9 Kw/Ft^2 (2). In other words, a 600 MW CAES plant would involve about 15 acres of surface land compared to 900 acres for a comparable sized pumped hydro.

Underground storage systems for CAES include salt cavities, mined hard rock cavities and porous rock reservoirs. The latter are presently known in sizes large enough to serve as regional energy banks serving perhaps as many as a dozen utilities simultaneously from one site. Plants with ultimate capacities of 10,000 MW or more can be built starting with equipment unit sizes as small as 150 MW and expanding at will. Unlike the open cavity storage systems which normally by economic necessity must be restricted to peaking use, the aquifer storage systems often will be able to operate for 10 to 12 hours per day. This is made possible through the lower incremental cost of storage expansion typical of aquifers.

PRINCIPLE BENEFITS OF CAES

Gas turbine power generating systems have been most desired because of low capital cost, easy installation, compact size, quick starting capability, versatility to accommodate quick load changes and minimal environmental impact. They have been least desired because of a very poor heat rate (around 16,000-oil-Btu/Kwh) and fuel costs (about 5¢ Kwh). Modifying gas turbines for compressed air energy storage sacrifices little with regard to the desirable aspects of gas turbines, while at the same time it markedly improves the heat rates (about 11,000 Btu/Kwh: 4200 Btu/Kwh-oil and 6,800 Btu/Kwh--coal or nuclear). Fuel costs are cut in half. Multiplying the oil savings of CAES over gas turbines (about 11,800 Btu/Kwh) for all of the nation's peak power would save about 350,000 BBL oil per day. Bringing energy storage into midrange power production could increase this savings to the million-barrel-per-day range.

With regard to the predicted energy famine, energy storage systems of this type would permit expanded use of existing base load systems and provide the least expensive and shortest term means of boosting total power and energy outputs.

The CAES technology can be operational in less than two years in the simpler forms but offers numerous avenues of system optimization and advanced stages for stimulating challenges to the researchers. Further it can be combined most beneficially with the emerging fluidized bed combustion technology (4), thermal storage--intercooler and aftercooler waters or hot air, and with solar power (5), tidal power (7), and wind power (6).

FOREIGN DEVELOPMENTS

At Huntorf, West Germany, the world's first compressed air storage peaking power plant has just been constructed and is currently undergoing extensive commissioning runs. The system is a 290 MW fully automatic, remote controlled unit which utilizes high pressure salt cavity air storage. It is a highly sophisticated plant employing variable blade pitch compression, synchronizing clutching and numerous other technical innovations. In spite of first time design and manufacturing setup costs, multiple stage compression, combustion and expansion, the completed facility cost only around $200/Kw of capacity. This is about the same cost as advanced cycle peaking or midrange systems which burn only premium fuel at about the same heat rates. Turbomachinery designed for low pressure storage is considerably more simple and is practical in the case of aquifer storage systems where volume specific reservoir development costs can be exceedingly low.

U.S. STATUS

The Department of Energy, after many months of delay, has recently awarded contracts for site explorations and feasibility studies which are hoped will lead to demonstration air storage electrical power plants in salt caverns and mined rock caverns. There are further stalled contract negotiations with a midwest utility team for site exploration and evaluation for aquifer storage. The latter is advancing from the status of "months pending" to the category of "years pending" and even when started would not advance beyond the paper study stage for about three years. An appropriate question is how did the U.S. program get so far behind the European efforts and what still holds it back?

The following treatment is an attempt to trace highlights of the history of the U.S. program over a period of time and detect where, when and how the technology development got off track. Although the summary is obviously incomplete, at least a few dates and events can be used for an overall yardstick to assess the progress, or rather regress.

1966 Studies for air storage with compressors and expanders began at LSU, Baton Rouge.

1968 Brown Boveri, New Jersey/Strata Power study directed toward small gas turbines and selected aquifer sites found the concept practical, technically feasible and economical. Projects were vetoed from Switzerland due to U.S. utility resistance to foreign gas turbine products.

1968 Gilbert Associates/Metropolitan Edison/Strata Power feasibility study and system design concluded underground compressed air-energy storage in aquifers was practical, economically competitive and feasible with existing turbomachinery equipment. Project halted for lack of suitable reservoir site in the desired area (Southeastern Pennsylvania).

1970 Westinghouse Research studied aquifer CAES technology proposals by Strata Power. The studies including reservoir computer modeling proved quite favorable. Planned projects were vetoed by Turbine Division due to preoccupation with the thriving gas turbine sales and difficulties meeting manufacturing schedules.

1972 AEP-headed utility consortium with Stal Laval planned air storage project up through detailed contract negotiations. Discontinued for fear of jeopardizing a pumped hydro project then seeking approval.

1972 Worthington International with regard to a NIPSCO/Strata Power project offered to manufacture from existing expanders and compressors a 36MW CAES plant for installation on a pretested and developed aquifer site for $144/Kw. This price included turnkey installation with full commerical gurantees. G.E. offered a better system modified from the 5000 series turbine at a lower price ($63/Kw plus installation) but stated that manufacturing time would be three or four years because of manufacturing schedules and other priorities. The utility finally declined at least largely because they already had the highest load factor in the nation and had no shortage of peaking power.

1972 AEC study at Oak Ridge concluded CAES technology in open caverns was promising and practical. This study did not include aquifers.

1972 NWK of Hamburg begins discussions and hires a geological group to study and select a site for CAES using one of many salt domes in northern West Germany.

1973 AEC study at Battelle PNL again concludes CAES technology is favorable and competitive with pumped hydro in certain cases. (Aquifers again were not included).

1974 NWK of Hamburg orders the world's first compressed air storage power generating plant from Brown Boveri Sulzer.

1974 AEC-Energy Technology Branch receives and rejects proposals for CAES site exploration and air injection testing of known aquifer sites which were partially predeveloped. Late in the year this group decided on a broad study reassessing all previous studies in the hopes that this would somehow catalyze application of the needed technology.

1974-1977 ERDA rejects all industry participation proposals related to specific site testing, evaluations and plant development ranging in size from $250,000 up to $24 million with industry group at times offering to pay 85% of the total costs (1). Approximately another dozen studies are funded.

1978 NWK Huntorf plant completed and operating in commissioning stages.

1978 DOE Energy Storage Program continues with the contracting and implementation of protracted long term studies in hopes of leading to sites and eventual demonstration.

The policy of the Energy Storage Systems Division of the Conservation Section of ERDA/DOE has been stated in the Division Program Approval Document FY 1977 dated October 1, 1976. It states: "The Energy Storage Program will support high risk, long term R&D areas less likely to be developed by industry alone." This is a sound policy which few would question. Perhaps in their zeal to assure success of the policy and give an illusion of effective R&D, the Energy Storage Systems Division of the DOE has sandbagged* the program by taking short term, low risk R&D programs already nearing industrial contract status and forcibly deforming them into the policy mold. The following is an attempt to determine how this was done:

I. Government energy research had to adopt a posture of complete domination in the field to force various interested utilities and corporations to back off. Promises or threats to throw vast sums of money around has the effect of stopping all nonfederally funded projects. This included EPRI as well as private research efforts in the past and continues to this day. ERDA staked a controlling claim on this technology by representing themselves to be more prepared to follow through

*Overstated the handicap in order to qualify under conditions calculated to assure success.

than they have ever been. The long-stalled, postponed and delayed programs speak for themselves. After turning down several low cost, site specific testing and demonstration programs in 1974, the AEC Energy Technology Branch decided on an intensive restudy of earlier AEC, other governmental and industry feasibility and design studies for underground compressed air storage. Coming at a time when many large company research staffs around the country were ordered to find government subsidy for their work, there was no problem in getting dozens of responses to the study RFP. This study which was completed a couple of years later (ERDA 76-76) managed to create so much confusion and misunderstanding as to make necessary a series of much larger and more specific but largely redundant studies.

II. ERDA promoted national confusion about availability, cost and characteristics of porous rock reservoirs.

A. Reservoir conditions in every hypothetical situation studied were at the best marginal with regard to permeability (the ease of receiving or delivering air) and vastly inferior to each of several sites specifically offered for testing in prior unsolicited proposals. Finally the unavailable Brookfield site which was selected for detailed design and operations studies was submarginal with respect to both permeability and hydrostatic pressure, thus compounding its unsuitability. The study gave no hint that many sites existed and were available with 10 to 30 times greater permeability and more appropriate hydrostatic pressures. Neither was it hinted that a direct correlation exists between permeability and reservoir development cost to the extent that costs would be cut by 90% with proper reservoir selection.

B. The confusion arising from ERDA 76-76 was then again compounded when several of the same parties of the ERDA study extended this confusion with the aid of EPRI at a major national report at the American Power Conference (8). Major areas of the nation which are most suitable for aquifer storage were designated as not suitable at all for compressed air energy storage. The misinformation which was credited back to ERDA 76-76 had the effect of killing most of the last few independent underground air storage projects. This error to this day has never been publicly corrected.

III. Aquifer gas storage is a well proven and accepted technology in several midwest states. Subsurface geological information is abundant, known and available sites are plentiful and the region has tremendous surpluses of nighttime nuclear and coal power. Federal site exploration activities for aquifers has been confined to the State of California where there is little low cost nighttime energy available for storage. This State is also especially blessed with topographic conditions which make possible the alternate and area proven pumped hydro energy storage.

IV. From the viewpoint of detailed equipment design and manufacturing, the AEC/ERDA/DOE philosophy has been that conceptual design and turbomachinery manufacturing innovations are necessary for the development of this new technology. This is true only if they insist upon using a few selected manufacturing favorites and continuously ignore others who already have and have had for some time the necessary equipment ready to sell with full commercial guarantees. At times the equipment could have been purchased and installed on a turnkey basis which would make almost all of the federal research efforts redundant.

V. The ERDA/EPRI Compressed Air Storage Workshop of December 1975 called for a highly qualified and broadly representative group of technical experts to make recommendations for the advancement of this technology. In spite of this panel's recommendation (3) that there was little research merit in duplicating the European compressed air solution mined salt cavern project, as the information concerning the details of this have at all times been freely available and widely disseminated in this country, the federal solution mined salt cavern CAES program has been the leading DOE-sponsored project and will surely yield in four or five years the same information. The specific technology further has ultimate usefulness only in a narrow Gulf Coast belt and should be categorized as a regionally exclusive utility subsidy, not disguised as a technology innovation.

VI. The energy storage program has been continuously confused throughout and disordered through a practice of persistently shifting responsibilities. On an average of about once every six months, the high level federal management responsibility for CAES' R&D shifts. Whether the musical chairs business is a major cause of the confusion with the programs or a necessary byproduct of it may be difficult to discern. At any rate, the net effect is to set the program back about six months for every major transition.

To summarize the reasons for failure of the U.S. government-dominated CAES program, it is principally because their program is designed to reinvent that which is invented, restudy that which is known, rediscover site situations which are available and redemonstrate that which is demonstrated and commercially available. It is hard to fix a rigid timetable for such a program, considering that it is possible to stretch it out indefinitely.

The aquifer portion of the CAES program at present standing could not be to the point of final construction and manufacturing contracting in less than four years. The 1982 date will see the program about to the same place where it was in 1972 when firm and guaranteed site specific manufacturing and construction prices were quoted. Then a three- or four-year construction program is anticipated rather than 13 months as earlier offered. The federal CAES program since the embryonic stages about four years ago has set the state of technology development back approximately 10 years already and is continuously widening the gap. They have not discovered the real problems constraining CAES development which are almost entirely legal and financial, but have instead created imaginary technical and manufacturing problems perhaps more to their liking. The geological and reservoir engineering aspects of these underground technical adventures are especially complicated by the fact that the AEC/ERDA/DOE research effort in this area has continually operated without the benefit of anyone with even elementary knowledge in these technical fields on the staff team. Consultants must write the RFP's, evaluate and interpret the responses in language understandable to the federal research management teams. If some of these consultants had vested interests in the projects it would be beyond the managerial team to identify these matters for they must implicitly trust their outside advisors.

SUGGESTIONS AND RECOMMENDATIONS

The President has declared that he was addressing the national energy problem as a declaration of war. It is herein suggested that he point some cannons toward the stagnant and redundant federal energy storage program for electricity. The following should be done to salvage this technology from the grips of the endless study propagators:

1. Cancel all existing CAES contracts, demonstration projects, and paper study programs which have been conceived and directed under the federal program paying just compensation wherever damage is caused by the cancellations.

2. Institute loan and loan guarantee programs similar to those in geothermal energy development to offset the risks associated in finding and verifying air storage sites. Currently utilities are not geared for such risks as they cannot charge their customers for the inevitable unsuccessful site exploration efforts.

3. By direct grant support worthy demonstration projects which are clearly original and pertinent to the technology advancement.

4. Continue to sponsor workshops and information exchanges on the emerging technology wihout extraordinary delays in publishing the data.

5. Examine the continuously ignored concept of regional underground energy storage banks operated by a federal corporation or with federal loans that guarantee equitable regional power distribution.

6. A priority standing with regard to fuel allocations should be given to CAES during any time of national crisis since this technology saves twice as much petroleum fuel as it uses in contrast to existing alternates for peak and mid-range power generation.

This testimony and the conclusions reached have been directly my own views. While they may not reflect a consensus of all those involved in CAES, they are quite likely to represent a consensus of views of all those who have been directly involved with this technology for more than five or ten years.

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QUESTIONS AND REMARKS

MR. OUTWATER: Are you asking for funds, Dr. Lang?

DR. LANG: I certainly am not.

MR. OUTWATER: We're here talking about RD&D.

DR. LANG: Okay, well, this is remotely related. Maybe we're talking about the same thing. I thought we were talking about technology development, which is not R&D.

But the first thing that I'd recommend is that they cancel all existing compressed air energy storage contracts, demonstration projects, and study programs which have been conceived and directed under the federal program, paying just compensation for whatever damage is done.

MR. OUTWATER: I'm sorry I asked the question.

DR. LANG: There is an area where they could help, and that's by loan and loan guarantees. These are areas of risk that the utilities are not set up to handle. There are a certain number of failures that are inherent in this exploration. Utilities have to be very conservative. They cannot stand these failures and they can't put them in their rate base, so that means they have to take them out of their stockholders' pockets.

This is the first area where they need loan guarantees, and I believe that this is the most effective means through which this technology development for energy can advance. Perhaps some direct grants, where the government does not manage them and control what's done, might be of great benefit.

DR. REZNEK: Dr. Lang, I would like to make some observations. First, this air storage technology does not really reduce the energy input for electricity generation. What it really does is substitute either nuclear fuel or coal for the more expensive fuels.

DR. LANG: Not correct. We're talking about peak power.

DR. REZNEK: No. We're talking about the daily cycle. For the same amount of electricity generation over a twenty-four hour cycle, the energy input remains essentially the same, does it not?

DR. LANG: No. No, it's reduced. Because normally during the day, you have a total heat rate of about 16,000 Btu/kilowatt hour. In this system, even with the energy losses, you have a combined heat rate going into this of 11,000. So you've saved the 5,000. Your total energy is reduced, and the first EPA study of this, back in 1971, said "This is of interest to us because by this means they can phase out old coal-fired peaking systems that operate very inefficiently and it replaces other systems." It does lower the total energy input.

DR. REZNEK: Over the twenty-four hours of the heat rate?

DR. LANG: Yes.

DR. REZNEK: The second question is: Won't this air storage technology tend to prolong the life of old power plants? If the future pattern of usage is one where the peak is growing less quickly than the base, and certainly the institution of this air storage technology would accomplish that, the load curve would flatten generally across the nation. This would tend to encourage the use of older plants. In other words, the life of older plants, which are now being used 30 percent of the time, would be prolonged. With this technology, you would be able to get usage rates up to 70 percent. Is that not so?

DR. LANG: Whatever plant it's used for -- a brand new nuclear coming off the line or the oldest plant you've got -- it will improve the capacity and the efficiency of each and every one no matter how bad it was. This can be substantial.

DR. REZNEK: But the nuclear plant is used now to the maximum extent possible -- the brand new one. It's the older one that's less efficient.

DR. LANG: No, no.

MR. OUTWATER: Taking away the peaking units.

DR. LANG: About 54 percent or 59 percent is typical for all the nuclear plants. In our area, in Chicago, they must bank them through the night. They have a tremendous surplus of nuclear energy that they don't know what to do with. They only use them to about 60 percent capacity.

DR. REZNEK: If the load curves were less steep, older plants would be used more. Most of these plants have less stringent pollutant emission standards applied to them. In other words, they are grandfathered under the state implementation plans. Therefore, the amount of air pollution associated with coal plants would actually go up with this technology. Is that not so?

DR. LANG: No, that's not so, and for several reasons. But one is that there's nothing inherent in this technology that says you have to keep the old high pollutant-emitting plant. But the thing of it is, by operating these old plants very inefficiently, like at 30 percent load factor, you're still operating the plant twenty-four hours a day.

Some of the plants that I know of in Iowa -- they bank them all night long. Everybody goes home, but they burn coal, run the plant, and it pollutes all night long. It's not making one kilowatt hour; it's just sitting there keeping warmed up, burning coal automatically until the daytime comes and the workers come in at 8:00 in the morning, fire the plant up to full capacity, and then shut it off at about 3:00 o'clock and put it on automatic.

You still have to pay for that plant and the pollution emissions twenty-four hours a day. You can't shut that thing off, although it's a peaking system. Now, it doesn't make any difference to me if they close it down or not -- that would be fine by me. But air storage does not lead to keeping old fossil plants. This was not the first conclusion of the Environmental Protection Agency; it was just the opposite of that: that the environment would benefit by putting some of these out of business.

I have a letter on that if you'd be interested in seeing this.

DR. REZNEK: If you'd like to submit that for the Record --

DR. LANG: It's from Sheldon Meyers.

DR. REZNEK: Would you like to submit that for the Record?

DR. LANG: As a matter of act, the Environmental Protection Agency, in 1971, said this was good and it could have impact on the air quality in the following ways: One, compressed air storage could be combined with nuclear power plants; two, by the replacement of older fossil plants not controlled by air pollution control devices with new incremental base load plus air storage.

This is just the opposite of the hypothesis you made. Three, it could be used as a partial substitute for spinning reserves, only not making any pollution during the time it's spinning. And four, time shift of generation patterns, such as generation powered by air storage during time intervals when pollution levels are high.

DR. REZNEK: Any further questions?

Thank you very much.

DR. LANG: Thank you.

DR. REZNEK: Our last witness for the day, if there are no other witnesses who are not on the program who wish to speak, is Dr. Ronald Doctor. He's Commissioner of Energy Resources in the Conservation Development Commission for the State of California.

STATEMENT OF DR. RONALD DOCTOR
COMMISSIONER OF ENERGY RESOURCES
CALIFORNIA CONSERVATION DEVELOPMENT COMMISSION

DR. DOCTOR: Good afternoon. There's just one correction -- I'm one of five Commissioners on the California Energy Commission.

I'd like to just do this informally if I may.

DR. REZNEK: Certainly.

DR. DOCTOR: I don't know how much you know about the California Energy Commission. We were created in 1974 by legislation that came into being in 1975, so we're about three years old now. We have four major functions.

One is forecasting and planning for electric utility resources in the state, and more recently, for gas systems -- that is, estimating future demand for natural gas. Second, on conservation: we have responsibility and authority for developing and implementing mandatory conservation actions in the state and a variety of non-mandatory actions as well. Third, we've got the responsibility for trying to speed up the implementation of alternative sources of energy, particularly solar, geothermal, and biomass. And fourth, we are what used to be called a one-stop shopping agency, and it isn't quite that in California, but we have basic power plant siting responsibility.

All of these functions and a host of subsidiary functions are integrated into a single package -- or we try to integrate them into a single package. Of course, everything tends to focus on our regulatory activities, which are the conservation and the power plant siting activities.

I understand your focus today is on solar and on conservation, and I'd like to outline for you what we've done and what we're doing on those two subjects. On conservation, we have in effect mandatory insulation, weather stripping, and glazing standards for all new buildings in California. For residential buildings, these are what are called "proscriptive" standards -- that is, they deal with the individual components of the building like the shell, glazing, heating systems.

For non-residential buildings, our mandatory standards come in two forms. One is the proscriptive or component performance standards; the other is an energy budget standard. That is, we have set Btu per square foot per year standards for all new commerical buildings by class of commercial building and by climate zone within the state.

We have restricted the use of electric resistance heating and electric resistance water heating, which are particularly inefficient and wasteful uses of energy, and we are encouraging the use of solar energy, both active and passive solar, for those purposes.

We've set minimum efficiency standards for new refrigerators, freezers, air conditioners, space heaters, water heaters, and a variety of additional appliances. We have prohibited standing gas pilot lights on selected new appliances, and in their place are requiring the use of automatic spark devices or intermittent ignition devices. We estimate that will reduce each participating household's gas use by between 10 and 20 percent.

We have set mandatory energy conservation standards for new commercial buildings, as I mentioned -- for non-residential buildings. Those standards, we believe, are going to reduce commercial building energy use by 30 to 60 percent.

Those conservation actions alone, we estimate, will reduce utility expenditures for new power plants in California by about $20 billion, and will reduce California's direct consumer cost for electricity and gas by between $1.2 and $1.5 billion per year. That means direct savings, now, of about $150.00 per year for every household in California. Indirect expenditures for goods and services would be reduced by several times that amount. It's difficult to calculate, but we know it's several times.

Now that's on conservation. We have additional conservation initiatives coming. We are in the process of developing performance standards for residential buildings -- we think we'll set a Btu/square foot per year standard for new residential construction that will be optional to the proscriptive standards or maybe in addition to them. We're not sure what form that will take yet.

On solar, we have a massive program going that we believe will lead to the use of solar energy in one-and-a-half million households by 1985 in California. The heart of the solar program is the state's solar tax credit, which is a 55 percent tax credit with carry-forward provisions different from the federal credit, in that you can carry forward any unused portion of the credit to future years until the entire credit is used up. That credit provides a rather powerful economic incentive for the installation of solar. It's hard to say what the effect of the credit is.

It was enacted in September of last year and was made retroactive to the beginning of 1977. We expect the first tax returns showing the use of the credit to be analyzed to get statistical data sometime within the next few months. We have conducted a couple of surveys that indicate that, at the beginning of 1977, there were something less than two or three hundred solar water heating systems installed in California residences. By the end of 1977, there were 5,000 to 10,000 solar water heating systems installed, and an additional 5,000 to 10,000 solar swimming pool heating systems, and between 500 and 1,000 space heating systems.

If our goal of one-and-a-half million solar homes is reached, we expect savings, mostly in natural gas, to amount to approximately $450 million worth of natural gas by 1985 -- $450 million per year savings by 1985.

DR. REZNEK: At present prices?

DR. DOCTOR: Well, yes, that is in 1978 dollars, but it's escalated and discounted.

In conjunction with the tax credit, we are requiring that certain conservation things be implemented. If you install solar heating and claim the tax credit for it, then you must also insulate your attic and weather strip your house, and we're giving the tax credit for that insulation and weather stripping.

We have a three-year warranty requirement on parts and labor: the first year a full warranty from the installer--that may include pass-throughs from the manufacturers; the second and third years, from the manufacturer. Of course, the warranty is not worth very much if the company that provides the warranty goes out of business six months later, and the solar business, unfortunately, is a very transient one at the moment. So we have proposed legislation that I believe stands a good chance of passage this year, that would create a solar warranty assurance association that would be a quasi-government association consisting of members of government, industry, and consumer groups -- consumer representatives.

There's a host of other legislation that we've introduced to move solar. One in particular that I'd like to mention to you is a passive solar design competition. We perceive a need to introduce passive solar design techniques to builders. The techniques are reasonably well known among energy literati, but are not well known among builders, and builders, by the nature of their industry, are reluctant to adopt what they consider to be new things.

We have tried design competitions in the past and they've been quite successful. This one would be tied to building designers, who must show a linkage to mass marketing builders. There would have to be -- according to the bill that's being proposed that provides money for this -- a commitment on the part of the builder to install some number of passive solar homes, if they were among the winning designs.

That kind of thing could be done on the national level, it seems to me, and it seems to me we're missing a bet if we don't start pushing passive solar a little bit more. Passive solar, unlike active, has the capability of reducing both heating and air conditioning requirements in one strike, and the information that our staff has been able to develop so far indicates that passive solar design features, for the most part, will not raise the cost of housing. In fact, the indications that we have are that housing costs could well be reduced by using passive solar design techniques.

The basic reason for this is that, although you have increased costs in walls and overhangs and maybe glazing, you've got reduced costs in heating and cooling systems, so you can go for smaller systems or, in some cases, none at all, especially in marginal areas where you can get away without artificial cooling by going to passive design techniques.

There's a need for much greater cooperation between the federal government and the states. I think the emphasis in these various conservation and solar programs should be on state implementation and on initiatives coming from the state. People within the states tend to know their areas best; they know the territory. There's less resistance when the states and local governments are involved in the implementation of some of these new programs.

That means, for the most part, that the feds ought to supply a good part of the money -- not all of it, certainly, but a good part of it -- for some of these innovative programs. I don't see that in the federal budget.

Whenever the federal govenment sets standards, I think those standards should have provisions for the states setting more stringent standards. The states should not be pre-empted, except where it's overwhelmingly in the national interest to have a uniform federal standard.

We could use help in California -- and I'm sure other states could use help -- in the development of computer models for modeling new buildings or existing buildings even, in helping us to develop analytic design tools, in helping us to develop climatic resource data. Inevitably, when you get into this kind of thing, you find out that you've got massive data, but none of it is the stuff you need. Data collection on this kind of scale, and in the short time periods that we're talking about to get rapid implementation of these ideas -- these ideas that are already available -- that kind of short-term data collection requires money.

If you stretch it out over time, you need less money, but to compress the time scale on it, you need more, and that means federal assistance.

We have been exploring the various possibilities of biomass use in California. As a short anecdote, we picked up on a Swedish design for a gasifier of organic materials that are fed into the machine and you get a methane and some other gases out. The stuff burns cleanly with air quality control equipment on it. It's inexpensive. It's an existing technology -- it was an existing technology outside of this country.

We tried to interest, at that time, ERDA in a project; they turned it down, so we went ahead and funded it on our own. It turned out to be a booming success -- just a tremendous success, so much so that the industrial participant in the project, Diamond Match Company, has taken bids and is installing larger gasifiers -- I believe it's seven of them, although I'm not sure of that -- to meet all of their energy requirements. And we have other industries in California beginning to pick up on this small-scale technology using indigenous resources, resources that would otherwise be wasted. We've made a success of it where the federal government wasn't interested at all.

Now, that kind of technology could be transferred from California to other states, and it could be done relatively easily. I don't see the kind of effort in the federal DOE R&D budget to do that, and I don't see the kind of effort in the DOE budget that would put enough money into the encouragement of the development of these kinds of devices and these kinds of ideas.

Another one in biomass is the production of methane gas from products grown on energy farms of various kinds -- energy farms that might be marginal lands growing crops that require minimal use of water, crops that could be converted to methane, or energy farms that use the ocean to grow kelp that could then be converted not only to methane but to a variety of products.

What we seem to be missing is the effort that ties together, that integrates, all of the different products that could come out of a system like this and that could give proper economic credit to each of the products. The result would be, we believe, a reduced energy cost -- an energy cost that would be lower than conventional energy costs today.

Kelp in particular seems to be quite attractive for this kind of project. The Naval Undersea Lab is trying an experiment in Southern California off San Diego. There are small-scale efforts on this, but the program, I believe, needs to be expanded and some greater sense of urgency needs to be attached to it.

I think there's potential for the use of small-scale solar electric systems, probably photo-voltaic, operating in remote areas where power is not readily available. But in those kinds of areas, even the high prices that we see for photo-voltaics now could be economically competitive with electricity, which would have to be brought in specially for this.

Wind, the same way -- the same remote applications. Some of these applications, by the way, are not dependent on storage, because it doesn't matter if the system is turned off for a day if the wind doesn't blow or if it gets cloudy for a day or two days or three days. It's a cyclical thing, and you pump water when the sun is out or when the wind is available.

I think we need a wholesale inventory of possible applications for these small-scale technologies. At the same time, if we pursue that, and if we also pursue the possibility of introducing a market pull kind of operation, that will help to bring the price down.

I think federal buildings could and should be showcases for conservation, for solar, and for the use of alternative technologies. I don't see that happening quickly enough today.

There's one more thing: fuel cells. There is a fuel cell demonstration project at ConEd in New York. We have an investor-owned utility in California that's interested in pursuing a demonstration project. The project seems to be lagging, and I have been in contact with the California Municipal Utilities Association, and they have expressed interest in putting together a consortium of municipal utilities to get hands-on experience with fuel cells. We've experienced the difficulty in getting concrete expressions of interest on the part of the federal government and the fuel cell manufacturer in this case.

I think, from the contacts I've made so far in Washington on this trip, there's a good possibiility of getting that going, but I think there needs to be more emphasis in the federal DOE budget on fuel cells. Whatever it is that's inhibiting the introduction of that technology, I think could be overcome and should be overcome, but I don't see the effort in the federal budget to do it.

Let me leave it at that and just open it to questions.

DR. REZNEK: Thank you. I enjoyed your remarks.

QUESTIONS AND REMARKS

DR. REZNEK: In the realm of energy conservation, California is certainly a leader, setting the pace for the rest of the country. But the progress that the Europeans seem to be making is far outstripping even California. We are talking in terms of reducing energy consumption growth rates from 8 percent to 2 or 4 percent. Something like that. The Belgians are committed to an absolute reduction, not a reduction in growth rate but an absolute reduction, of 18 percent in their energy consumption. Sweden is committed to no-growth.

I did have a few questions about some of your suggestions. For example, regarding kelp, doesn't the dewatering process associated with kelp enormously bias the efficiency of the process?

DR. DOCTOR: I don't know, but my response would be that if it does, is it a bias towards inefficiency that we can still live with? The briefings I've heard on kelp from our staff and from DOE contractors who have come in to tell us about their efforts indicate that, sure, there are problems. There are problems with CO_2 upwelling, and we don't know what the net effect of that will be.

But let's get on with exploring these problems a little more rapidly than we are now. I don't know that kelp is going to be THE answer, or even a viable answer, but I don't even see the programs that are going to provide us with answers to the questions we have about viability, and that's what bothers me.

DR. REZNEK: I also have the same feelings about fuel cells. Wasn't there a long history of disappointment with fuel cells?

DR. DOCTOR: There is a long history of research -- basic research on fuel cells. I wouldn't say that there is a long history of disappointment. United Technologies Corporation has, of course, dominated the scene with fuel cell operations, and they are reluctant to make guarantees or commitments as to the performance of the systems that they would put out. That makes the area ripe for government demonstration projects. I think we ought to have more than one demonstration project going on in this country on something that has the potential of fuel cells.

MR. OUTWATER: I'm reasonably familiar with ConEd's problems, as well as the fact that they keep pushing it as something that they have great faith in for the future; in fact, they're looking at that as a great energy alternative. There's a lot of community pressure to move fuel cell research somewhere else, as you know, and a lot of concern that the thing's going to blow up.

DR. DOCTOR: That the fuel cells themselves will blow up?

MR. OUTWATER: Yes.

DR. DOCTOR: Are those concerns founded?

MR. OUTWATER: I think not.

DR. DOCTOR: Then there's an institutional selling job that's got to be done; there's a public information campaign that's got to be undertaken in conjunction with the technology demonstration.

DR. REZNEK: Are you finding interest expressed by the other states in California's solar and conservation programs? Are they coming to you?

DR. DOCTOR: We have been making our information available to other states, and wherever I go where representatives from other states are present, they ask for whatever information we have. We're glad to cooperate with them.

I find that there's an enormous lack of communication across the country, despite established institutions that are supposed to communicate results from state to state or from state to federal government and back. The communication links don't seem to work effectively. I don't know why that is, but I'd pinpoint that as an area that needs some significant improvement.

Maybe the thing to do is just to have people from states with successful programs funded to travel from one state to another and put on dog-and-pony shows and have state people helping state people.

DR. REZNEK: Thank you very much. Any questions from the audience? Thank you.

DR. DOCTOR: Thank you.

DR. REZNEK: We'll close today's session, and we'll meet tomorrow on advanced coal processes.

(Whereupon, at 5:40 p.m. the session was concluded.)

synthetic fuels and oil shale

FRIDAY 31 MARCH 1978

PANEL:

DR STEVEN REZNEK, Acting Deputy Assistant Administrator for Energy, Minerals and Industry, Environmental Protection Agency

DR JOHN DAVIDSON, Council on Environmental Quality

MR ROBERT SIEK, Deputy Commissioner, Department of Natural Resources, State of Colorado

MR ALAN MERSON, Regional Administrator, Environmental Protection Agency

MR JEFF HERHOLDT, Assistant Director, West Virginia Fuel and Energy Office

MS REBECCA HANMER, Deputy Regional Administrator, Environmental Protection Agency

Federal
non-nuclear energy
R&D Program

contents

MORNING SESSION

AFTERNOON SESSION

31 MARCH 1978

The hearing convened, pursuant to Notice, at 9 am
Dr Steven Reznek, presiding:

opening remarks

DR. REZNEK: Good morning. This is the third of the three days of hearings on the environmental and energy conservation portions of the Federal Non-nuclear Energy R&D Program.

The panel members with us today are Alan Merson, on my far left, Regional Administrator for Region 8. EPA Region 8 is our western Rocky Mountain Region. Next to me is John Davidson from the Council on Environmental Quality. On my right is Becky Hanmer. She is Deputy Regional Administrator for Region 1. Region 1 is New England. Next to her is Robert Siek. He is Deputy Commissioner of Natural Resources for Colorado. And, finally, -- I see we reciprocated off our State Representatives -- is Jeff Herholdt and he is Assistant Director of the West Virginia Fuel and Energy Office.

The record will remain open beginning next week for three weeks. Any written comments that any witness would like to submit or any member of the public would like to submit will be accepted up to that time.

Our first witness this morning is Mr. Richard Jortberg from the Commonwealth Research Corporation.

STATEMENT OF RICHARD JORTBERG
COMMONWEALTH RESEARCH CORPORATION

MR. JORTBERG: Good morning. I am glad to be with you this morning. I am Richard Jortberg with the Commonwealth Research Corporation, General Manager thereof. It is a subsidiary of the Commonwealth Edison Company, the electrical utility in northern Illinois.

One of our projects is to design, construct and operate a coal gasification and demonstration plant in Illinois. This is a jointly sponsored plant with the Department of Energy, Electric Power Research Institute, the

State of Illinois, and the Commonwealth Edison Company providing the funds for the project.

The coal gasification plant that we will build will utilize two Lurgi gasifiers which have been designed and built for us in Germany. The gas will then go through a sulfur removal and a sulfur recovery unit and then to a gas turbine designed to operate on a low-Btu gas.

Part of our design effort is to develop a combustor for a low-Btu gas. In a full scale plant the exhaust from this gas turbine would go to a steam boiler to provide steam for a steam turbine generator. However, because of the capital costs, we are leaving that part out of this plant.

We were going to break ground to start this project this coming summer, but we have been advised by EPA, Region 5 that we must submit a PSD application for a construction permit and that no way would an exemption be considered regardless of the R&D nature of the plant, its small size or its limited testing period of three years.

We are assemblying material now for this request, but in view of the time required for assemblage and review, we are probably going to have to delay construction until next year. It does seem a shame when the objective is to develop means to use Illinois high sulfur coal in an environmentally acceptable manner.

In listening to the witnesses yesterday, I am beginning to wonder if we are taking a very narrow view of the energy problem in general. We really should step back and look at the needs in the energy field.

We want energy available when we want it, in a form we can use, and in adequate quantity. When we flip that switch, we want those lights to go on. Having it when we want it leads to energy storage, truly one of the real needs of the energy field, particularly for solar and wind power. There is also a very real need for a utility which has to have rotating machinery for the peak load. All sorts of benefits would result from the ability to level out peaks and draw from storage when it is needed.

In the usable form requires the right match of the source and the use. For example, coal cannot be used directly for automobiles or aircraft. Solar in many ways provides unusable Btu's because of low temperature differentials, but when you couple that with the input of a heat pump, high temperature can result and can be utilized.

In the quantity necessary is self-explanatory, but this leads to the question of whether there really is an energy shortage. In a world-wide sense, no, there is not. In fact in the near term, there is a glut of oil, but in the United States there is a shortage; hence, to massive imports of oil.

We have traded an energy problem for dollar exports, and every day you read and hear about the dropping of the value of the dollar. Our national economy is in many ways like a massive fly wheel. It has taken 200 years to get it up to steam. We better stop draining from it to buy foreign oil. We are going to have to stop solving the energy problem by ruining the future of our economy.

We should recognize that we do have an energy problem and accept the facts. We should do something about it. One of our national assets is our supply of coal. We should make a massive effort toward making coal more widely useful, such as in liquification and gasification.

I would like to address the specific issues you indicated in the announcement of this hearing. Perhaps you now have an idea that the answer to the first one is that it is too late now. When do we need gasification? We need to do it and early.

Next, you wanted to know about environmental issues. Can you adequately anticipate and solve them? Yes, only by taking an adequate size demonstration plant to provide a good basis for modeling large and multi-plant installations.

Predictions from empirical data are not adequate enough to provide assurance for major capital outlays. Will the potential effects of short-duration events, such as catastrophic accidents, transients, and control system failures, be included in environmental assessments? Yes, I cannot promise they will be included in the other ones, but failure modes and effects analysis was made of our test facility prior to the final location of components on the site.

A sensitivity analysis of *variable parameters should be undertaken in* the assessment of any new installation.

How can we include the assessment of socioeconomic, health, and other factors, both in the production and use of these fuels? Systems analysis theory provides for the measuring and quantification of all the elements of a problem and the inter-relationships of the benefits and the costs.

In a problem such as the production and use of synthetic fuels, systems analysis can be employed. The only caution is to employ it for the whole problem, from obtaining, from the mining and so forth, basic fuel stock, converting to synthetic fuel, and use of the fuel. In this manner, the true cost may be measured against the benefit.

Can chronic health problems be detected before the general population is exposed? In the operation of demonstration plants of an adequate volume, parameter averaging is provided to determine what difference in ambient condition is caused by the operating plant.

The difference can be quantified, it can be examined in context with ambient history. Once having determined the effect on the ambient, you would have to turn to the medical profession for advice as to what the resulting meaning would be.

Theory can provide predictions, but only in confirmation by observation can progress be made.

How can the development of synthetic fuel technologies best be managed to assure that the costs of pollutant control devices are fully explored and demonstrated? It would appear to me that a catalog of pollutants combined with the various available treatments of facilities with capital costs, operating costs and effectiveness should be developed and maintained.

When a process is initiated at the demonstration plant level, the amount of pollutants can be categorized so that any scale-up can be made with confidence in the cost of the installation and the cost of the operating in order to achieve an acceptable initial risk.

That concludes my prepared testimony. Any questions?

DR. REZNEK: Thank you. Does the panel have any questions?

QUESTIONS AND REMARKS

MR. HERHOLDT: Yes.

DR. REZNEK: Mr. Herholdt.

MR. HERHOLDT: How are you avoiding the agglomeration problem associated with the Illinois coals with the Lurgi gasifier?

MR. JORTBERG: That is one of the problems we are facing. We designed the gasifier with Lurgi with Illinois No. 6 coal. That is what they are designed for, and how we are going to operate with it, we are going to have to find out when we work. We don't have a real good answer for you yet.

MR. HERHOLDT: Are you thinking about a stirred bed type process?

MR. JORTBERG: Yes.

DR. REZNEK: I would like to ask a question. What percentage of the cost of your facility or of a full-scale facility would be associated with the desulfurization?

MR. JORTBERG: I can't give you a good answer for that today. That is one of the things we have to do in a developmental plant of this size. That is, we are going to break down the cost of each element of it to determine the operating costs, to determine the benefits of it.

We are going to use a stretford process and a hot potassium process for the sulfur removal. We don't know the economies of each individual part of the plant yet.

DR. REZNEK: Thank you.

MR. MERSON: I detected in your opening remarks certain dissatisfaction with having to proceed to meet PSD requirements at this point. It is going to slow you down somewhat in getting your modules started. Are you advocating that somehow for R&D work for testing out new processes that somehow we waive the PSD process?

MR. JORTBERG: I think the door should be open to that, to examine each one on its own merit, to determine the significance of the thing rather than going through the lengthy process to show that we don't really count that much.

MR. MERSON: What about using sort of the test module that you are discussing really for an exploration of various pollution control techniques?

MR. JORTBERG: This plant that we are going to build is more than just building a plant to test it. It is providing almost a national test site for coal gasification, various treatments for different gasifiers and things like that.

Our initial test program, the one we are installing, is for three years. Past that, DOE has an option to lease the site, whether we are a part of it or not, for another seven years. So, the installation here is far more than just the one time thing.

It is to determine enough of the economies of it and the usefulness of it so that a utility can go into it with a minimum risk, knowing darn well that when they put their money into it, they are going to have some return on their investment.

MR. MERSON: Well, if it gives you any comfort, we have some oil shale projects out in our part of the country and we have required PSD permits for those as well. I think part of the theory is that if you are going to have a small scale experimental process and you are going to have trouble meeting PSD, you are sure going to have a lot of trouble with the larger scale.

MR. JORTBERG: I don't think we're going to have trouble meeting it at all. It is a fact that we have to go through that same time period for any size of a plant regardless of whether it is large or small.

This project has been underway now -- really it started in about 1973 going in start and stop and start and stop and going full way now. All of a sudden, now, we have come this far and now we have to go up the --

MR. MERSON: How long is the PSD process taking?

MR. JORTBERG: It allows up to a year.

MR. MERSON: I know it allows up to a year, but has Region 5 indicated that they are going to take a full year to process it?

MR. JORTBERG: One of the problems they run into, of course, are the open hearings and what develops there. No, they think they can do it in less than a year. That is why I have to be realistic when I buy the equipment and get it on the site. When am I really going to be able to use it?

MR. MERSON: Thank you.

DR. REZNEK: Would you recommend that the Agency develop a special test facility PSD review policy which imposes on the Agency a definite time frame in which to perform the review and beyond which, if the Agency has not made an adverse finding, the construction of the facility is allowed?

MR. JORTBERG: Yes, I would.

DR. REZNEK: One other question. I realize that in complex processes like this, it is nearly impossible to separate environmental control costs from actual process costs, but can you say approximately what percentage of your investment or your research program will be spent on process variables and what percent on environmental protection variables?

MR. JORTBERG: I am afraid I can't give you a real good answer to that today because we are still only about 20 percent done in the design part of the project. The actual operation of the project is to be guided by a Technical Advisory Commission Committee which is made up of DOE representatives, State of Illinois and the Electric Power Research Institute. I would think EPA would get in here and see how we are doing and where do we go from here.

DR. REZNEK: That is an offer I would certainly like to explore. One of the things we in EPA are trying to do is to impact the development of new energy development technologies early enough to make sure that the environmental concerns are designed in. I believe that to optimize a new facility design, one must understand the relationship between cost curves for environmental pollution reduction and the cost curves of the processes themselves. We would all like to have a thorough understanding, since it would shed light on the role of sulfur removal and hydrocarbon and particulate emissions reduction to the economics of the process. These are some of my concerns. I certainly appreciate your offer and I would like to explore the joint participation further. Thank you.

MR. JORTBERG: Thank you.

DR. DAVIDSON: I just have a brief question that sort of follows up on what Steve was discussing, I think. Simply, I wonder if you could comment briefly on the difficulty of scaling up technical and environmental and economic data from a facility such as a pilot plant scale operation to a commercial sized plant.

As I understand it, one would see a considerable amount of difficulty in trying to really estimate some of the pollutant levels and the economic characteristics as well. Is that an overstatement of the situation, do you feel?

MR. JORTBERG: It is not an overstatement. One of the things that we have learned in the electric industry right now, the utility industry, is that if we scale up factor three to four, we can do it with pretty good comfort and assurance. If we would start going to a factor of ten we are way out on a limb and our projections are just scary, the risk is too great.

As you will note in here, I am very strongly in favor of the demonstration plant of adequate size that you don't go from a pilot plant to a commercial plant. You have to go in steps in order to really understand the risks involved. I think you have to go to a large enough plant so that you can measure the little things that escape you in a pilot plant that can really hang you in a commercial plant.

DR. REZNEK: Any further questions?

MR. SIEK: You are talking about a modular approach. What do you consider to be a reasonable modular site demonstration facility?

MR. JORTBERG: Ours is 20 tons per hour, and it is only a 25 megawatt generator. I think what we learn from there will provide probably enough to go much higher. I think if you go lower than that, then I don't know what you are really going to do.

The gasifier, itself, is good for about 20 tons per hour. We are putting in two gasifiers; one is installed spare, and we will actually run two of them in parallel for test runs.

The modular base we have used here is one gasifier at full power. For instance, there is a plant down in South Africa using Lurgi gasifiers that has 36 of them. So we will find that with our basic modular unit, what can we do and where do we go. Then we can scale up from there.

MS. HANMER: You mentioned, I think, about the concern of the public hearing phase of the PSD permit application. I would be interested to know what public objection you would anticipate getting.

MR. JORTBERG: I don't know. I don't anticipate getting any at all, but I'm afraid after living in this environment a while, you know, you get a lot of surprises.

DR. REZNEK: One final question for the record -- at the present time there is no federal money in this facility. Is that right?

MR. JORTBERG: Yes, there is federal money in it. It is jointly funded with the Department of Energy and these other activities.

DR. REZNEK: The federal percentage at this point?

MR. JORTBERG: The federal percentage right along about 60 or 70 percent.

DR. REZNEK: Thank you. Any other questions?

Thank you.

MR. JORTBERG: Thank you.

DR. REZNEK: Our next witness is Dr. Benjamin Schlesinger, Director of Policy and Economic Analysis of the American Gas Association.

STATEMENT OF DR. BENJAMIN SCHLESINGER
DIRECTOR, POLICY AND ECONOMIC ANALYSIS
AMERICAN GAS ASSOCIATION

DR. SCHLESINGER: Good morning. I am Ben Schlesinger, Director for Policy and Economic Analysis, American Gas Association. The A.G.A. is a national trade association representing 300 member natural gas transmission and distribution companies, which provide gas service to 160 million consumers and 200,000 industries in all 50 states.

The purpose of my testimony this morning is to address the environmental implications of federal priorities in the area of synthetic fuels research, development, and demonstration within the context of overall national energy policy.

The peaking and decline of U.S. oil and gas production in recent years as a result of artificially low regulated prices has led our nation to the point where nearly 50 percent of our oil consumption is imported, chiefly from price-controlled sources such as the OPEC cartel.

Nevertheless, all of the recent authoritative estimates of remaining recoverable conventional gas resources in the United States are in the range of 700 to 1200 trillion cubic feet or approximately 700 to 1200 quads of remaining gas that could be produced.

These include estimates of the U.S. Geological Survey, the National Academy of Sciences, and the Potential Gas Committee. I have several attachments today and I urge you to look at these for comparison of the various estimates.

Thus, at the current U.S. consumption rate of about 20 Tcf per year of natural gas, there are between 35 and 60 years of conventional U.S. gas supplies remaining to be produced.

All of the numerous federal energy plans that have been developed during the past four years since the 1973-74 oil embargo have shared one central feature: each placed a substantial reliance on aggressive development and combustion of our nation's largest single proved energy resource -- coal.

One of the most aggressive plans in this regard was President Carter's proposed National Energy Plan (NEP), announced last year.

Specifically, the President's NEP projects a 25 percent growth in total U.S. energy consumption over the next nine years, that is from 74 quads per year to 93 quads per year of fuel use. Of the additional 19 quads, the President's NEP relies on coal for 13.

Of this energy, 6.8 quads, or a little over half, would be used to generate electricity with the remainder used directly under large boilers in industry. The 6.8 quads would translate into approximately 130,000 megawatts of additional electric coal-fired capacity by 1985 or about 260 new coal-fired units over the next eight years.

Last year, the A.G.A. undertook an analysis of the constraints to this massive conversion of gas-fired industrial and utility boiler fuel use to coal.

Our purpose in conducting this analysis was to determine whether, indeed, the 3 to 4 quads of natural gas now burned in large boilers for steam and electric generation could be supplanted by coal between now and 1985 so that this gas could then supply higher priority residential, commercial and industrial demands.

The A.G.A. generally supports this large boiler backout. The intent of our analysis was to determine how quickly the 3 to 4 quad backout can realistically occur.

Accordingly, we examined coal production, mining constraints, transportation, and end-use burning constraints posed by the 1977 amendments to the Clean Air Act. While no major constraint could be discerned to massive increases in coal mining, production and transportation, our analysis which is attached hereto, indicates that the proposed near-doubling of U.S. coal burning by 1985, even using Best Available Control Technology, is not likely to be achieved with strict implementation of the provisions of the new Clean Air Act.

The major reason for this impending NEP failure is that the new non-attainment rules which are designed to enable growth of new pollutant sources by tightening up pollution controls on existing sources, might backfire in many locations to the extent that compliance of existing sources is not achieved.

The result of the Clean Air Act, we believe, therefore, may be to leave our industry with a substantially greater demand for gas than is envisioned in the President's National Energy Plan.

While the precision of our estimates can be discussed at length, there is little question in our minds that massive increases in coal burning in the United States cannot occur if we are able to maintain our nation's environmental quality goals.

Parenthetically, I would add that the jist of that is that somewhere coal burning has a limit with respect to our national environmental quality goals under current technology and the kind of cleanup technology we foresee over the next several years.

Our industry, therefore, which supplies the cleanest fuel in widespread use in the U.S., as well documented in your Energy/Environment Fact Book, has focused major attention on coal gasification, Alaskan gas, and LNG, as a means to continue supplying our customers, present and future, with clean fuel.

In sharp contrast with the uncertainties involved in coal burning -- even with flue gas desulfurization or atmospheric fluidized bed technology --we believe that numerous studies conducted by ourselves and others clearly have shown that coal gasification is the most economic, most efficient, least capital intensive, and most environmentally desirable way of substantially increasing coal use on a national scale.

Detailed comparisons of coal use for making gas versus making electricity reveal that a coal gasification plant such as a Lurgi coal gasification plant producing high-Btu coal gas would result in 6 to 10 times less air pollution of the various criteria substances and one-ninth the water consumption of the equivalent conventional coal-fired electric power plant equipped with the Best Available Control Technology.

High-Btu gas from coal is feasible using current, proven technology. A number of commercial plants are proposed and construction of the first few plants can proceed with federal loan guarantees. With such support, two plants producing a total of approximately 0.2 of a quad could be operational by 1985.

The potential for subsequent capacity is projected at 13 plants by the year 1990, 24 such plants by 1995, and about 44 plants by the year 2000. This growth rate is consistent with the rate of growth experienced by the nuclear power industry between the late 1950's and the early 1970's.

The benefits to the environment of this emphasis are clear. The benefits to labor of realizing this potential for coal gasification is also substantial because construction and operation of a coal gasification plant is labor intensive.

Indeed, the significant environmental advantage for coal gasification should place such facilities high in priority for Western coal development because of their relative ease in siting compared to coal combustion.

Similarly, major environmental benefits could be realized with other kinds of synthetic fuel facilities as well. I think the gentleman's testimony that preceded mine amply underscored that.

Medium-Btu coal gasification plants for industrial fuel use would make substantially cleaner neighbors than coal-fired power plants. Again, the application of non-attainment rules in some of our nation's heavily industrial regions may make medium and low-Btu coal gasification a more viable option than ever.

Several A.G.A. member companies have been in the forefront of medium-Btu coal gas development, although efforts to market medium-Btu coal gas have been constrained by proper industrial classification -- that is an identification of those industries that would actually be interested in medium-Btu coal gas -- by geography, and by scale of users. These three constraints would not be present in the case of high-Btu coal gas markets.

From both the gas supply and the environmental quality perspectives -- and we believe they are highly coincident -- the A.G.A. would strongly recommend a continuation and strengthening of programs to commercialize synthetic fuels from non-fossil, renewable resources as well as from coal, including agricultural products, biomass, and urban solid wastes.

Although today's agenda is focused on synthetic fuels, I would like to turn briefly to the issue of imbalance in the federal RD&D program budget.

We believe that inadequate federal expenditures for energy research and development to tap new gas energy resources have left virtually ignored the vast potential of such unconventioanal gas energy sources as methane from geo-pressured reservoirs, coal seams and tight sands, as well as from peat, biomass, and other sources.

While these estimated in-place domestic resources are uncertain, federal R&D expenditures continue to be quite small. I think you will find our attachment particularly enlightening in that regard. Total federal support for technologies to utilize these resources represents less than 2 percent of total federal energy R&D expenditures.

By contrast, the Department of Energy's fiscal year '77 budget calls for spending several billion dollars on no fewer than 16 different ways to make electricity. Considering this, we suggest that the very small commitment to new gas-related technologies does not reflect a wise allocation of national resources.

In summary, the A.G.A. strongly advises that current federal energy RD&D priorities, which are heavily tilted toward electricity rather than direct fuel use, are environmentally inferior to a balanced approach using gaseous and other fuels.

Natural and synthetic gas are by far the most environmentally desirable of all our domestic fuel options. This is because methane, the principal component of natural and synthetic gas, is clean burning since it emits very small quantities, comparatively small quantities of sulphur oxides and particulates when burned. Again, this is documented in your own handout today. During production of synthetic gas from coal, we've seen how comparatively small quantities of sulphur oxides, particulates, and other criteria substances are released.

Enclosed herewith are several items of information related to the future of natural gas and benefits of developing new sources of gas from a perspective of labor and employment. Thank you very much.

DR. REZNEK: Thank you. Does the panel have questions?

QUESTIONS AND REMARKS

MR. HERHOLDT: Yes.

DR. REZNEK: Mr. Herholdt.

MR. HERHOLDT: I have a couple of questions. The first one -- you stated a coal gasification plant would result in 6 to 10 times less air pollution and one-ninth the water consumption of a typical coal-fired plant. I would assume you are not --

DR. SCHLESINGER: Excuse me, I did not say typical plant. I said equivalent.

MR. HERHOLDT: Excuse me.

DR. SCHLESINGER: Typical, but equivalently scaled.

MR. HERHOLDT: Okay, but I would assume you are talking about low-Btu gas as opposed to hydrogenation stages which use a good deal of water.

DR. SCHLESINGER: It might be helpful to turn to Attachment 3 in this regard. A full-scale, which is 250 million cubic feet per day, high-Btu coal gasification plant utilizing a Lurgi process with methanation has been estimated to produce the environmental residuals that are shown in Attachment 3.

It is right after that 23-page Energy Analysis. The cost of such a facility in 1976 dollars has been estimated at 1.3 billion. Five such plants have been proposed for construction by various of our member companies and the environmental estimates come from the Council on Environmental Quality.

If this energy is carried through the end user, using residential space heating as the basis for comparison -- excuse me, using a composite residential end use of space heating, hot water heating, and all efficiencies are taken into account through to and including the point of end use, the similar quantities of Btu can then be moved back through the electricity chain.

The comparable coal-fired power plant would be approximately 3,000 megawatt peak rated capacity or equivalent to the proposed and demised Kapairowits project. Again, that is a fair comparison since it would utilize the same kind of coal.

MR. HERHOLDT: What are you saying, that the comparable end use cost would be assuming that there are environmental protection devices on the coal-fired plant?

DR. SCHLESINGER: The comparable facility costs approximately 2.7 billion dollars or approximately twice as much as the coal gas plant.

MR. HERHOLDT: I was referring to the end use cost of the electricity to the consumer.

DR. SCHLESINGER: The end use cost of electricity to the consumer is about $14.00 on an incremental basis, about $14.00 per million Btu as opposed to the coal gas which, if fully incrementally priced to the end user, would cost $4.45.

MR. HERHOLDT: That is a substantial difference there.

DR. SCHLESINGER: Yes, it is. It is primarily due to the inefficiencies of producing electricity from coal.

MR. HERHOLDT: How would you get from your gas to electricity? You still have to burn the gas in a turbine crypt.

DR. SCHLESINGER: No, we're not comparing use of gas production to electricity. We are comparing the direct use of gas in the home.

MR. HERHOLDT: Okay, so you are still talking about augmenting our declining reserves in natural gas with synthetic natural gas rather than replacing the electric generation plants that are currently on line or scheduled to go on line.

DR. SCHLESINGER: This kind of comparison is focused on the issue of what is to be done with our coal resources. A large part of my testimony was devoted to that issue: that we do have a massive coal resource, and it occurs to us that one of the major energy issues is what do we do with that coal. Do we just burn it and proceed kind of slowly on a gasification program or do we intensify our R&D efforts on gasification. The purpose of this chart is to furnish information which I think astoundingly shows the efficiency, capital stock benefits, and of course environmental benefits in gasifying the coal and utilizing gas in the home as opposed to utilizing electricity in the home, or in addition to that.

We are not suggesting that all this coal be gasified. None of it is being gasified at the present time. Many transcontinental pipelines cross right through major coal fields. It occurs to us that that kind of siting is ideal for coal gasification. Does that answer your question?

MR. HERHOLDT: Yes.

DR. REZNEK: For the record, did these typical electrically heated homes employ heat pumps?

DR. SCHLESINGER: They did not use the heat pumps.

DR. REZNEK: Did the gas heating use the heat pump?

DR. SCHLESINGER: No. This is based on conventional end use technologies. Our chart shows the same kind of comparison with advanced equipment comparing gas heat pumps and electric heat pumps.

DR. REZNEK: Regarding the water consumption, that was a wet cooling tower, not a wet-dry cooling tower, right?

DR. SCHLESINGER: In the case of gasification, the estimates which were furnished by the Council of Environmental Quality were for dry cooling.

DR. REZNEK: But the electricity did not assume dry cooling.

DR. SCHLESINGER: The electricity is based on the Kapairowits project which was not a dry cooling project. I think there ought to be -- there are several reasons why the water efficiency advantage of gasification exists and one of the major reasons is not so much the wet/dry cooling issue. The major reason is the fact that the coal gasification plants utilize the moisture in the coal.

DR. REZNEK: That is clear. The question is whether or not a 9 to 1 water use ratio reflects an efficiency in electricity generation.

DR. SCHLESINGER: Attachment 3 compares the water requirements stated in the Environmental Impact Statement for the nearest coal-fired power plant to the proposed coal gasification plants in New Mexico.

DR. REZNEK: Mr. Siek.

MR. SIEK: I am interested -- you refer to western coal in your comparison. What are you basing it on -- low sulfur or high-Btu? I guess my question is if all of your projections are based on the use of Western coal, obviously you are thinking about siting these gasification plants in the west to take advantage of the coal deposits.

DR. SCHLESINGER: The five large scaled coal gas plants that have been proposed by various groups of our member companies have all been proposed for location in the west as a result of not only a coal availability decision and a cost decision, but also a technological decision based on tests conducted in Scotland and Germany using the Lurgi process.

It is clear that Lurgi would not encounter difficulties. In fact, Lurgi has been shown to work successfully with non-caking western coals. So, this kind of a location is a technologically feasible one with respect to a kind of plant that could start up within the next year.

MR. SIEK: Another question that always concerns me is the water consumption, number one, that will be required in the west, and number two, the environmental impact which may be biased toward the west over the east with electric generation, this taking the place of electrical generation.

Right now, we import our coal or export our coal. Here, we will burn our own coal and export our gas so we have the generation facility located in the west instead of the fuel located in the west for exporting and the generation of the power --

DR. SCHLESINGER: I understand that there are a number of coal-fired power plants proposed for location in the Western coal regions. My understanding is that they have encountered substantial difficulties in siting not the least of which factors are related to prevention of significant deterioration regulations.

EPA completed a study jointly with FEA last year that demonstrated -- in fact, out and out stated -- that a coal gasification plant at the proposed locations of our five projects could be co-located with itself. That is, you could have approximately eight full scale coal gasification plants at the proposed locations, not only one, and still meet the requirements of PSD, whereas at some of these locations you could put probably one or no coal-fired power plant. Again, this is because of the difference of residuals expected.

MR. MERSON: If the advantages of coal gasification are as impressively documented as you indicate in Attachment 3, why is it that utilities generally are not investing in coal gasification, but are going ahead with conventional fossil fuel electrical plants?

DR. SCHLESINGER: That is a very good question. Our member companies are very interested in investing in these projects and have been attempting to obtain financing for a number of full scale coal gasification plants. There is no full scale commercial coal gas plant operating in this country. There are a number of pilot plants that are 1/100 and 1/200 commercial scale.

There are a number of proposed projects that would increase that to maybe one-tenth proposed in the Department of Energy, but lenders have been reluctant to assume risks of first of a kind full-scaled coal gas plants, in spite of the fact that the technology is demonstrated. I think that is the reason.

MR. MERSON: You have indicated also that you felt governmental policies at this point tend to tilt toward electrical generation rather than gas generation.

DR. SCHLESINGER: The National Energy Plans have been massively weighted toward burning of coal.

DR. REZNEK: If there were a commitment today to go ahead with the first full sized plant, how long would it take before it would be operational?

DR. SCHLESINGER: It depends on which project. One of them could be -- I would say between four and six years.

DR. REZNEK: For high-Btu?

DR. SCHLESINGER: That is correct. Five projects are fully designed and environmental impact statements on several of them have been finalized and filed with the Council on Environmental Quality sometime ago.

DR. REZNEK: Let me explore another topic. You have laid out the environmental impact in terms of the conventional --

DR. SCHLESINGER: Excuse me, Dr. Reznek, I really have to come back to one point and that is the water report. I am really troubled that perhaps the wrong impression might be left by our table. One of our projects, which is the Wesco Coal Gasification project, proposed for location in New Mexico, is filed with the FPC now, FERC, and in their plans -- their engineering plans call for, and their request for water rights is based on, a water requirement of 7,900 acre-feet per year. That is 7,900 acre-feet per year.

The proposed Kapairowits power project which would have produced an identical amount of energy at a location 50 miles away similarly filed and their filing requested 5,400 acre-feet. Excuse me, 54,000 acre-feet of water. That is 54,000 as opposed to 7,900.

Another one of our projects, American Natural Gas, has proposed to use approximately 5,000 acre-feet per 1/2 scale plant. Another one proposed to use 4,900 acre-feet, proposed for location in New Mexico. I think the water advantage of gasifying coal rather than burning it in Western locations is amply documented.

DR. REZNEK: I agree it is amply documented. At a minimum, the water use rate of electricity generation via coal gasification is 1/3rd that of direct coal combustion systems, and at a maximum, it would be the 1/9th value you cited earlier.

Let me ask some questions on a slightly different subject area. You have laid out your environmental impacts in terms of conventional air pollution parameters, namely, total particulates, SO_2, and oxides of nitrogen.

DR. SCHLESINGER: Right.

DR. REZNEK: One great fear inspired by coal gasification and liquifaction is that those parameters are not an exhaustive list. Nor are they necessarily the most applicable ones. Evidence from the coal gasification industry as it existed in the 30's -- not very far from this location as a matter of fact -- indicated that the gasification workers in the population had high incidence of cancer. The particular type of cancer was one associated with certain types of organic emissions. This sort of data has created in everyone's mind a fear that this technology would produce a new dimension in environmental pollution.

That fear is a real public concern. What do you suggest can be done to put an upper bound on emissions and on the associated public health hazard of coal gasification and liquifaction, and to communicate that upper bound to the public?

DR. SCHLESINGER: That is a good point and a widely misunderstood one. The kinds of plants that you are referring to are primarily facilities to produce town gas, low-Btu gas, or other coal products called tar products and so forth, coking plants.

There is a considerable body of knowledge that suggests that there is a substantial worker hazard in these plants and possibly an environmental hazard.

The kinds of facilities that are proposed now in the late 1970's for construction and operation in the 1980's are vastly different facilities. They are facilities that are to be constructed in a completely different manner from these plants, drawing upon the work exposure experience from them. They would be more resembling a refinery than a low-Btu coal gas plant of the kind that you are referring to.

I remind you that NIOSH, National Institute of Occupational Safety and Health, is presently preparing a criteria document that would govern occupational safety and health standards for a coal gasification plant -- high and medium and low-Btu. They have based the study on their tours of all three kinds of facilities, are quite concerned with the deployment of this technology on an informal or user location basis, or anything other than a very strictly controlled environment.

The results of their criteria document as well as our own studies on the subject, and of ERDA's and now DOE's studies on this topic, strongly indicate that a high-Btu coal gasification plant would have significant advantages from a health and safety point of view over a low-Btu coal gas plant or a low-Btu installation at a user location.

I am not sure that this is widely understood. In fact, I know it is not and I think this is something that we are going to be discussing in the future.

DR. REZNEK: Let me agree with you that the relative safety of centralized high Btu plants is not widely understood. I think there are two tasks: One is to establish, to the extent that science can, the degree of risk; and the other is to deal with the public perception of that risk. The fact that public perceptions of these risks are more important, perhaps, than the scientific criteria documents is a problem in the energy crisis.

Are there any further questions?

DR. DAVIDSON: I just have one question. Given the view that the AGA has that the research program within the Department of Energy is very likely out of balance between the various coal technologies, I wonder what response you have had when you have explored this with the Department.

DR. SCHLESINGER: First of all, we testified to this effect before Congress about a month ago and received a very positive response to our comments on imbalance in Federal R&D programs in the energy area. We are increasingly getting a positive response, I think, from the Department of Energy.

Their original impression was that they had developed a very cost-effective national energy plan and a very environmentally sound one. I think that misimpression is being corrected all around, but I can't say that we are getting awfully far. There is still a very major tilt in the Department of Energy toward the production of electricity.

Our concerns have been echoed. They have been echoed by environmental groups, who have expressed parallel concerns about the lack of emphasis on the direct fuel use. So, we will just keep hanging in there.

MR. MERSON: I have a question, just one further point. You indicated that we have a pipeline network that essentially can handle a good share of this newly generated gas. I assume, however, that that network would have to be augmented to some extent if we are going to have this infusion of new gas. Or, are you essentially saying that our transmission and delivery problems have been essentially met by what we have?

DR. SCHLESINGER: We have an estimate of the total capital needs of the gas utility industry after the year 2000 based on ongoing maintenance programs and new pipeline construction at our historic pace, and based on an infusion of supplemental gas of the sort that we believe is possible with the right Federal emphasis and regulatory climate.

We don't see the need to go out and construct brand new intercontinental pipelines. I think it is widely accepted, by us included, that our natural gas resources -- whether it is 35 or 60 years -- in the Texas, Louisiana area are finite.

I guess the point that I made about the transcontinental pipelines that happen to cross major coal areas is a relative one in this regard. It strikes us as common sense from a national energy point of view to gasify coal along the line or in locations near the line, which happens to be the situation of the proposed coal gasification plants.

I don't think it will require new transcontinental pipelines or new distribution systems to carry the supplemental gas to the end user. I think the system is in place. The total estimated capital value of our gas transmission distribution system in the entire country consisting of about a million miles of pipeline is about 52 billion dollars.

To reconstruct that system today would cost a lot more than 52 billion dollars. That is for sure.

DR. DAVIDSON: Considering the importance of the resource problem within the gas area, I am wondering, what do you see as the opportunities and likelihood of a widely deployed gas actuated heat pump system by the next decade or somewhere in the nineties?

DR. SCHLESINGER: As you know, we have a lot of research in that area going on now in the Gas Research Institute. Our engineering and research activities have been transferred to that in Chicago.

We think that is an essential item, and again, I draw your attention to the Federal budgetary comment in my statement. That is another way of conserving the gas resource and lengthening it.

DR. REZNEK: One final question. The environmental performance of any facility in this day and age is determined as much by regulations as by basic chemistry and physics. Would you favor interim guidance which sets the environmental performance for a gasification plant at a more stringent level than current standards for conventional electric power plants? Such guidance would make clear the environmental benefits of gasification plants. It would state emission limits for specific air pollution parameters and express them in terms of quantity of pollutant emitted per unit of useful energy generated for some market basket of uses.

DR. SCHLESINGER: I think we are on record as welcoming that.

DR. REZNEK: Thank you.

MS. HANMER: I have one further question. Have you done a similar kind of analysis for the east for a potential, for example, using eastern coal?

DR. SCHLESINGER: We haven't. We're doing it right now. Are you talking about environmental comparison?

MS. HANMER: Your Attachment 3, something like your Attachment 3 in terms of coal requirements, key environmental parameters.

DR. SCHLESINGER: I think it should be recognized that the focus of Attachment 3 is on existing planned projects.....

MS. HANMER: Yes, I understand.

DR. SCHLESINGER: ...projects that could come off the shelf and into construction within the next year. There are no such full scaled coal-gas proposals for eastern location.

The kind of comparison that we are going to do and are in the process of doing is one that compares direct fuel combustion with medium-Btu gas for use in industry. It would talk to the unit capital requirements and environmental comparisons and efficiency comparisons as well.

We are due to complete that study in very short order and I will be very happy to send it to you because I believe it shows substantial advantages as well to be documented.

MS. HANMER: Okay.

DR. SCHLESINGER: Incidentally, this Attachment 3 has not been refuted by any authority that we are aware of.

DR. REZNEK: Thank you. Any other questions?

Thank you.

DR. SCHLESINGER: Thank you.

DR. REZNEK: Our next witness is Mr. William L. Rogers who is Manager of the Environmental Affairs for Gulf Mineral Resources Company.

STATEMENT OF MR. WILLIAM L. ROGERS, MANAGER
ENVIRONMENTAL AFFAIRS
GULF MINERAL RESOURCES COMPANY

MR. ROGERS: I am Bill Rogers, Manager of Environmental Affairs with the Gulf Mineral Resources Company, a division of Gulf Oil Corporation, headquarters in Denver, Colorado.

Gulf and its subsidiary, the Pittsburg and Midway Coal Mining Company, have been developing the solvent refined coal process over the past 15 years, primarily under the sponsorship of the Department of Energy and its predecessor agencies.

Recent experience in large pilot plant operations with the SRC liquid process on a variety of high sulfur bituminous coals has demonstrated a technical feasibility of the process for producing a clean coal derived fuel oil and by-product synthetic natural gas.

Product characterization and testing of the SRC liquid product indicates potential for displacement of petroleum fuel oil in industrial and utility boilers. Large scale combustion testing is now scheduled in 1978. Low-ash and low-trace element levels suggest further application as gas turbine fuel.

Our work on SRC began in laboratory research in 1962. Much of the earlier development work was carried out on a version of the process now known as SRC-I.

In the SRC-I process, coal is dissolved in a distillate recycle solvent, in the presence of hydrogen, at elevated temperature and pressure. The undissolved portion of the coal, primarily ash, is then filtered from the solution. The filtrate is vacuum distilled to recover the solvent for recycle. The product from vacuum distillation is a solid low-ash fuel known as Solvent Refined Coal.

The experimental work at the various pilot facilities has pointed out three technical problems in commercialization of the SRC-I process:

First, solid/liquids separation, particularly with filters, will be difficult and costly to scale up to a practical commercial operation.

Second, in the SRC-I process, the solvent balance is marginal. That is, the solvent recovered at steady rate is barely sufficient to satisfy the requirements of the process.

Third, dusting of Solvent Refined Coal presents an environmental problem in handling and transportation.

Further research work has led to the development of variations in the original process which overcome these problems. The modified process, now known as SRC-II involves use of a portion of the product slurry as a solvent in place of the distillate used in the SRC-I process.

Such use of the slurry makes it possible to further react the dissolved coal to produce a distillate liquid product. Since the quantity of unreacted coal remaining is then relatively low, it becomes practical to feed this material to a gasifier, together with the undissolved mineral residue. This eliminates the requirement for filtration or other de-ashing procedures and means that the primary product from the process is a distillate liquid.

SRC-II facilitates the use of coal in conformance with the standards we understand the EPA is proposing to satisfy the Clean Air Act Amendments of 1977:

SRC-II will meet the proposed standard of 90 percent sulfur removal.

SRC-II will meet proposed NOx coal limits.

SRC-II will meet proposed particulate standards with the use of control devices such as bag-houses.

We understand that consideration is being given to designation of SRC products as "emerging technologies," deferring the establishment of specific standards until a later time. Establishment of standards now would encourage and speed the application of the fuel, as potential users could plan with assurance. Since SRC-II can meet the proposed coal standards, we see no benefit from delay. We recommend, therefore, that standards for SRC-II be established now.

Throughout our SRC development, we have directed special attention to understanding and mitigating environmental impact of the process.

Of particular importance, of course, are potential health effects. Since SRC products and intermediate streams are new materials, information on their carcinogenic potential has to be developed.

To be on the safe side, a continuing education program, a medical surveillance program, and an extensive industrial hygiene monitoring program were instituted at the SRC pilot plant to limit employee exposure to a low level.

These programs also are providing basic information for the process control design and the industrial hygiene program in the demonstration plant.

At the same time, a toxicology program was undertaken to determine the short and long term effects of SRC materials through dermal and inhalation exposures on animals. Studies on teratogenic effects are included. When this program is completed, we will have a basis for validating design criteria which adequately protect those who might be exposed to these materials.

Another concern from a health effects standpoint is that of trace metals contained in the coal and the fate of these metals during subsequent processing of the coal. Several sets of samples representing all of the process streams have been analyzed for about 40 different elements. The trace metals appear to concentrate in the mineral residue which, in the demonstration plant, will be contained in the vacuum tower bottoms and fed to the gasifier. Thus, most of the metals will concentrate in the slag from the gasifier, which can be disposed of as fill near the plant site.

Health effects studies will continue and results will be utilized to insure proper and safe demonstration plant design. Data obtained thus far indicate the hazard to be small and that it can be contained through proper design, training and hygiene.

Socioeconomic impacts from the SRC-II demonstration plant will be basically three: the temporary impact on the local area during construction, the long-term impact on the local area during operation of the plant, and the long-term impact on the mining area that would supply coal to the plant.

Since the SRC-II demonstration plant will be located near an eastern source of high sulfur coal, the population base of nearby communities and the availability of labor will ameliorate the temporary impact on the local area during the construction and the long-term impact on the local area during operation of the plant. The impact on the mining area that supplies coal to the plant may be positive as the SRC-II process will create a demand for high sulfur coal to replace markets lost from the trend toward non-polluting fuels.

Environmental issues in the water area include water supply and impacts of plant discharges on surface and ground water. Again, location of the plant in the east where water is relatively plentiful will minimize the water supply problem.

No discharge of process water is planned. In the event discharge is later required, a waste water treatment system has been demonstrated on pilot plant scale and will be applied to produce an effluent of acceptable quality.

Solid waste will consist mostly of slag and fly-ash from the gasifier and its disposal will utilize modern techniques of placement and surface reclamation as required to achieve an environmentally acceptable result.

The above discussion touches briefly on some of the important environmental considerations pertinent to the synthetic fuel from coal with which my company has experience -- SRC-II liquid. An aggressive research and development program during the pilot plant phase to gather necessary information on environmental issues enables feedback to the demonstration plant design, which is insuring incorporation of necessary environmental controls.

Much remains to be done, of course. We have in place quite adequate and comprehensive environmental laws, the implementation of which will provide assurance to all that everything humanly possible will be done to anticipate, evaluate and mitigate the environmental effects from the application of synthetic fuel technologies.

The experience we have all had in the development and refinement of NEPA procedures enables us to address in a systematic way all environmental concerns as we develop new synthetic fuels technologies.

The EPA is to be congratulated on the careful way it is going about the formulation of regulations to implement the many pieces of environmental legislation which govern these activities. The effort to obtain comment from all concerned at each step along the way should be continued and when conclusive data is available, specific standards should be established.

I will be happy to try to answer your questions.

DR. REZNEK: Thank you. Any questions?

QUESTIONS AND REMARKS

MR. HERHOLDT: This process seems to be rather unique in the aspect that it focuses on eastern bituminous coals.

MR. ROGERS: Yes.

MR. HERHOLDT: How much federal support has been obtained or do you anticipate obtaining for this project?

MR. ROGERS: The pilot plant effort over the past several years at Fort Lewis, Washington has been supported practically 100 percent by the Department of Energy or its predecessor agencies.

There is consideration now being given by the Department of Energy and Gulf to a demonstration plant program which has not been finalized. It is a joint program with joint participation.

DR. REZNEK: Any other questions?

MR. MERSON: Yes. Is there any type of comparison that you have as to the relative quantities of slag that would be produced in this process and obviously would have to be disposed of in one way or another and the fly-ash that has to be disposed of in a coal electrical generating plant?

MR. ROGERS: I don't have that fact at hand, Mr. Merson, but I would be happy to submit that for the record.

MR. MERSON: You would have, I suppose, the same kinds of problems in disposing of the slag in terms of trying to line, I suppose, whatever beds you have for it, that they are confronted with in the fly-ash disposal situation.

MR. ROGERS: That is right. Certainly one of the considerations in slag disposal would be the potential impact on ground and surface waters and that would have to be carefully thought out, worked out, analyzed and appropriate measures taken to see that the ground water quality in the area was not degraded or that the surface runoff did not adversely affect the nearby area.

MR. MERSON: You haven't looked upon the disposal process as an unusually serious one in this case, no more so in your eyes than the fly-ash disposal.

MR. ROGERS: That is correct. The leaching test which EPA is working on now to determine whether a solid material is toxic or not, certainly would be applicable here. At the moment, we don't think that the material we are talking about would turn out to be toxic, but certainly all of these things would have to be investigated.

MR. MERSON: Thank you.

DR. DAVIDSON: In your testimony you mentioned that you understand that now no process water or discharge of process water is planned. I am wondering in that regard, what technical concerns still need to be resolved to determine if in fact you can avoid any discharge of the process water?

MR. ROGERS: We do not now anticipate that any water will be required to be discharged. Results in the pilot plant scale indicate that this can be maintained in design of the SRC-II demonstration plant.

I think it would be only an unanticipated development, something that didn't work out as we planned, that would cause a discharge to be required. We feel pretty confident at the moment that we can design and operate the plant without a discharge.

MR. HERHOLDT: Do you think that the product of a -- once a plant of this type, an SRC-II plant, has been commercialized, do you think that the final product can be competitive with other sources of oil?

MR. ROGERS: Yes, I think it can. I must hasten to add that that is a very crucial and primary part of the reason for the need for a demonstration plant to really tie down and determine what the cost will be.

Obviously, neither Gulf nor the Department of Energy would be as interested as we are in examining future possibilities here if we did not think that it can turn out to be competitive.

DR. REZNEK: Do you see that market for SRC-II as essentially a substitution for oil across the board or is it more selective? For example, would it be limited to power plants located in urban areas which can't retrofit scrubbers or even install a coal handling capacity?

MR. ROGERS: We see the market as selective and not a wholesale replacement of all applications. As you said, Dr. Reznek, the area that SRC-II might be particularly attractive to would be, for example, such applications as power plants in the east which are now in urban areas and locked in and would have considerable difficulty in finding the additional space in which to store coal if they convert to coal. They might be attracted to liquid fuel which could in effect use the same storage tank, the same handling facilities that they now have.

DR. REZNEK: And your fuel will be compliant in the sense that it will meet the proposed NSPS, New Source Performance Sandards.

MR. ROGERS: Yes.

DR. DAVIDSON: How does the overall energy efficiency of the process compare with some of the other synthetic fuel technologies?

MR. ROGERS: You are speaking of Btu's in the pound of a product compared to the Btu's at the outset. I don't have numbers at hand to give you a clear comparison between SRC-II and other versions. I know that the SRC-II fuel has about 17,300 Btu per pound versus the 11,000 Btu per pound of coal which is used at the outset.

DR. REZNEK: Any further questions?

Thank you.

MR. ROGERS: Thank you.

DR. REZNEK: There are three-by-five cards available for questions from the audience either to the panel or if the witnesses are still available, maybe I can transfer them back to the witnesses. If anyone wants to be sure they receive copies of the hearing, they can leave their name with either myself or David Graham of my address.

Our next witness is Mr. Bob Humphries. He is Environmental Information Manager of Georgia Power Company.

STATEMENT OF BOB HUMPHRIES
ENVIRONMENTAL INFORMATION MANAGER,
GEORGIA POWER COMPANY

MR. HUMPHRIES: Thank you, Dr. Reznek and distinguished panel members. I come here today representing a major electric utility, although I suspect that my invitation was due as much to my local reputation as an environmentalist who has been deeply involved in air, water and energy issues.

I would like to speak, as Mr. Rogers did, to a non-nuclear technology which has not received much attention or publicity, yet one which appears to offer a real hope in helping to solve some of the energy-environmental problems facing the nation.

This technology is solvent refined coal and on this technology some $100 million in federal research and development funds have been spent since 1966. In addition, several millions in private funds have been spent by industry separately and in cooperation with the government.

Because of this effort, solvent refined coal or SRC -- and I should add here, I speak to SRC-I, the solid version of SRC -- has been carried through the pilot plant stage to combustion tests in a utility boiler and is years ahead of other synthetic fuels from coal.

In spite of this great amount of successful work, in reviewing the recent coal technology literature of various federal agencies, including the Department of Energy, the EPA, and the Department of Interior, I was struck by the almost total absence of reference to SRC.

This is all the more surprising in view of the many benefits beyond air quality offered by SRC, not the least of which is its ability to fit into our present systems of electric generation with a minimum of disruption.

I will not bother you here with details of the process which I can make available in writing, and we have heard already some of the details. I would like to use my time to speak briefly of the test burn of SRC, touch on the economics, and make some general comments about SRC and other methods of using coal to help us out of our energy situation, all of which seem germane to federal non-nuclear R&D activities.

Our associated Company, Southern Company Services, has for some years operated a six-ton per day SRC pilot plant in conjunction with the Electric Power Research Institute and, more recently, ERDA. A 50-ton per day plant at Fort Lewis, Washington, has been operated by Pittsburg and Midway and we have heard of this plant already.

The Fort Lewis facility produced 3000 tons of SRC I which was used last year in a series of test burns in a Georgia Power Company 22.5 megawatt coal-fired electric utility boiler. Only minor modifications to the system were required.

We had to change the pulverizer spring pressure slightly, use cold air feed, and had to install water-cooled burners into existing boilers.

Emission tests during the burns showed that SRC easily met present EPA standards for SO_2 and NO_x. Particulate loadings into the primary precipitator were seven to ten times less than when using coal.

Perhaps even more important were the boiler operating characteristics in terms of maintenance. Soot blowing, normally required 6-12 times a day, was not required at all during the 18 day test. Bottom ash was virtually non-existent.

Based on these tests, the low ash-loading, easy pulverization, exceptional boiler cleanliness, and non-abrasive characteristics of SRC should improve boiler and auxiliary equipment availability and reduce maintenance significantly.

Lest it be said that we in the Southern Electric System have put all our eggs in one basket, let me say that we have also extensively tested three scrubber systems, the Foster Wheeler Dry Absorption, the CEA Dual Alkali, and the Chioda Dilute Acid, and are looking at continuing this type of testing.

Since we rely heavily on coal as a basic energy resource and expect to continue to do so in the foreseeable future, as some 87 percent of electric production last year was from coal using about 16 million tons, we have taken a leadership position in developing both flue gas processing and fuel processing as techniques to enable compliance with required air quality regulations while using coal.

Most of this work has been done with the Department of Energy or its predecessor agencies. With this experience, of the choices available, we believe that solvent refined coal uniquely meets the needs of the electric utility industry and within the meaning of Section 111(a) of the Clean Air Act as amended.

In our efforts to assess the merits of solvent refined coal, we have performed a number of economic studies, and comparisons with coal-derived liquids, gases and flue gas desulfurization systems. We sincerely believe we have made credible and objective comparisons in view of our experiences as outlined above.

Our economic studies indicate that SRC offers an economically attractive alternative to flue gas scrubbing. This conclusion is at variance with some federal analyses we have seen which, at best, were incomplete in regard to SRC. I have copies of our economic analysis here for you so that you will be able to see in detail how this conclusion was reached.

Based on these studies and experiences noted above, we are in a position to make several positive statements in support of SRC and continuation of major developmental efforts towards its use.

One, SRC provides a way to use coal to make electricity in an environmentally acceptable manner at less cost and with greater overall efficiency than coal-derived liquids or gases at the present time.

Two, since SRC technology is further advanced than technology for producing these other coal-derived fuel oils, it can be commercialized and introduced on a large scale at an earlier date, probably just a few years, which could be critical in resolving the current energy supply dilemma.

Three, SRC, and only SRC, provides significantly increased productivity of the existing bulk transportation system, since each ton of SRC has 30 to 50 percent higher heating value than a ton of new coal, bringing savings to the public and perhaps avoiding a severe shortage of transportation facilities which might otherwise occur in the future.

Four, SRC provides a way to standardize plant design and operation to a degree not possible with flue gas desulfurization, so as to facilitate the shift from oil and gas to coal-based electricity for many applications, and to create savings to the public associated with shortening design and construction time for new facilities while using the least expensive coal-derived fuel.

Five, SRC provides a way to generate electricity while meeting legitimate health-related environmental goals with lower capital costs and greater reliability than with flue gas desulfurization.

It is even possible that the greater reliability could result in reduced emissions over other methods since there would be less use of older plants not governed by new source standards when the newer plants have forced outages.

Six, SRC technology completely avoids the unproductive costs, land use, and energy use associated with production, delivery, and utilization of reactants and disposal of wastes required for flue gas desulfurization.

Seven, SRC, if commercially available, offers the potential for even more benefits to existing plants faced with uncertain fuel supplies or emission offsets as well as new peaking plants.

For existing oil-fired plants with fuel availability problems or facing conversion orders, SRC could be substituted directly for oil with relatively minor retrofitting, primarily for fuel storage and fuel burners. New combustion turbines can be designed to burn either molten or pulverized SRC. This would also help to realize the advantages of future, larger combined cycle generation with greater efficiencies than today's systems.

I have taken this time to give you this quick and elemental overview of SRC potential. I would be remiss, however, if I did not let my ecological background come out and speak to the systems involved in the energy/environment situation we find ourselves in.

Obviously I don't think I need to tell you that energy research, development, and use are interrelated to our environmental quality, goals, and regulation. Economics, a small part of the science of ecology, is also a part of this matrix.

Yet, when I see the projects being done, the regulations being written, the compartmentalization of efforts, I wonder if the personnel or agencies involved fully appreciate or understand these interrelationships. I must quickly add that there have been recent signs of progress in this direction.

Congress has shown recognition of these relationships as recently as the Clean Air Act Amendments of 1977. I would quote in part from Section 111(a)(C) of the Amended Act, "... which reflects the degree of emission reduction achievable through the best system of emission reduction which (taking into consideration the cost of achieving such emission reduction, and any non-air quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated for that category of sources."

During my discussion of SRC, the subject of flue gas desulfurizaton was inescapably brought in. In any analysis of present and future coal-based synthetic fuel development the effects of the presently proposed New Source Performance Standards must be considered.

The present draft proposals quite honestly appear to force the use of flue gas desulfurization. This has been called a demonstrated technology yet in my view, and I think that of the industry, this is far from the case.

I cannot go into great detail here but there is serious doubt that scrubber technology meets the above quoted "non-air quality health and environmental impact" proviso. Possibly even scrubbers could be the most energy intensive of the presently available options.

The crux of this forcing regulation is, of course, the 90 percent reduction in potential emission. This number appears to have come from alleged scrubber efficiencies but at a time when EPA is saying they cannot revise sulfur or particulate criteria documents because of a lack of data.

It is strange to us that a decision involving billions of dollars, new environmental insults, and with a lasting effect on our energy future can be made on the evidence available.

I do not wish to dwell on the air quality regulation aspects of non-nuclear research and development but do wish to emphasize their importance as either an incentive or a disincentive to future projects. Only through wise, cooperative decisions with a holistic view using the best, most complete data available can we solve the problems facing us.

As an example, we have seen great interest and expenditures on the so-called nuclear fuel cycle. Our knowledge in this area is orders of magnitude greater than that we have of the coal or fossil fuel cycle.

We must proceed with all dispatch to correct this deficiency. At the same time we must avoid making disastrous decisions based on this lack of data. We must look at the side effects, the fringe benefits, social and economic shifts, as well as the primary goal of any decision.

I must point out one potential effect of the current draft New Source Performance Standards that may or may not have been recognized by those who will promulgate the regulations.

For the foreseeable future, our electric power needs can be met by only two basic energy sources, coal and nuclear. The capital costs for a new plant using either fuel today are quite similar. However, a 90 percent reduction of sulfur emission standard will provide a decided impetus to choosing nuclear for many new plants. This would appear in conflict with some of the present Administration's goals.

To close, we have heard often and frequently that process changes, new techniques, and so forth, are the real way to control pollution. I'd like to use a term my former major professor, Eugene Odum, is fond of. He calls it the "tail-end Charlie" approach and he simply says that this is not going to get it. Simply hanging another device on the end of the pipe has got to be a last resort solution.

Give us an opportunity to pursue the development and commercialization of new or synthetic fuels like SRC with all their advantages. Thank you.

DR. REZNEK: Thank you. Are there questions? Al?

QUESTIONS AND REMARKS

MR. MERSON: I would like to ask you the same questions that I asked Dr. Schlesinger earlier about coal gasification. That is, if there really are the advantages --and I'm not suggesting that there are not -- to SRC that you discussed, what is it right now that is holding it back, as you see it? What are the constraints right now to having this as a viable alternative? Is it primarily the new regulations -- the statute plus the regulations -- that are being proposed that you see as the main obstacle?

MR. HUMPHRIES: Let me answer it this way. Not quite a year ago there was a considerable amount of interest on several large commercial -- well, as least one large commercial firm to go into a much larger production module of 2-6,000 tons per day SRC.

Along about last August, it began to wane in interest and in December the interest died completely. I think that relates to the presently proposed standards and the act, of course, which created those. It is the regulation aspect which is slowing it.

MR. MERSON: I guess I am moved to ask why didn't we see this any sooner, if there were real advantages here. Is it because we didn't have the pollution control framework that provided the impetus for the development of this process?

We're talking about some relatively recent developments. You are saying that this process is economically competitive with other ways of using coal. It has certainly a pollution control benefit that other processes don't have. I am just wondering why we are sort of "tail-end Charlie" in terms of talking about it within the context of the past year.

I am interested in knowing why somehow we didn't get into these things somewhat earlier than the last few years.

MR. HUMPHRIES: May I be blunt and state a personal opinion? This isn't a company opinion, although they may well share it. I think I used the word "holistic" in this statement. I think we have been guilty in the past; I think we have been guilty since 1970, with the great advent of environmental concern, of having a degree of tunnel vision when we look at air pollution or we look at water pollution or we look at solid waste, and there has not been enough concern with of the interrelationships between these.

There has been some; don't misunderstand me. I don't think we have really looked at this. I think in the case at hand, solvent refined coal, the analyses of it have not really taken into consideration the advantages it has to the increased reliability of the system so that you perhaps need fewer plants or those plants operate more frequently and so on and so forth.

There may well be less consumption of fuel totally and therefore less emission even though the percentage may not be as good as some people would like to see.

MR. MERSON: Just to conclude on this point, it seems to me that if private enterprise is working the way it is supposed to, that those advantages should become obvious to companies such as yours probably at some earlier point and some investment made in them.

Now, I understand your point about your regulations impeding this progress, but I am concerned that somehow the market place does not seem to work very well in producing these technologies within the private sector.

MR. HUMPHRIES: That may be a valid point. This, of course, with us is a very recent -- we've been in it since about 1972. Of course, we have been doing it -- trying to develop the technology, and we haven't done, I suppose, a good job of broadcasting the benefits of that technology, not as well as we perhaps should have.

Of course, the developments like the 1977 amendments force us into trying to make these things work at this point which may be too late.

DR. REZNEK: I would like to ask one question. One of the problems that is inherent in improving environmental performance of our technologies is a lack of market incentive to do so. Everyone would like a more efficient energy system. The discoverers of ways to reduce costs can realize a profit for themselves. I know of no profit motive for producing a cleaner technology. Cleaner technologies come about, not through market action, but through federal action, especially federal regulatory actions. Would you comment on both private industry's role and the Department of Energy's role in fostering improved performance of environmental controls?

MR. HUMPHRIES: This is a difficult question for me to answer, if I do indeed understand the question. We have problems and we all know that. My company has been aware of them for quite sometime. We have done things before there were environmental regulations.

At the same time, particularly in this area of air quality, I have heard quite often -- you know people say -- well, before 1968 or 1969 nobody had heard of sulfur dioxide. We have come a long way since then.

Private industry, like a large government agency, moves slowly its wonders to perform. Quite honestly, I don't know that we can really encourage this except with what has been called a technology forcing type regulation or something like this which sometimes works and sometimes doesn't.

DOE, of course, has the responsibility perhaps for providing financial incentives to prospective or likely technologies. I don't think I have answered your question, but I am not sure I can.

DR. REZNEK: Thank you.

MR. HERHOLDT: A previous witness indicated that there were some problems with solvent refined coal, SRC-I process. Are you implying here for use as an electrical generation source that the SRC-I process essentially does not have these problems?

MR. HUMPHRIES: During the test-burn that we made at the 22 megawatt plant, which was chosen simply because it was the smallest one in the system and they only had 3,000 tons to burn so it gave us the most efficient use of the available supply, we were very much encouraged that it came out much better than we thought it would.

We are not aware of any great problems or impediments that we think can't be overcome as a utility fuel. As a matter of fact, we see many more benefits as I have suggested; greater reliability, and utilization of the existing water or rail transportation systems when we are not transporting coal, but transporting cleaner coal, more Btu's and less mass.

DR. REZNEK: What type of testing did you do on your burning?

MR. HUMPHRIES: I can leave you a complete series of test results and I think this has been available to EPA. I think EPA was there as an observer. There were a number of series of tests run under different operating parameters to see what did happen, but basically complete emissions data were kept.

DR. REZNEK: Your company did emission testing?

MR. HUMPHRIES: It was done by a consultant for us and the Department of Energy was also involved. I can't quote you the specific figures right at the moment, although the SO_2 emissions as I remember, and I could be slightly wrong, on the various burns ran between .7 and 1 pound per million Btu's. Yes?

MS. HANMER: Did I understand you to say that there was a net energy benefit over conventional technology with flue gas desulfurization?

MR. HUMPHRIES: A net energy benefit --

MS. HANMER: You said there was less cost and possibly flue gas desulfurization was more energy intensive.

MR. HUMPHRIES: I said there was a possibility that there might be. We have not been able to determine that any real net energy analyses have been done on flue gas desulfurization taking the entire picture of going back to the limestone mine or whatever it might be -- transportation disposal, the whole cycle of it if you will.

Certainly, there is an energy penalty in the operation of the device at the electric plant. Our impression, and we can't quantify this as yet, but we are also working on this, but that energy penalty might be equalled by the energy penalty of solvent refined coal. In other words, these might be cancelled with the energy losses there.

DR. REZNEK: What is the efficiency in the SRC-I process? The energy efficiency?

MR. HUMPHRIES: The energy efficiency itself -- that is a variable figure depending on the time and temperature the coal is in and a number of things. I can't really give you a definite answer. The SRC, of course, comes out with your through put as solid fuel. It can be varied and this is where the differences with the SRC-II come in.

Also, in the production of SRC-I you do get a light oil similar to Number Two, you get some SNG and LPG which are also marketable and usable.

DR. REZNEK: Can the energy recovery be as high as 75 percent?

MR. HUMPHRIES: I believe it could be. Now, I'm taking the process energy into effect here, but of course in doing the work itself.

DR. DAVIDSON: I am wondering if you might comment on the role of DOE in your perspective in developing these technologies. What recommendations might you have on improving the performance of the Department in this respect?

MR. HUMPHRIES: That, again, is a difficult one for me to address. I am beset at home from all sides from people who tell me that DOE is not spending enough money in this area or they are spending too much in that area and all of that.

Quite honestly I hear so much of this that I am at a loss sometimes to know what to think. They are still in an organizational posture, I gather, and I certainly believe that they need to at least establish some method of establishing better priorities.

In other words, let's do put emphasis and money on the most promising technologies and tend to go away from the less promising technologies. I'm not going to comment on which ones are more promising or not right now. That would be open to question.

DR. DAVIDSON: Maybe just a comment I think on the overall energy efficiency of FGD versus SRC I or II. I am not completely sure of the SRC efficiency, but I believe it must be in the order of 60 or 70 percent, comparing the energy of the coal going into the process versus the products coming out.

MR. HUMPHRIES: Yes.

DR. DAVIDSON: Roughly in that ball park. However, with the FGD system the penalty due to the scrubber added is in the order of five percent. So the numbers that I would see there would be a comparison between roughly, you know, a 95 percent value versus a 70 percent value. Of course, you have to take into account the efficiency if you are going to put it through an electrical facility which is roughly a third, you know, electrical energy coming out of that system.

MR. HUMPHRIES: That would be the same, no matter how you control it by the system.

DR. DAVIDSON: Yes.

MR. HUMPHRIES: That would be an applicable figure at the plant itself. Our concerns would be the energy involvement, or as I choose to call it, the care and feeding of the beast when you do it there, of course. This is the area that we have not been able to determine that anyone has really examined in any great detail.

This is certainly a function that DOE should perhaps look at.

DR. REZNEK: Any further questions?

Thank you very much.

MR. HUMPHRIES: Thank you for your attention.

DR. REZNEK: Our next witness is Dr. Chester R. Richmond from the Oak Ridge National Laboratory.

STATEMENT OF DR. CHESTER R. RICHMOND
OAK RIDGE NATIONAL LABORATORY

DR. RICHMOND: Mr. Chairman, Panel Members, Ladies and Gentlemen. My name is Chester R. Richmond. I am Associate Director for Biomedical and Environmental Sciences at the Oak Ridge National Laboratory which, as you know, is one of the major multipurpose scientific research and development institutions operated by various private contractors for the Department of Energy.

As Director of a large biomedical and environmental program, I have had the opportunity to personally participate in both the planning and implementation of health, safety, and environmental research related to both nuclear and non-nuclear energy technology.

I have also participated, during the past several years, in the planning, organization, and implementation of a life sciences program in support of synthetic fossil fuels which can be considered to be a major national research effort.

My comments today will address the planning and implementation of energy-related research and development activities that deal specifically with the environmental health and safety aspects of developing technology for converting coal to gases and liquid products.

To begin with, I believe the Congress displayed much wisdom by embodying this important Public Hearing and review process into PL 92-577. I believe that the Congress was reflecting public concern that energy development and other scientific and technological endeavors should proceed with proper attention directed towards the health, safety, and environmental considerations.

Research and development conducted towards the important goal of energy independence must be undertaken with proper regard for health, safety, and environmental factors. We must not compromise or mortgage the future health of our citizens and their environment while we strive to achieve energy independence.

These goals are not mutually exclusive as some would prefer to believe. Neither is the problem simple. However, I believe that virtually everyone benefits if we can satisfy both goals such that energy independence can be gained by developing the technologies in a way that is socially and environmentally acceptable; that is, with minimum societal and environmental costs. I should point out, however, that no energy producing technology will be environmentally benign.

The nation must learn how to use its collective wisdom to decide what level of potential harm or detriment is socially acceptable in exchange for the energy produced to sustain the needs of our industry, our cities, and all our numerous institutions. This need, incidentally, applies to all other human activities that can result in harm or detriment to mankind or his environment.

Earlier this morning, I believe it was Dr. Reznek who pointed out the need for us to worry about acceptable risks. I would like this panel to consider something even further. We need to pursue the question of acceptable risk from a broad national level which transcends the interest of the regulatory agencies and other agencies. Because there are risks from many areas it is becoming, I think, a national problem on how the nation grapples with this question of acceptable risk or de minimis risk, if you will.

In addition, and I will emphasize this, we cannot afford to be wasteful of energy because each wasted unit adds an unnecessary increment to the societal costs, health and environmental, we pay for obtaining energy.

The DOE enabling legislation also states that the DOE Assistant Secretary for Environment is responsible for assuring that all DOE programs are consistent with environmental and safety laws, regulations, and policies. The Assistant Secretary also provides guidance for the DOE Secretary to assure compliance with environmental protection laws and is responsible for review and approval of environmental impact statements prepared by the DOE.

Also, the Assistant Secretary must monitor DOE programs to make sure that the health and safety of both workers and the general public is protected.

In May 1977, President Carter presented an Environmental Message to the Congress in which he called for a variety of efforts relating to the environment including those related to the effects of pollution, toxic chemicals, and damage caused by the demand for energy. He addressed five major areas, one of which was Energy and the Environment.

In this, the President called for the Administrators of ERDA -- now the Department of Energy -- EPA, and the Secretary of HEW to establish a joint program to identify the health and environmental effects of each advanced technology that is the subject of R&D.

President Carter also directed ERDA, now DOE, and EPA in May 1977 to jointly develop procedures for establishing environmental protection standards for all new energy technologies and further he asked that the procedures be agreed upon within one year, which is about two months away and I assume the panel might want to comment on this later.

I believe the mandates and intents are clear. However, it takes people to make things happen and we all share the responsibility of seeing that these joint goals are realized.

I would like to now address some of the issues that were sent out to individuals. One asks about decision strategies -- how to satisfy both goals -- that is energy production and environmental protection.

I believe a decision strategy in which the environmental issues play an equal role with technology feasibility and economic costs would be most useful. This necessitates that the Assistant Secretary for Environment or whoever is responsible for that function in DOE be fully and meaningfully incorporated into the management team to ensure that the environmental issues are identified and that the necessary research is initiated to ensure their resolution at all stages of process development.

I also believe that there is an increased need for interagency cooperation and coordination. This has been improving and I think it is the rate I would quibble with. I would like to see an increased rate of interagency collaboration and cooperation.

I think this is obvious because we do have the need to development environmental protection guidance, regulation, and standards for pollutants that are associated with these developing technological processes.

Another question related to the Federal resource constraints on technology development, and I think in this case implementing a management strategy that ensures the early identification of potential issues and problems and provides sufficient resource base to allow the R&D necessary to resolve the problem is in order.

Assigning the technologists the sole responsibility to conduct this research probably will not work.

By encouraging strict implementation of the spirit, and I emphasize spirit of NEPA, following the adoption of the strategy which would ensure the development of necessary environmental research within the time constraints of technology decision making process.

I would also encourage more intermixing of private and federally-supported research involvement whenever possible at specific sites so that a combined approach can be adopted early on and more views and needs considered.

The development and demonstration of new energy technologies must proceed in concert with research supporting process design. An earlier speaker alluded to this point.

Research to ensure protection of environment and human health must be initiated during the early stages, and I emphasize early stages, of process conception and continued through operation of demonstration facilities.

A serious concern is that in the haste of developing new demonstration units, the technologies may not consider environmental issues to be of significance until the licensing procedures have to be initiated.

Environment is sometimes viewed as an obstacle to be overcome, rather than a partner in the design of new facilities. Environmental research should not be left solely to the technologist for either the identification of the needs or as a source of resources to conduct the work.

Close coordination between technology development and demonstration and environmental research must be effected at the appropriate management level to ensure that they are both complementary and mutually reinforcing.

The Federal government should assume a primary role in not only the development, but also the siting of advanced technology facilities. Guidelines for operation and environmental surveillance need to be developed and uniformly applied. Working closely with the state and municipal organizations is axiomatic and must be done.

Identification and solution of potential environmental issues surrounding developing energy technologies I believe can be accomplished only if environmental research is conducted in parallel and in concert with the developing technology.

Over the past years various agencies including DOE have produced many documents such as the Balanced Program Plan and the Environmental Development Plans for the various technologies. The purpose of these documents was to identify the environmental issues.

Recently an interagency committee comprised of DOE, EPA, and HEW has initiated a plan whereby the specific research needs -- that is at the project level -- for the various environmental issues will be identified. Hence, the planning for the necessary work is well underway.

Undertaking, however, this research to provide solutions to the potential problems is not proceeding, I believe, in as timely a fashion as it should. Perhaps, because the R&D is not progressing in concert with the technology development.

A mechanism must be initiated which ensures that the environmental activities receive equal consideration in the process of technology development.

The development of coal conversion technology should include the following three components: one needs to determine the technical feasibility; one needs to determine economic viability; and one needs to determine environmental acceptability.

The determination of environmental acceptability must be given equal emphasis with respect to the other components at the earliest stage of evaluating this technology. The anticipation of environmental issues can be achieved at one level by providing interaction of environmental scientists and process design engineers at the onset of technology development planning.

Environmental scientists can identify generic environmental issues based on appropriate design specifications and effluent source term characterization utilizing existing environmental data.

The second phase of anticipation of environmental issues necessitates a well thought out environmental research effort that keeps pace with the characterization of effluent source terms. This research effort should not only anticipate new issues, but should work toward solving well understood issues and provide feedback to the environmental control technologist in the process development.

The demonstration phase of coal conversion technology development will offer the first real opportunity, I believe, for determining environmental acceptability of the specific process being tested.

All of the above efforts that I have mentioned, working toward anticipation and solution of environmental issues regarding coal conversion technology development, will come to focus during the preparation of a site specific environmental impact statement for a demonstration scale coal conversion facility.

I believe at that time that the environmental issues will be anticipated to the degree that technology development and the most up-to-date environmental research will allow. If well planned environmental monitoring programs and plant-specific environmental research programs are implemented at demonstration scale facilities, the data generated should be of sufficient quality and kind to evaluate the environmental issues.

The environmental monitoring programs should attempt to evaluate the predicted impacts; however the plant-specific environmental research should address the causes and effects of those relationships that can determine, on a plant-specific basis, what additional control technology is needed to ensure environmental acceptability.

Research on the environmental programs needs to be tied closely together with the developing of synthetic fuel process technology, as I mentioned earlier. Alterations in process and pollution abatement technology will modify anticipated contaminant release levels and possibly shift environmental and health research priorities.

Environmental research must incorporate both laboratory studies utilizing identified contaminant compounds and field studies at small-scale conversion facilities or similar industrial processes to ensure development of an environmentally acceptable synthetic fuel industry. It is important that a holistic approach to solving this problem be adopted.

The inclusion of socioeconomic and environmental, and here I include the human health factor, factors in the assessment of various energy technologies is assured by the NEPA. What is somewhat unfortunate is the fact that the data necessary to produce an accurate estimate of potential ramifications are not being developed as rapidly or completely as necessary.

This problem goes back to the second specific issue I discussed earlier. The environmental issues must be addressed concurrently with the process development, and I can't emphasize this too strongly. There has to be an equal partnership between those responsible for environmental protection and the process development within the DOE.

The various synthetic fuel processes tend to produce reasonably large size quantities of gaseous, aqueous, and solid effluents. The toxic and carcinogenic nature of some of these is currently being tested and it becomes imperative that the various process configurations and pollution control devices be investigated fully in parallel with the development of the coal conversion process under consideration.

In a discussion of the chronic health problems which was another issue we were asked to address, I will point out that I do believe that there is no "fail safe" approach to this question. What can, and must, be done is to incorporate the integration of chemical and biological screening of process, produce, and effluents at the earliest stages of process development, even though the validity of the samples may be in question.

This necessitates that human studies -- I am sorry, health studies -- be developed parallel and concurrent with the process development time schedule.

Longer term studies designed to validate screening procedures, determine mechanisms of effects for effluent types and to determine form, source, and critical pathways to man then can be also incorporated in the studies.

I believe that the key to the early detection of potential chronic health problems from synthetic fuels is in the integrated holistic approach of chemical and biological screening. "State-of-the-art" chemical methodology can be coupled with short-term tests such as microbial and mammalian cell mutagenesis along with cellular assays for toxicity.

With the proper validating experiments available now in higher organisms, these cellular assays can be useful predictors of potential health effects.

I would like to close on one point and that is the need for consensus-building. At a recent Congressional hearing Lewis Branscomb suggested that the biggest single challenge to science and technology policymaking in the U.S. is that our consensus-building machinery has broken down.

Facing national decisions on the use of new technologies that require far more than majority support before a strategy can be implemented, we find that we only know how to relate to each other as adversaries, sharpening our disagreements rather than arriving at a consensus view.

Consequently, the movement of our non-nuclear energy research and development toward decisions on commercialization, either pro or con, is delayed. Very often, the focus of the controversy is the environmental accept ability of energy technologies.

I believe that a conscious aim of the Federal energy research and development program should be to help create a broad national agreement on an energy supply strategy, recognizing that our energy policy system is pluralistic, and we believe that there are some concrete ways to do this.

For example, technology demonstrations near or close to commercial scale can be made the cornerstone of utilization decisions.

Confidence in data about the environmental impacts of a technology is highest when they come from an actual commercial scale facility, where the interested parties can verify information for themselves and resolve disputes about impacts by observing them together. By together, I mean states that are involved, the commercial enterprises and those who have the Federal responsibilities for regulatory functions, and those who supply money, obviously.

In order to make full use of demonstrations as consensus-building activities, it is essential to anticipate the diversity of possible interests in both phenomena and processes that need baseline information for evaluation, and it is important that the operator of the demonstration plant develop and use a plan for broad participation by parties-at-interest in verifying the resulting impact information.

In environmental research programs, more emphasis can be given to anticipating future information needs. Because large scale research on the environmental and health impacts of coal utilization was not begun until quite recently, we find it necessary to make coal policy decisions without an adequate knowledge of the hazards.

For instance, research on possible genetic effects of coal compounds probably cannot be completed rapidly enough to make decisions about coal use by 1985. We are catching up as quickly as we can for coal, but what about the other energy options? They may look better to us partly because we know so little about them.

In general, the further any technology is away from development or demonstration, the more benign it appears from the health, safety, and environmental standpoint. As we learn more about a system, we become more aware of its potential impact or, as I prefer, societal cost, relative to human health impacts and environmental deterioration. Thank you.

DR. REZNEK: Thank you. Are there questions?

QUESTIONS AND REMARKS

MR. MERSON: I have one.

MS. HANMER: Yes, I have one. It is striking that both you and Mr. Humphries before talked about a holistic approach. What would you say are the major constraints at this point for adopting such an approach and towards getting the R&D?

DR. RICHMOND: I guess I need to congratulate the agencies that are involved. I mentioned earlier and I stand by my comment that we need more integration in working among agencies, for example, EPA, DOE, and HEW. But in the interest of conserving paper, I brought but two copies of my testimony; one for the Chairman and one for my presentation. I have attached to these a schematic diagram showing a holistic approach, if you will, specifically, for synthetic fuel.

If I may, I'll just read you some of the areas that are involved. We are concentrating as a goal to try to get an environmentally acceptable fossil energy system. Now, that involves societal decisions not only addressing the technical R&D aspects.

This involves the characterization and analysis of the process and the product and the effluents, both chemical and biological. It involves the study of the transport mechanisms through various media in the environment, and it involves the study of the ecological effects, the health effects, and finally an integrated assessment.

It involves teams of analytical chemists; it involves the chemical engineer and the chemical technologist. Again, we are speaking of a research phase. It involves the environmental scientist and the many sub-disciplines. It involves biologists, physicians, the occupational medicine types, instrumentation design engineers, and information specialists.

I'll give you one example. There is a need, I think, for increasing efforts in control technology using biological systems. Very often you can produce a product which is merely CO_2 and water. When I say merely CO_2, let's put aside the potential global problem from CO_2.

There are many indications we see already where we can use a biological system to change a pollutant from one chemical form into another. We've already had some very successful experience with this, in fact, using reactors containing biological organisms to convert organic phenols to CO_2 and water.

So the point I am getting at is that it is a very complex and involved team effort. What we lump under a life sciences approach to match the technological approach during the development of the technology.

DR. REZNEK: I would like to ask one question regarding your reference to Federal involvement in siting decisions. Are you implying that the ultimate decision on the siting of these new technologies should be made by a Federal entity?

DR. RICHMOND: I realize I'm treading on soft ground in this area, but I think there has to be some involvement of Federal interests that are broad and can see the many problems whether they are municipal, state, or regional. Obviously, what is done in one area affects the other; witness acid rain even on an international scale.

The west has made it very clear that they are not going to lose their environmental integrity easily, let's say, in this race to get energy. It is a very complicated problem, but I am told by people who are very expert in this area in our laboratory that very often demonstration site facilities are put in an area that might already be degraded environmentally, so it is extremely difficult to see the potential impact of the site, since you are putting it on an area that is already quite involved in terms of pollutants and other sources.

I mention this issue more as one that I think needs more discussion.

MR. MERSON: I caught a statement earlier that suggested that we demonstrate these technologies on a commercial scale as much as possible. You are not suggesting that we somehow skip over this smaller prototype stage and immediately go to commercial scale?

DR. RICHMOND: By no means. My point, and I again want to emphasize this since I apparently did not make it clear, and I apologize for it. Even though the laboratory R&D work is accomplished and the pilot stage is accomplished, I think it is imperative that the R&D -- the life sciences supporting work -- continue into the large commercial size demonstration plants.

Again, this is underway now. There are developing programs within DOE to actually have a team-like approach, and I do sincerely hope this works, at low Btu gasifiers where the technological demonstration is proceeding jointly with the demonstration of environmental acceptability.

MR. MERSON: Are you suggesting a greater Federal role in participating, then, in commercial scale projects perhaps than is now present? It seems to me if we are viewing the commercial scale operation as a demonstration essentially, we can't expect private industry, I assume, to bear that burden by itself. That if you are trying to demonstrate a technology, I think it implies that we are talking about pretty significant Federal participation.

DR. RICHMOND: I'm not an economist and I am not astute about the problems of industry and government, although I've heard arguments pro and con. I think the nation has a very serious problem in getting the energy. If, indeed, it requires changing our thinking in having more interaction between industry and the Federal government to make this happen in terms of environmental acceptability, then I am all for it.

DR. REZNEK: Earlier witnesses have expressed concern over the credibility of the technical data. By technical data I mean the engineering data on energy systems. The user community for this data includes mostly engineers. You have raised questions about the risks of new technologies. I am very concerned with the question of the public credibility of the health data and the environmental assessment data generated by a Federal establishment.

Did you say that we are facing a crisis of consensus? I have a feeling that we are facing a crisis of credibility, particularly in federally generated environmental assessments and in federal determination of acceptable levels of environmental risk.

Would you share your feelings on the credibility of data generated either by DOE alone or by projects with multi-agency (HEW, DOE, EPA) participation? Can data from these sources be used effectively to allay unfounded public suspicions of dangers from a carcinogenic or toxic material generated by new and strange technology?

DR. RICHMOND: I'm not sure we will ever solve that problem. Frankly, I think the latest stage is that the National Academy of Science is no longer looked on by some as being an open body, which I think is ridiculous, personally.

Our approach to this is to publish information as it becomes available in the open literature and through that mechanism it will be reviewed by the peer scientific review body as is the case for any technical information. I urge all people working in this area to do so and do it rapidly so that the information becomes available for review and consideration.

I want to emphasize one thing. There are many aspects of this problem, only one of which is health and environmental. Society has to make that decision, collectively, of what is acceptable in terms of what you pay in health, safety and environmental costs for a process. I don't make that decision. The life sciences doesn't, and I'm not sure who does. I'm not sure who will ever make it, frankly.

MR. HERHOLDT: You had stated and rather realistically that there could be some incorporation of all the various disciplines together to come out with one decision. Would you assign veto power to any body group of technicians or whatever in arriving at this ultimate decision?

DR. RICHMOND: I can't answer that intelligently because I really haven't thought about it.

DR. DAVIDSON: I want to see if you would have any comments concerning a very practical and troubling problem that we at CEQ see on a fairly regular basis and one that concerns us a great deal. It is simply that we have several mechanisms to do the job of integrating the environmental concerns with the technology development process. The first thing we sense from overviewing this effort is that the mechanisms are carefully thought out and put together in a way which should work in a reasonable fashion.

But, when we look closer at this situation we see that from a practical standpoint it may not be working too efficiently. Let me give you an example. I think that the tension between the technology development people -- the engineering staff, who are developing technology "X" in the fossil fuel program -- and the views of the environmental part of the department is such that quite often a cooperative effort is basically an impossible task because there are some very defensive positions taken by one part of the department versus another part.

I'm wondering if there would be some way that you might see where a more cooperative situation could be fostered.

Presently, we see a great deal of tension between those two groups.

DR. RICHMOND: Again, that is a very difficult but good question. In my testimony, perhaps in the written portion, I indicated that I think it is important that the decisions related to pilot and demonstration stage facilities be mutually signed off on -- mutual responsibility, if you will -- by the technologists and whoever's responsible for the life sciences or environmental sciences.

I think there has to be some provision for a meaningful, what I call, corporate approach to the problem within not only DOE but other agencies who are involved. Again, I often tend to be somewhat critical at some of the rates of progress of agencies, but I think I should compliment again the recent at least apparent renewed interest in a very active interaction with EPA, DOE, and HEW.

DR. REZNEK: Any further questions?

Thank you.

DR. RICHMOND: Thank you.

DR. REZNEK: Our next witness is Mr. Kevin Markey from Friends of the Earth.

STATEMENT OF KEVIN MARKEY
FRIENDS OF THE EARTH

MR. MARKEY: I am Colorado Representative for Friends of the Earth. FOE has commented in previous hearings on Federal Non-nuclear Energy Research and Development before the Council on Environmental Quality. We welcome the opportunity to comment again.

This year we wish to pay particular attention to synthetic fuels and biofuel alternatives due to the pending announcement of National Energy Supply Strategy (NESS) options which may emphasize the commercialization of liquid and gas synthetic fuels from fossil fuels despite considerable uncertainty concerning the mitigation of environmental problems associated with synthetic fuels. We will review these problems and uncertainties and will try to correct popular misunderstandings of advanced oil shale technologies. We will evaluate the environmental research needs related to synthetic fuels. Then we will discuss an alternative to massive synthetic fuel development, energy conversion of biomass resources. We will evaluate the inadequacies of the Department of Energy's current Fuels from Biomass (FFB) program and recommend changes.

ENVIRONMENTAL IMPACT OF FOSSIL-BASED SYNTHETIC FUELS AND UNCERTAINTIES

EPA and DOE are certainly aware of the impacts of oil shale and coal based synthetic fuel production (synfuels). They include air and water pollution, considerable water consumption, salinity impacts in the Colorado River Basin, effects on hydrology, subsidence or the effects of surface mining and waste disposal, health and safety aspects, socio-economic effects, impacts on fish and wildlife, parklands and others. We will not reiterate these in detail here. (See also, FOE's recent testimony on Senator Haskell's S.419)

Below we summarize the most important environmental uncertainties from recent ERDA environmental statements on synthetic fuels and from our experience with synthetic fuel research efforts in the west.

It is currently unclear what trace elements volatize in each of the synfuel processes, what compounds they form and to what extent they are emitted into the environment. Ecological pathways of toxic elements are not well known, and mitigation measures are untried. This is an important issue since flourine and mercury are the two toxic elements most likely to volatize. Carcinogenic production is also unknown, as is the fate of carcinogens in synfuel processing, sources of emission, and potential controls.

The extent to which water can be recycled in western synfuel plants is unknown, as is the water needed for reclamation, especially in oil shale mining and disposal and for shale oil upgrading. Surface water consumption for shale development may be reduced by use of ground water, including that removed during mining operations. However, the interaction between ground and surface waters is not well understood. On the two Colorado prototype lease tracts dewatering operations will reduce flows into the already fully appropriated Piceance Creek. Augmentation of surface waters will be required by the State of Colorado. Water use in the west will be a limiting factor in synfuel conversion plans.

Means for controlling pollutants in coal plant effluents are uncertain. For zero discharge designs an effluent is traded for a solid waste problem. Potentially much more difficult to control are the effluents which result from contamination of ground water by leaching from spent modified in-situ oil shale retorts or in-situ coal gasification. Control technologies for these are only conceptual.

DOE (ERDA) analysis of compliance with clean air standards which appeared in the Alternative Fuels Final EIS was minimal and its assumptions optimistic. Meeting air standards in fact requires more detailed modelling, better knowledge of plant siting, cumulative assessments, and comparison with new PSD and visibility standards. Air pollution may be a severe limiting factor to mine-mouth synfuel plant siting. Additionally, current air pollution control technologies must be adapted to oil shale and new technologies may be required. Greater electric power requirements may add cumulative air pollution effects and further limit development.

Finally, mitigation of socioeconomic impacts is still uncertain. Impacts of existing boom towns are still waiting to be solved. Solutions should be demonstrated in existing boom towns before creating new populations of guinea pigs.

In addition to these uncertainties, it is unfortunate that developers and other promoters of advanced shale technologies have not been entirely accurate in their descriptions of environmental impacts. Use of modified in-situ processing does not guarantee reduction of air pollutants. According to company plans on prototype tracts, certain critical pollutants may actually increase compared to surface retorting technologies. It has been reported that EPA had enough confidence in the two Colorado prototype operations in December to grant them PSD permits, but it is not generally known that those permits do not cover planned commercial scale operations.

Most serious will be potential leaching of spent retorts by ground water. A report by Golder Associates to the Bureau of Mines estimated that impacts substantially greater than those from surface retorting and disposal are likely. Complete mitigation by backfilling and grouting may at least double production costs and are unproven.

Occidental's public confidence in the technical feasibility of its unique retorting technique may not be an entirely accurate reflection of its true status*. Success of the MIS process requires precise rubbling of shale in the MIS retort. Oxy has admitted problems with its fourth retort but claims success with its two subsequent experimental retorts in rubblization tests on its D.A. Shale property. However, it has obtained DOE aid in testing additional retort rubbling on its private property and has requested funds for similar testing on tract C-b. Material supplemental to its detailed development plan also indicates uncertainty on this subject. It clearly does not have confidence in its technique to transfer results directly from D.A. Shale property without an extensive testing period on tract C-b.

*See: R.D. Ridley, "Status of Occidental's Shale Oil Efforts," 11th Annual Oil Shale Symposium, which indicates significant technical uncertainties and problems.

PROBLEMS WITH RESPECT TO SYNFUEL R&D EFFORTS

The greatest problem with synfuel R&D efforts is an emphasis on premature commercialization. Congress is considering an increased tax credit for all energy production capital investments and a $3 per barrel credit for oil shale production. The White House is considering an extensive program of incentives and regulatory measures to commercialize all forms of synthetics. Senator Haskell's S.419 proposes a modular commercial scale test of several retort technologies. Another rumored plan anticipates DOD participation in a massive oil shale commercialization scheme.

It is our position that these efforts are premature. The uncertainties with respect to synfuel impacts are serious enough to warrant a more cautious approach. Most of the uncertainties identified above do not require the construction of full scale facilities for their resolution. The Department of Interior admits that it will have little information on many impacts until more extensive information has been collected by the prototype program. We would propose that existing and planned DOE and private research and development precede any serious commercialization effort. These efforts should be subject to conditions discussed below.

Thus far most DOE and private research has placed emphasis on determining technical feasibility with little truly integrated environmental assessment efforts. Environmental researchers have typically had access only to simulated retort conditions. Research on processes has not been geared to minimization of impacts or the designing of mitigation measures into the processes. Any environmental improvements have been fortuitous.

Public dissemination of existing environmental research has been poor. Citizens and independent scientists have not had access to company environmental data, even after such data are submitted as part of a federal program requirement. Company discretion in setting confidentiality criteria have excluded full public access to potentially important data, such as pollution emissions and spent retort shale. Finally, there is no routine public participation in DOE's research policy decisions, discussions or formulation of research goals.

SYNFUEL R&D PROGRAM RECOMMENDATIONS

Aside from commercialization and research priority questions, we would make several recommendations limited to the conduct of synthetic fuel research:

(1) Federal participation in the research, development and demonstration of new energy technologies and concomitant environmental research is proper.

(2) Federally sponsored research should not be exclusively devoted to questions of technical feasibility. Environmental assessment should be made a fundamental part of any major energy R&D effort. Such research need not be conducted by the promoter of a technology, but mechanisms should exist for environmental research in conjunction with basic process development.

(3) Greater public participation should be sought in formulating research policy and goals and in identifying environmental concerns which should be evaluated in R&D programs. Data developed by federal programs should be publicly available. All environmental data submitted to a federal program by a private developer should likewise be available. Moreover, NEPA is currently our only institutionalized mechanism for public participation in decisionmaking and access to environmental information. It should be properly applied.

ADVANTAGES OF BIOFUELS

The Carter administration has determined that our most critical energy need is liquid and gaseous fuels. Even if fossil based synthetics can be developed in an environmentally sound manner, we must recognize they are finite. We will ultimately require liquid and gas renewable fuels. This can be provided by the conversion of biomass. We believe that biomass provides environmental and economic advantages over fossil synthetics today, not just in the distant future.

Biofuel conversion results in few environmental residuals. By-product benefits include eliminating or recycling waste streams. Microbial conversion systems retain nutrient values, can provide animal feed supplements, and with proper water management and use of residues, can cut considerably net water requirements.

Its dispersed and benign nature is economically beneficial to the agricultural community, offering jobs and local self-reliance. Several processes are competitive with marginal costs of traditional energy supplies, especially those such as propane which have impacted agricultural communities most severely.

Finally, lead times for development of biofuel resources are a fraction of that required for large synfuel facilities. This may give biofuels a more significant early contribution to U.S. liquid and gas fuels deficits than fossil synthetics, if DOE will be more aggressive in its approach to biofuels.

DOE BIOFUELS PROGRAM INADEQUATE

We now wish to evaluate the biofuels program based on discussions with industry personnel, other state and federal agencies, discussions with DOE and analysis of its materials. We find that the biofuels program's extreme caution is in marked contrast to the premature DOE commercialization of environmentally questionable fossil technologies.

(1) There is a general complaint that DOE is not responsive to public, agency and industry requests or suggestions. Many informants complained of DOE's lack of imagination, lack of urgency, lack of aggressiveness in developing a budget, identifying industry needs and promoting biofuels.

(2) DOE is overly concerned with technically exotic research projects and tinkering with economically marginal efficiency or process improvements. Many such activities are important for long term biofuel productivity, but some such activities will only delay commercialization by prolonging research unnecessarily. For example, methane from feedlots has long been approved by the FPC, and several large scale anaerobic digestion operations are planned or existing, but DOE is expending considerable sums to speed up digester reaction times or evaluating dirt feedlot economics. This also duplicates the work of several private investigators.

(3) We believe DOE is not seriously interested in commercialization of biofuels technologies. Roscoe Ward, Bureau Chief of DOE's Fuels from Biomass (FFB) program, told FOE that his bureau is not more active in commercialization activities because biofuel prices are still undercut by low energy prices. He said, "Commercialization must take place on a natural basis" in the marketplace. We agree with this judgment, but this is clearly distinct from historic ERDA and prospective DOE emphasis on market intervention to encourage fossil synfuels commercialization and places biofuels at a definite disadvantage. Ward's office does not encourage multiple-resource recovery efforts, which also places biofuels at a disadvantage since most biofuels processes involve multiple resource efforts. The exclusive use of grants by the office also discourages demonstration of large facilities which may be economically feasible but cannot obtain capital because of typical conservative lender uncertainty about novel technologies. One staff official of a

state energy agency has told FOE of numerous suggestions made to DOE for funding which his agency believed were economically feasible. DOE consistently refused to budge from its own predetermined schedule and program and consistently rejected the proposals. One of two reasons were given: either the process was commercial already and therefore did not need DOE help; or it was not commercial yet and DOE financial help would be premature. Finally, Ward told FOE that commercialization is not his responsibility. Rather he said it was the responsibility of the Assistant Secretary for Resource Applications. A March 16, 1978 DOE memo establishes "commercial activities" for "renewable resources" as one responsibility of the Division of Resource Applications; however, this function appears nowhere in the organizational chart, which emphasizes coal and oil shale commercialization.

(4) FOE received several comments about DOE biases in awarding contract grants. We were at first skeptical, but an evaluation of current FFB program grants indicates that 8 of 39 (20%) grantees have received 38% of the contracts and 55% of the funds. They are:

	Thousands of $s
Hamilton Standard	$1114.4
Bechtel	973.0
Battelle	730.5
USDA	643.0
California Institute of Technology	577.9
Dynatech	534.0
University of Illinois	462.6
Lawrence Berkeley Laboratory	437.0
subtotal	5472.4
31 other grantees	4566.6

(5) DOE has also been criticized both in and out of government for its lack of cooperation with other agencies, critical for multi-resource programs.

(6) Finally, DOE has no effective means for marketing, technology transfer, or public dissemination of information or technologies it helps develop. Its activities seem to be limited to academic conferences and NTIS publications. Commercialization will require a more active approach, even if lending, loan guarantees or other subsidies are not used. In comparison, the California Energy Commission has held workshops at which it deliberately brought together firms and individuals with specific complementary biomass resources, energy needs, and conversion technology, some of which resulted in biofuels projects.

CASE STUDY - BIO GAS OF COLORADO

Bio Gas of Colorado is a small research firm in Denver which has designed a major anaerobic digestion unit to provide methane for the natural gas fired steam electric generator owned by the City of Lamar, Colorado. Construction of the facility will cost $9.8 million, $14.2 million including interest during construction. Manure will come from 50,000 head of cattle in feedlots near Lamar. The digesters will produce 1040 MCF per day and 516 tons per day (129 tons dry) of cattle feed including centrifuged digester residue and algae. The algae is produced in a water treatment system which will allow 100% water recycle, necessary in the arid west. Heat for CO_2 removal and heating the digesters to reaction temperature came from the Lamar Power Plant.

Bio Gas has requested aid in the form of loans or loan guarantees for this facility on behalf of the city of Lamar, which is currently bonded to its limit in other obligations. DOE has been unwilling to aid. A briefing by the FFB program for O'Leary and Myers (1-17-78) and our discussion with Ward indicate several inaccuracies or misrepresentations by the FFB project.

FFB is unwilling to help directly because 82% of the plant's revenue comes from the residues to be sold as cattle feed. Ward says it is "not an energy project." Lamar desires the project specifically because of the natural gas. Its alternative is to rebuild the boiler and import coal. It prefers to use the "coal" in its own community -- its manure!

Paradoxically, Ward also questions the feed value of the residue claimed by Bio Gas. He told FOE that the cattle do not fatten as quickly, thus the feed will not attract a market. However, if an animal does not fatten as quickly, it must stay in the lot for a longer period. This difference is reflected by the value of the feed. The value has been estimated in feeding experiments by the respected E.S. Erwin and Company to be $38.5/ton compared to $60/ton for dried alfalfa.

Ward's presentation to O'Leary and Myers also claims that the Food and Drug Administration prohibits refeed with digester residue. This is not true.

FFB claims that no new technology developments are represented in the Bio Gas proposal. This is not at issue. All the components have been developed elsewhere. The issue is whether DOE should provide aid for commercialization. The proposal is the first commercial application of this set of technologies. In fact, this is the first integrated application of algae treatment of digester effluent to achieve complete effluent recycle and the first commercial use of centrifuged residue for refeed. Thermonetics, for example, in Oklahoma, refeeds confetti, not digested sludge. (Confetti is the undigested food present in manure.)

FFB also claims that Bio Gas capital costs "appear high." It compares Bio Gas to a DOE funded demonstration project in Florida and to Thermonetics' Oklahoma project.

The DOE project does not experience interest during construction since it is a direct grant. It also does not have an algae recycle process. Its construction cost per head of cattle is $230. Lamar's total capital cost including interest during construction is $300 per head. However, construction cost per head is $196, consistent with the DOE cost.

How anyone can compare costs with Thermonetics is uncertain, since it refuses to release capital cost figures. FFB claims the cost is $3 million for 100,000 head of cattle, or $30/head. However, the capacity is overstated by FFB. FFB's figure comes from a brochure describing capacity of nearby feedlots. The size of the digesters, assuming the same loading rate as Bio Gas, can only support 20,000 head. This results in a $150/head cost, not inconsistent with Bio Gas, considering the greater sophistication of the Bio Gas project.

RECOMMENDATIONS

We do not argue that biofuels require massive subsidies. In fact, several industry people suggested that they are entirely unnecessary. We do believe the apparently substantial differences in attitude and treatment between biofuels and synfuels must be rectified immediately. Commercialization responsibilities must be clearly defined. A more aggressive approach must be developed by the Biomass program. Considering the economic and environmental advantages, it should actually receive much greater priority by the administration. The faults identified above must be corrected.

Commercialization of synthetic fuels should not proceed until its consequences are better understood. There is no need for subsidies. Subsidies for any commercialization effort -- synfuel or biofuel -- will only underprice energy supply and encourage wasteful use and unnecessary production. But the capitalization problems of biofuels and synfuels are different. For the latter, energy companies have capital but are unwilling to invest in marginal resources at the expense of their other activities. For biofuels, however, capital is usually not readily available to its typical promotors such as municipalities and farmers. Conservative financiers are unwilling to risk a venture into a new technology. Thus, risk capital is necessary. That risk capital need not be subsidized.

Finally, an adequate transportation policy emphasizing conservation should precede synfuels commercialization.

DR. REZNEK: Thank you. Are there any questions?

QUESTIONS AND REMARKS

DR. REZNEK: One of the concerns that I have always had about biomass is that the program is designed specifically and exclusively to produce energy from biomass such as agricultural byproducts. The net energy balance of such systems are not very good and the adverse impact on soil fertility and soil condition is significant. Poor soil condition results if these agricultural byproduct materials are removed. Have you looked into either of those questions?

MR. MARKEY: The second question was the fertility question and the first question was the net energy. I haven't seen many net energy studies of biofuels production. There is a net energy study which is part of the Bio Gas proposal and it indicates that there is a net gain of energy.

Whenever you are dealing with any solar proposals, especially in the initial phases of commercializing a solar process, there are going to be substantial questions concerning the net energy of that process.

I think it is important to recognize that there is cause for concern that we use our existing fossil energy capital to help subsidize, as it were, the energy necessary to build a renewable energy economy.

The second question with respect to fertility, I think, is a very valid question. In another longer paper specifically on biofuels, I have discussed that as one of many uncertainties with respect to biofuels.

I think the main place where the fertility question crops up is in various destructive biofuel conversion processes. Processes such as bio gas, anaerobic digestion, various fermentation processes do not have that problem if the residues or a portion of the residues are returned to the field. Unfortunately, a lot of current questions and a lot of current research is being devoted to destructive types of processes such as biofuel burning in power generation and destructive distillation for methanol.

There are potential microbial processes which can do the same job. I think that the initial emphasis on the destructive processes might be helpful insofar that it can commercialize a biomass gathering and collection network, but in the future I would hope that research and commercialization will be devoted to biological types of conversion processes.

DR. REZNEK: Thank you. Any other questions?

MR. MERSON: Yes. Kevin, Friends of the Earth obviously opposes subsidies for commercialization of synthetic fuels such as oil shale or coal gasification. Do you have a position on Federal participation in funding prototype operations in those areas?

MR. MARKEY: It depends on how one defines prototype. If one defines it as the Department of Interior in a prototype oil shale leasing program -- definitely not. However, in terms of funding pilot type research programs or bench scale research programs up to commercialization, I think there very definitely is a Federal role and that Federal role in funding can aid in obtaining publicly available environmental information.

We are not opposed to reasonable Federal subsidization of research in other fossil fuels or in biofuels. The big question is what happens at the point of commercialization. The biofuels program or the specific project, Bio Gas from Colorado -- they are requesting essentially Federal loans, not subsidized Federal loans or one form of loan guarantee or another, mainly because it is a municipal project which does not have the capitalization and whose bonding obligations are at its bonding limit.

The institutional barrier that they have run across is the inability to attract risk capital from traditionally conservative financial institutions. Most of the people in biofuels research and the industry that I have talked to say that they feel that once some sort of indication is given which would help in establishing credibility of those efforts, and financial confidence or investor confidence, then the sky is the limit.

DR. DAVIDSON: The problems associated with the Department of Energy's biomass R&D program I think have been commented on by several groups over the last several months. I am wondering if in fact you have some more specific suggestions on precisely how best to proceed if one were to attempt to improve the R&D strategy and program effort.

MR. MARKEY: The first thing is to reverse some of the faults that I have identified here. The second thing is a fundamental policy realization on the part of the administration of the necessity to make biomass an important research and development priority. That is clearly not there. Roscoe Ward is somewhat conflicting in some of the things that he said publicly.

On the one hand he tells us that their job is not commercialization and things like that and that they only have limited resources. On the other hand, he has told people that it has just been recently that his program has convinced the administration of the importance of biofuels.

I tend to think that it is not his organization that has convinced the administration. Rather, it is the public and the public pressure. His organization made a request of about $52.1 million this year to OMB. OMB chopped it down to somewhere under $30 million and then the House Committee on Science and Technology boosted it back up to its original request.

That is one story I hear. I hear about 20 other different stories.

DR. REZNEK: I can think of two possible reasons or conditions for not going forward with the commercialization program. First, there seem to be serious questions about net energy return from mature biomass industry. By this I mean there is concern about the amount of energy which must be invested in the form of fertilizers and soil conditioners. In other words, will it be possible to operate the whole process so that its net energy return is high? Second, it may be that a biomass system can already be operated with a high energy return and in a commercially viable way. If either of these two conditions match the reality of the current situation reasonably well, why go ahead with the technology commercialization program?

MR. MARKEY: Okay. You can go ahead with commercialization programs where those questions are answered. I think that one of those commercialization programs is very definitely a program in anaerobic digestion. I think that can proceed. There are other technologies which are not as well advanced and which do require more basic research.

We are not saying that the commercialization should precede the research that has to be done, but where it has been done and where I think there has been demonstration of net energy returns and that residues can provide the sort of soil fertilization that you are going to need, where those questions are answered, commercialization can proceed.

DR. REZNEK: Are there any other questions?

MR. MERSON: I want to ask you a question.

DR. REZNEK: Fine.

MR. MERSON: Then maybe Kevin can comment. I am trying to learn a little bit today myself. Excuse me. Does it matter if there is not a high net energy return? Suppose the net energy return from this process is negligible, but that the biomass that is used for energy conversion is essentially wasted today. Suppose if you count in everything that goes into this process to produce the biomass -- the manure in this case -- you get a very low net energy return, but that the material itself isn't really used in a productive way.

Do you need a high net energy return in order to justify the commercialization process? I guess that is my question.

DR. REZNEK: As you phrase it, no, a high energy return is not needed to justify the commercialization when true waste materials, which is to say, materials that can be used for nothing else, are used to produce the energy. But if plowing the biomass back into the field is found to be a better use for that material, and if this is not being done today, then the probability that this better use will ever be achieved goes down if high technology pyrolysis is commercialized.

MR. MERSON: Okay, so you really have to look at the alternatives, then decide which is the better use.

MR. MARKEY: Right. I agree with that and it also depends upon where you draw your boundaries in the net energy analysis. If you are looking, for example, at the current energy system versus the current energy system plus the addition, for example, of anaerobic digestion, you have to draw one boundary. If you are looking at the total energy system in comparison to alternative types of cattle production, you are going to draw another boundary.

It is a question almost of whether it is a conservation technique or an application of solar energy.

DR. REZNEK: You will admit that if energy from biomass is an application of solar energy, it is one with perhaps the most serious unsolved environmental problems.

MR. MARKEY: In terms of several technologies, yes. Again, I would emphasize the need for development not of destructive types of conversion processes, but rather bioconversion processes in the true sense of the word.

DR. DAVIDSON: One very brief question -- I am wondering in terms of the overall biomass potential for the country, would you have a feeling for what it might contribute, say at the turn of the century or the 2025 timeframe.

MR. MARKEY: The Department says that by the turn of the century it will contribute 3 quads, by 2020 it will contribute 10 quads. I have seen biomass resource estimates ranging an incredible gamut based on existing resources. Based upon net energy efficiencies ranging from 25 to 50 percent, I calculated the collectible residues resources at 5.4 quads. Now, those residues might be likely to proceed upward proportionately to population. You add to that potential plantation biomass resources and you might bring that up to about 10.8 quads in today's economy.

In terms of what that means per capita -- let me find the stuff here -- on this basis the per capita net energy available from all organic sources for 2000 would be about 41 million Btu's. Compare this to the vehicular transport demand of today's population which is about 17.1 quads -- I'm doing an end use analysis look at the end use which requires liquid resource for example and that in order to assume that biomass is going to do anything, you are going to have to do some conservation measures -- some effective conservation measures.

That is why the last statement in my testimony mentioned the transportation conservation policy. According to Williams -- I can't remember the other guy -- Ross and Williams. According to Ross and Williams that could be further reduced to about 8.7 quads by technical fixed measures alone. That on a million Btu per capita basis is 41. That was entirely fortuitous coming out with those two numbers being equal. There are a lot of uncertainties in both.

One of the problems I think -- one of the questions earlier was what we have to do. There has been a lot of literature search type of evaluation of biomass resources, and those literature searches all go back to essentially the same person, Larry Anderson.

There have been a few very site specific and intensive inventories of biomass resources. One, for example, has been done by Bio Gas of Colorado.

I don't know the extent to which they are compatible with Larry Anderson's original study. Those have to be extended.

In addition to that, most national studies have ignored indigenous biomass resources which might be best found by state agencies. For example, the University of Minnesota is finding that they can use 25 percent of their wetlands in the state of Minnesota to produce biomass which will yield them 10 percent of their entire state's energy production or energy use.

DR. REZNEK: Thank you. Any further questions?

Thank you.

MR. MARKEY: Thank you.

DR. REZNEK: We will break and reconvene at 1:30.

AFTERNOON SESSION

DR. REZNEK: We are ready to start the afternoon session. The next witness is Mr. John McCormick from the Environmental Policy Center.

STATEMENT OF MR. JOHN McCORMICK
ENVIRONMENTAL POLICY CENTER

MR. McCORMICK: Members of the panel, my name is John McCormick and I speak as a representative of the Environmental Policy Center. The Environmental Policy Center is a lobby organization based in Washington. It represents organizations, individuals, labor groups, farm groups, and citizen groups throughout the nation on national legislation pending before the Congress.

It is a pleasure to be here this afternoon, particularly to be testifying before a dear old friend, Alan Merson. Our relationship goes back several years and it has been a very important one for me.

I am also delighted to see that the Environmental Protection Agency is hosting this hearing which traditionally has been hosted by the CEQ. I testified before the CEQ on this issue several times and I always found it to be very beneficial.

The analytical review that goes into reviewing the hearings and recommendations coming from these hearings, I hope will find a welcome ear within the DOE.

Before I begin reading a short written statement, I would like to say that we are pleased to see that this administration and the Department of Energy's budget do not reflect the continued obsession that the previous administration had for Congressional action on a loan guarantee program for synthetic fuels commercialization.

That was a bitter struggle over several years and, while there was a compromise of sorts in that the Congress did give generic authority to DOE to negotiate guaranteed loans, we are pleased to see that the valuable time of the Congress is not being taken up with debating the rationale for multi-billion dollar guaranteed loan programs for synthetic fuels development.

While I have several comments on DOE's fossil R&D program related to synthetic fuels production, there are general comments which should be brought to your attention. As the Congress debated the amendments to the Clean Air Act during the first session of this Congress, other committees within the Congress were shaping up the DOE R&D budget for fiscal year 1978.

Since the Clean Air Act amendments were not signed into law and regulations pertaining to that statute were not published, it was impossible for the Congress to synchronize the two bills. Consequently, passage of the much-needed improvements in the Clean Air Act posed serious problems for the future of certain coal utilization technologies because new sulfur dioxide and nitrogen oxide effluent levels may be too restrictive for the processes to meet.

This is not to infer that changes should be made in the Clean Air Act or in the regulations. Rather, this situation calls for a close working relationship between DOE and EPA in order that pending regulations and those which are being contemplated -- such as trace element guidelines and sulfate standards -- can become a part of the thinking within DOE as it designs new programs to be included in future budgets.

The anxiety created by press stories regarding the possible unacceptability of fluidized-bed boiler SO_2 emissions in light of the new source pollution standards expresses the critical need for closer cooperation in a graphic way.

The public will become more disenchanted with federal participation in energy research programs if it becomes aware of expensive technologies being abandoned in midstream as new pollution standards require emissions the technology cannot meet.

In light of this concern, it is fortunate that EPA has become the host for these hearings. With the careful analysis they may foster, this agency will be in a better position to advise the Executive branch of possible incompatabilities which might arise as decisions and actions pertaining to pollution abatement are made.

Hopefully, the Congress will benefit from a synchronized approach to passing laws and authorizing research programs. There has to be a greater appreciation for the lead times that are a part of bringing new technologies on line.

If technologies such as liquefaction of coal will not come on line before 1985 or 1990, regardless of increased funding of ongoing research, the public and the Congress should be made aware of this. Therefore, public policy will not be debated in an atmosphere of misunderstandings and false promises.

Another benefit of a closer relationship between EPA and DOE is the greater concern for worker health and safety which must take a higher priority within the federal government's synthetic fuels R&D program. Not enough is known of the health effects upon workers exposed to the escaping toxic gases during the operation of coal gasification or oil shale plants.

Russia became aware of the presence of carcinogens in the work areas around oil shale conversion facilities many years ago. ERDA did not show any real willingness to increase its understanding of this potentially serious situation.

Continued reluctance to attack worker health and safety dangers while researching synthetic fuels technologies is a gross irresponsibility. While more emphasis is being placed in this area by DOE, the EPA should become the conscience of DOE by doing independent analyses of potential dangers to workers.

With the new Administration and the personnel changes that have taken place within DOE, there has come a new regard for the commercialization of technologies that have proven themselves successful. That concept has been long awaited and was, in the past, overshadowed by ERDA's continued interest in Congressional authorization of a synthetic fuels guaranteed loan program.

That appeared to be the summation of its commercialization plans. However, that legislation was intended to benefit billion dollar coal gasification and oil shale plants rather than low-Btu coal gasifiers and small fluidized-bed boilers. The Federal government has made bold claims about commercialization efforts but little has been accomplished to date.

Under the direction of DOE's Assistant Secretary for Resource Application, George S. McIsaac, there may be some important changes made in encouraging industry acceptance of proven technologies and tailoring future programs more closely to market needs.

In his words, McIsaac stated that in the future, "There should be a very serious market planning kind of analysis for every technology...".

Presently, this is not procedure within DOE. Using this kind of policy and devoting more staff time to working through a research project from conception to marketing, that long lead-time for new technologies may be diminished significantly as potential problems are dealt with and solutions derived before they occur.

Two coal utilization processes which should benefit from an increased emphasis on commercial application are fluidized-bed coal combustion and low and medium Btu coal gasification. These processes are very close to commercialization and every effort should be expended to hasten their use throughout industry.

They also are best suited to small decentralized facilities but they could become most valuable as the federal government continues to pursue mandatory coal conversion of oil and gas-fired industrial boilers.

Without fluidized-bed coal boilers available to potential conversion candidates, it is difficult to perceive any positive gains in replacing oil and gas with coal in the industrial sector.

Plant managers will be reluctant to opt for coal and, instead, will turn to greater reliance upon electricity as the substitute energy source or will fight conversion orders thereby defeating the purpose of the program.

Stoker boiler manufacturers will not have the capacity to fabricate cast iron boilers and pollution control equipment necessary for their operation in accord with environmental laws and may rule out such boilers for economic reasons.

Recent successes with the 30 MW fluidized-bed boiler in the Rivesville, West Virginia research project give encouragement to boiler manufacturers that a market for small boilers is at hand.

Several companies are ready to give warranties for such boilers and with a longer track record for successful operation of the West Virginia facility, the reliability concerns that potential customers will have are likely to be appeased. There is considerable interest among the Rivesville participants to scale-up the 30 MW boiler to 200 MW.

This should be resisted by the Congress and DOE until a solution to recycling of the spent bed material has been proven. Failure to accomplish this will trade one pollution problem for another; stack gas effluent cleanup will be a positive benefit but disposal of the ash and waste will become a detractant as the amounts of waste continue to grow and more land is committed to their disposal.

Low Btu coal gasifiers can also play an important role in the substitution of coal for oil and gas in industrial boilers. The Center is satisfied that the initial approach toward commercializing these gasifiers is proceeding in a responsible manner.

However, more demonstration plants should be encouraged with the help of DOE. There should not be as much concern for avoiding redundancy as there appears to be. That, perhaps, is a concern that is voiced most often by the Office of Management and Budget.

If several more gasifiers were constructed and operated in the west and southwestern regions of the nation, their successful demonstration might hasten their acceptability in a region where the market potential is not as obvious. Therefore, the low-Btu gasifier program should be increased in funding significantly and the RFP's should go out as soon as possible.

The coal extraction R&D program appears to be adequate from our perspective but it would be an unfortunate outcome if DOE did not work closely with the Department of the Interior or the coal labor unions as this part of the R&D program proceeds.

The new Office of Surface Mining within DOI, charged with enforcing the coal strip mining law, should be a participant in any decisions to fund a strip mining or reclamation project designed to create innovations in removal and replacement of overburden in the reclamation process.

The Center will follow activities in this program closely as it works to assure that the strip mining law is enforced.

Coal liquefaction, particularly SRC-II liquefaction process, should replace high Btu coal gasification as a priority program within DOE. The benefits from that technology are more varied and its ability to accept all coal types adds to this attraction.

That program is moving ahead in a responsible manner and we hope that a commercialized plant can be in operation by the early 1980's.

I would like to interject something at that point. We have not taken a position against high-Btu coal gasification as a viable technology. That ought to be pursued by the Federal government.

We have seen in the past that there is an imbalanced appreciation for that technology over others. While there is certainly a crying need for additional methane in the distribution systems of the gas transmission companies, we also see some possibilities for conservation of that natural gas without the expenditure of much money.

For instance, electric start mechanisms in gas ranges and gas water heaters replacing gas pilot lights would have a significant savings in the amount of natural gas we use daily. While that isn't as attractive as some people would like it to be, there is probably more gas being used in pilot lights than in the annual output of a single gasification plant.

The gasification plant's capital cost might be in excess of a billion dollars. To convert pilot lights from gas to some non-gas means of starting the fire would be virtually inexpensive when you compare it to the capital costs of a gasification plant.

In summary, the Carter administration has shown constraint and wisdom in its approach to synthetic fuels technology research. Gone is the earlier administration's obsession with guaranteed loans for synthetic fuels commercialization.

That has been replaced with a visible appreciation for a more careful and better selection process before it recommends the type of high Btu coal gasification process to be scaled up from pilot plant size.

This is a healthy change and one that speaks well of the new management within this program. We hope that this thinking will become a part of the remainder of DOE's synthetic fuels research program.

I haven't mentioned anything about oil shale. I realize that the part of the DOE budget pertaining to oil shale amounts to something like $30 million. The Environmental Policy Center continues to hold the premise that this nation does not need to look toward oil shale as a potential source of new energy.

I think that is probably the last place on this earth we have to begin looking for new energy because the amount of land disturbed to supply a very limited amount of synthetic oil from shale tells us that it is just not practical. While continued research ought to proceed on the in situ oil shale recovery process, we feel that the surface retort process that requires either underground mining or surface mining should be abandoned.

That summarizes my statement and I will be glad to answer any questions.

DR. REZNEK: Thank you.

QUESTIONS AND REMARKS

DR. REZNEK: Do you have a view of the relative emphasis for SRC-I and SRC-II?

MR. McCORMICK: Yes, my understanding of the characteristics of the SRC-I product tells me that it isn't likely to comply with the New Source Performance Standards as far as sulfur dioxide removal.

I am told that the SRC-II product is considerably more beneficial in that regard, and for that reason I hope that the SRC-II process will get the greatest emphasis in the future.

DR. REZNEK: Thank you. Are there any other questions?

MR. MERSON: I just want to ask an informational question of John, and perhaps any member of the panel who might care to comment. That is the fluidized-bed coal combustion process -- I'm not familiar with it and I would really appreciate it if someone could just give me a thumb-nail sketch of what we are talking about.

MR. McCORMICK: I'll try to. Conventional coal-fire boilers inject powdered coal--pulverized coal in powder form. That combustion results in stack gas having to be treated at another part in the plant.

The fluidized-bed coal combustion boiler is a boiler box constructed with a grated floor -- with holes of one to two inches in diameter perforating the steel grate on the floor.

A bed material of crushed limestone is placed upon that grated bed in thickness of about eight to twelve inches. Air is forced up through the holes in the bottom giving these particles of limestone a buoyant property as they float up and down carried by this air pressure.

Nuggets of coal less than a quarter of an inch in size are then injected on top of the bed material as the bed material is heated from external sources using gas or oil-fired jets. When the material is hot enough and the coal begins to combust, the calcium oxide in the limestone becomes an absorbent for SO_2 and calcium sulfate, $CASO_3$, is the property that the bed material takes on.

The bed material is able to be drained off and the unburned coal portion recaptured and reinjected. Evidently the combustion efficiency is exceedingly high.

The configuration of the water pipes inside the boiler is such that they are completely enveloped by this molten bed material. Therefore, the heat transfer co-efficiency is about six times greater than a conventional steam boiler with the water pipes affixed to the sides of the boiler.

That would allow for a more compact unit and perhaps one that could be constructed in a shop and delivered on site ready to be put together.

The heat range of a fluidized-bed boiler is between 1500 and 1800 degrees which is less than that heat required to develop nitrogen oxide. That might be another benefit. A further benefit in fluidized-bed boilers is that the spent bed material is in a dry form and lends itself to road-bed construction or light construction materials.

While I didn't mention it, I am glad I had this opportunity to mention it here. We've continued to request the Department of Energy, or ERDA, to increase its emphasis on reinjection of this spent bed material by stripping the sulfur dioxide from the calcium sulfate, thereby reinjecting the calcium oxide.

The ratio of limestone to coal where the coal has a sulfur content of about four percent -- maybe five pounds of limestone to eight pounds of coal -- so you see the solid waste problem that we have if we didn't have some reinjection potential in this system.

DR. REZNEK: Have you examined the relevant properties of the solid waste from a fluidized-bed and from a forced oxidation limestone scrubber?

MR. McCORMICK: The characteristic of the spent bed material in the fluidized-bed boiler is more stable because it is a dry material. It can be more easily handled, whereas the sludge from a limestone slurry scrubber represents problems of instability in landfill disposal.

DR. REZNEK: Including forced oxidation?

MR. McCORMICK: I'm afraid I can't make an opinion on that on the limestone scrubber.

MR. MERSON: I'll ask my usual question. What are the constraints, John, to the proceeding as you see it with this process? What is holding it back at this point?

MR. McCORMICK: My understanding is one of the constraints is the feeding mechanisms supplying the right amount of coal so that you don't have an overload of coal, and thereby an ineffective sulfur dioxide removal because most of the limestone has absorbed the sulfur dioxide.

That control procedure is one that has been demonstrated successfully on a limited basis, but on a base load boiler operating perhaps 80 percent of the time for several years, that hasn't been demonstrated yet. I think there lies one of the constraints in that the overall reliability of fluidized-bed boilers in this country has not been proven to the satisfaction of customers and boiler manufacturers.

However, in Europe, fluidized-bed boilers have been used for a number of years. I don't know if they have the same concern for sulfur dioxide removal at the levels that the Clean Air Act would require. So I don't have an opinion as to whether European experiences could translate to U.S. experiences.

MR. MERSON: Then do our regulations pose a difficulty in terms of enabling this process to meet the standards of our proposed regulations?

MR. McCORMICK: I think it might be too early for me or for EPA for that matter to answer that question because the reconsiderations are still going on as to whether fluidized-bed coal combustion boilers will meet that ninety percent removal standard.

The early indications from the trade association press were that fluidized-bed boilers are now in trouble because of this new regulation. However, I think a closer analysis of the problem seems to have diminished some of that anxiety and perhaps that isn't quite as serious a problem as we earlier anticipated.

MR. MERSON: Thanks.

MS. HANMER: Do you foresee -- you seemed to suggest it at one point -- a case where various environmental values would have to be traded off against each other in some of these new technologies?

MR. McCORMICK: I was afraid that was the way that statement would come out and in rewriting it I wished I had spent some more time on that. I am not saying that tradeoffs ought to be made and that environmental standards ought to be weakened. We have made some real gains in the public's appreciation of what a cleaner environment can do for them.

I don't think we should start backtracking on that. At the same time, we have to become more realistic about the standards that we do set and the amount of lead time that goes into developing techologies that can attain those standards.

I certainly wouldn't be doing the environmental movement any good if I said therefore we should build new lead times into the Clean Air Act or perhaps lengthen exemptions, but certainly we have to give more appreciation to these lead times.

Then, if that dictates that more money be put into a research program or that -- I guess it might heighten the pressure that DOE should feel to come up with solutions rather than continue. As in the fluidized-bed boiler case, the decision on the part of the researchers was to go from 30 megawatts to 200 megawatt size, when what industry really needs is five and ten megawatt size boilers.

In the mandatory coal conversion program, if an industry burning oil or gas is required to go to coal there are very few choices on how to burn that coal and to burn it in an acceptable way.

DOE should be aware of this and instead of scaling up that fluidized-bed boiler technology to 200 megawatts, should look for the solutions that the industrialists will need to convert to coal. Fluidized-bed boilers at that range could comply with new source standards if there were improvements made on that Rivesville plant.

I know I haven't answered all of your question, but I guess I am trying to make the point that DOE has got to respond to provisions in the Clean Air Act more than I think they have in the past.

DR. REZNEK: Are there any further questions?

DR. REZNEK: Thank you.

MR. McCORMICK: Thank you.

DR. REZNEK: Our next witness is Mr. George Bolton, Director of Technology Supply for the Columbia LNG Corporation.

STATEMENT OF MR. GEORGE H. BOLTON, DIRECTOR SUPPLY TECHNOLOGY COLUMBIA LNG CORPORATION

MR. BOLTON: Mr. Chairman, I am George Bolton, Director of Supply Technology of Columbia LNG which is a subsidiary of Columbia Gas, which supplies natural gas to about 10 percent of the nation's natural gas customers.

Columbia LNG is engaged, not only in LNG, but in other non-historic gas supplies. I have with me Dr. Atherton from our Environmental Affairs group. He is an environmental engineer and he may assist in answering some of your questions.

Thanks for the opportunity to present views examining the adequacy of emphasis on environmental implications of the Federal energy RD&D program. I would like to underscore the last D -- the demonstration.

These remarks will be confined to coal gasification which I have been heavily involved in since 1964, and I'll only focus on one item here; getting the needed environmental data by putting more emphasis on demonstration programs of available technology.

Coal gasification appears to be the most effective way to turn high sulfur coal into an environmentally acceptable fuel. We can debate that later. To me, it would seem to be inevitable. Yet EPA, in one of their Decision Series reports, points out, and I agree completely, that there is an "uncertain future of the synthetic fuels industry".

At the top of the list of environmental uncertainties is lack of quantitative data. We seem to be missing the boat because we don't have the answers, and the fundamental problem appears to be that our national energy activities continue to aim at a moving target.

We are always preoccupied with advancing technology and we fail to establish an environmental benchmark, and that is certainly the key to a sound coal conversion program.

The need is for a gasification demonstration plant using the environmentally best available technology to provide the quantitative data that we don't have. A process is available that produces essentially clean fuel gas, inert slag, and elemental sulfur. This seems to be as close to environmentally ideal as possible.

Any possible pollutants appear to be minor and manageable. I think we ought to have the quantitative data to confirm these opinions, and I say opinions because I became convinced, as I sat in the audience today, that what we do in this country is sit around and debate opinions rather than get facts.

Now, some associate gasification with alleged carcinogens such as tar, and the process is free from tar. Over four years ago in January of 1974, EPA put out a report on a process. I will paraphrase the conclusions here: "More complete information is available than on some other processes". There are a number of plants in operation. These plants are overseas.

Another EPA report pointed out that monitoring non-U.S. operations might not be applicable. The reason is that they are not built to our standards; they are not operated the way we would operate them -- not only environmental standards but also construction standards. It is a different ball game.

To draw an analogy with a car built for the European market, it has to get a "fix" before it can enter the U.S. import market. It is apples and oranges.

Going back to the EPA report, "It is a simple and relatively clean process in that it does not produce tar, oil, or phenols." Minor amounts of other items which I think any coal conversion process is going to produce, are produced; but it does not produce tars, oil, or phenols, and many people feel that gasification equals tars, oil, and phenols; and EPA themselves over four years ago said it wasn't true.

This sounds like the starting point to overcome the "lack of quantitative data". If we had a demonstration plant with a commercial size module, we would get data directly comparable to a commercial facility, and this would establish an environmental framework for coal gasification.

Let me say that our problem of energy supply is not an "either-or". It is not we do coal gasification and we don't do everything else. We need almost everything. Let's pin down coal gasification. It looks like an easy one.

The process produces a medium Btu, a 300 Btu gas. Columbia has analyzed over 2,000 industrial customers, and this gas is a widely applicable industrial fuel. Low Btu gas is not a widely applicable fuel and I am distressed to hear that there is continuing confusion about that point.

Industry has the need for this medium Btu fuel and the process has feedstock flexibility. It can utilize any coal directly, including the fines which are a problem with some processes, and the high caking, high sulfur bituminous coal which is that great energy resource we want to use in this country.

Furthermore, the gas cost is estimated to be about a quarter less than that for high Btu; and this kind of savings is more than projected for the currently identified advanced gasification processes. We may wish to fight about that a little too.

While research certainly has to continue in the quest for superior performance, it seems we still reach for the birds in the bush.

We should not continue to ignore the bird that could be in hand. Our national energy activities can provide the necessary coal gasification benchmark quantitative environmental data if it includes a Koppers demonstration plant, and I urge that we work that into our national program. Thank you.

DR. REZNEK: Thank you. Are there any questions?

QUESTIONS AND REMARKS

MR. HERHOLDT: Mr. Bolton, I would assume that the process you are talking about -- this gasification process -- is Koppers Totzek?

MR. BOLTON: That is correct.

MR. HERHOLDT: That produces hydrogen as to its natural gas or methane.

MR. BOLTON: It produces primarily hydrogen and carbon monoxide, which is a superior industrial fuel to natural gas. It is about one percent more efficient due to about a 150 degree higher flame temperature, combined with less hydrogen than is in natural gas. Even though the hydrogen is separate in 300 Btu gas, the total amount of hydrogen is less than the hydrogen that you get in methane, which is CH_4.

MR. HERHOLDT: Right.

MR. BOLTON: That reduces the stack gas losses and that is where the efficiency improvement comes from.

MR. HERHOLDT: Then, what you are talking about here is like the development of a fuel complex where one gasification plant would provide this hydrogen for plants right in the area as opposed to --

MR. BOLTON: We're not providing hydrogen.

MR. HERHOLDT: Okay. We're providing fuel gas.

MR. BOLTON: Fuel gas.

MR. HERHOLDT: As opposed to introducing this gas within, let's say Columbia's network.

MR. BOLTON: That is correct, but maybe I should add that medium Btu gas is a precursor to most high Btu gases.

MR. HERHOLDT: Right. I understand that.

MR. BOLTON: It is the classic route, and again I come back to not so much what we are going to do with it down the road, but let's gather this environmental data and quit having to argue about whether it is this or that, and know what it is.

MR. HERHOLDT: The Columbia Gas made an announcement, I think a year ago or a year and a half ago that they intended to build a coal gasification plant in Steubenville, Ohio. Is that correct?

MR. BOLTON: That is not completely correct. What the announcement said was that we were in an ERDA procurement.

MR. HERHOLDT: Okay.

MR. BOLTON: That might lead to such a plant.

MR. HERHOLDT: Was that going to use the Koppers process?

MR. BOLTON: Yes. We've been at this most recent activity going back to the late sixties, and in the early seventies we started to try to interest industrial users in coal gasification, which led to an analysis of the whole gasification picture. The conclusion at this point in time is that the Koppers technology will be the best deal from all angles.

At that time when the ERDA procurement came along it looked appropriate and we tried and lost.

MR. HERHOLDT: And, again, you say that Koppers Totzek would use all kinds of coals.

MR. BOLTON: Yes, that is one of its great advantages. It is insensitive to feedstock. Take the worse coal you can think of and it should work.

MR. HERHOLDT: Thank you.

MR. SIEK: What is the logical size for a demonstration plant? You mention building a demonstration plant and then what do you project as a full size plant?

MR. BOLTON: Philosophically, to me the demonstration plant is the smallest commercial module that you can build, so that you have full confidence that your commercial project has been adequately demonstrated; and the smallest to keep costs down.

MR. SIEK: Do you have any idea what that would be?

MR. BOLTON: Sure. In numbers, for the Koppers process the demonstration plant would be something like 4 billion Btu per day, which is 4 million standard cubic feet a day of energy equivalent natural gas. If you think in tons of coal, it is in the order of 300 tons of coal per day. I'd have to stop to think if you wanted to hear it in electricity.

MR. SIEK: No, that is fine.

MR. BOLTON: A commercial plant would be anything from five times that size. That is the order of 20 million cubic feet per day of natural gas equivalent, up to 150 to 250.

MR. SIEK: How would you site a facility like this? Would you locate it in an industrial area to serve a complex?

MR. BOLTON: If there were a large industrial user, it could be a one user facility. Otherwise, it would be in the center of gravity of the user requirements from an economic standpoint, absent some environmental aspects which would shift it depending upon whether or not you can get a site there for environmental reasons.

MR. SIEK: I guess the next logical question -- what is the water usage required of this? Is this water intensive?

MR. BOLTON: No, the coal gasification plant fundamentally uses much less water than an electric generation plant for the same amount of net energy because of the greater efficiency. Most of the water associated with coal gasification has to do with the heat losses -- the efficiency, not the source of hydrogen. You need some for hydrogen, but that is not the major water use.

MR. SIEK: This would be regardless of the quality of the feedstock?

MR. BOLTON: Fundamentally, yes. If you had a wet feedstock, but not too wet, it would cut down on your water use; but it is not a large amount in the total picture.

DR. REZNEK: I assume by your commitment to this process that when your company reviewed the availability of technical information on it, they found that some reasonable amount of information on the performance of the process was available.

MR. BOLTON: Yes. There are, I believe, 16 commercial plants, two of which are under construction and one that started in the last year and a half, I would say.

DR. REZNEK: Are these the South Africa and Yugoslavia plants?

MR. BOLTON: The Yugoslavian plant is not a Koppers plant. There is a Koppers plant in South Africa. That is the one that started up most recently.

The two under construction are, I believe, in India.

DR. REZNEK: Would you compare the technical data, the performance data, the process data to the environmental data available.

MR. BOLTON: We looked at all the data we could get our hands on.

DR. REZNEK: Was there good environmental data available from these?

MR. BOLTON: We placed a lot of weight on the EPA report, including that it didn't have tars, oils or phenols. It was a clean and simple process. That gave us cause for great enthusiasm.

DR. REZNEK: That is one of mine.

[Audience Laughter]

MR. BOLTON: You did a good job.

DR. REZNEK: We have looked at water use in these processes. One of our conclusions is that, particularly for cooling, you can trade dollars for water. Whether or not it makes economic sense depends on how much you are willing to pay for water, but you certainly can reduce consumption. For gasification plants, it is possible to make process water, the water used as the source of hydrogen in the gasification process, by far the dominant component of water usage. But you have to be willing to spend the money for other types of cooling.

MR. BOLTON: I'm sorry. I have to flatly disagree. I have in my head the high Btu plant figures and this would be analogous. A fully water cooled 250 million a day high Btu plant uses something on the order of 20,000 GPM total water consumption of which -- 2,000 GPM or so is process water. Maximum practicable air cooling will cut the total to something around 6,000 GPM, leaving cooling water as still the dominant amount.

Maybe if you pushed it real hard you could get it to be equal. I have to disagree that the cooling water is not the dominant amount.

DR. REZNEK: Thank you.

MR. MERSON: In the discussion I've heard so far about coal gasification there seems to be an emphasis on the eastern part of the United States as being the place where we would try to demonstrate this initially.

Do you see a future for this in the Rocky Mountain region -- the western United States as well?

MR. BOLTON: Since our marketing area is in the east, I have only casually thought about the Rockies. The problem is in the east because industry is in the east and it is industry that needs the fuel that turned out to be oil imports. I would say offhandedly that the Rockies would not present an area of great application. Of course, they don't have the industry there.

MR. MERSON: I see, even though they have the coal.

MR. BOLTON: It goes with industry.

MR. MERSON: It would be not as feasible to try to ship the gas, essentially.

MR. BOLTON: No, that is an application probably for high Btu.

MR. MERSON: Yes.

MR. BOLTON: This is not to say that you can't ship medium Btu gas, but I think the answer will come out in terms of hundreds of miles, whereas from the Rockies you would probably want an answer of thousands of miles.

DR. REZNEK: Any further questions?

Thank you.

MR. BOLTON: Thank you.

DR. REZNEK: Our next witness is Mr. John B. Rigg, a private consultant.

STATEMENT OF JOHN B. RIGG, CONSULTANT

MR. RIGG: Good afternoon. My name is Jack Rigg and I am from Denver, Colorado and I have been associated in the oil shale industry for a number of years.

I want to thank you for the opportunity to appear today and discuss energy conservation and environmental implications of the Federal Energy Research, Development and Demonstration Program as it relates to oil shale.

In order to assess the adequacy of both the public and private endeavors, two of your publications were reviewed. The Office of Research and Development report "Oil Shale and the Environment", October 1977, indicates over $35 million have been earmarked for research on oil shale during the next five years.

The basic federal endeavors -- The Process and Effects Program and the Control Technology Program -- offer factual answers to basic research which government should perform.

The private endeavors, covering air and water pollution and broad environmental research, plus projects by federal agencies and private companies on a host of environment economic issues are covered rather thoroughly and should answer a number of questions concerning oil shale development.

The Decision Services Document of DOE/EPA entitled "Energy/Environment Fact Book" of December in 1977, has some excellent data concerning oil shale and its environmental issues in the immediate and near future.

General pollution information on oil shale is quite good and is put in today's perspective by the somewhat overwhelming information concerning coal and other current energy sources.

To update the status of oil shale beyond both the above mentioned reports, each of you have before you a packet containing information of recent data concerning oil shale. These items will be referred to in this paper under three categories.

The middle of the packet is Current Status Report by the Cameron Engineers, Inc., "Oil Shale Status Report" of March 1978 prepared for the RMOGA Oil Shale Committee. It will be helpful because it relates directly to the eight current pilot and prototype commercial stages of development and to programs now underway which will allow adequacy of basic research in environmental, sociologic, health and safety and economic factors to be tested.

It affirms that without increased larger sized projects, the rewards, challenges and effects of oil shale production will never be known.

Current Department of Energy oil shale programs show about $31 million programmed for the year 1979. These activities appear adequate. This is about a 30 percent increase over 1978 and should give some needed answers.

The Federal Prototype Oil Shale Leasing Program of the Department of Interior, with the sale of four leases for $449 million dollars in 1974, is the cornerstone for domestic oil shale development. Energy development and environmental improvement are co-equal objectives under this endeavor.

Cameron describes it as "...the most ambitious major resource management program ever undertaken in the world." If socio-environmental and economic policy questions are not adequately answered here, serious delays in the evolution of a full scale mature oil shale industry could result.

Two specific concerns arise. The first is why the Charter for the Oil Shale Environmental Advisory Panel has not been renewed. EPA was represented on this panel, as were other Federal Agencies, the affected states and the citizens where shale is located.

Continuation of citizen input to this oil shale program is a proper responsibility of government.

The second is why ancillary aspects languishing include title clearances, land exchanges, off-site disposal of spent shale and sodium lease issuances. These should be pursued so that access to mineable units and tenure to stimulate development by the private sector are encouraged. I thank Mr. Merson for being here.

Environmental Uncertainty -- the copies of the interchange between EPA and TOSCO of January and February 1978, concerning "reasonable certainty as to Government policy", i.e., whether environmental requirements in effect at time of permit issuance will most likely remain in effect throughout the lifetime of the facility -- strikes at the very heart of the oil shale development/ environmental constraints problem.

The enclosed Federal Register notice of March 3, 1978 and Rocky Mountain News article of March 20, 1978 indicate that EPA is not following its own policy concerning ambient air standards in rural areas.

There is no industrial development in either the Piceance Basin of Colorado or the Uintah Basin of Utah that can be corrected to mitigate the non-compliance edict on ozone emissions. EPA should review this attainment status of the oil shale region and seriously consider revising the designation.

Mr. Thoem describes industry's dilemma most properly in his memo to Mr. Merson when he says ..."EPA is obliged to eliminate the number of yellow lights and present either a red or green light industrial development (per Costle's remarks in the latest EPA journal)."

Economic Incentives: Two of the four program goals of the Federal Prototype Oil Shale Leasing Program of 1974 are: to provide a new source of energy to the nation by stimulating the development of commercial oil shale technology by private industry; and to permit an equitable return to all parties in the development of this public resource.

It appears four years later that private industry is having difficulty justifying massive capital investments because of inability to assure equitable return.

Perhaps a new Prototype Oil Shale Commercial Production Program, in parallel with the Prototype Oil Shale Leasing Program, is in order. Various options could be presented and it is recommended that the Departments of Energy, Interior and Defense join EPA and selected others in a review of policy options.

The enclosed New York Times, February 26, 1978 article, "Herman Kahn Revisited", discusses a report by the Hudson Institute titled "Suggestions for a Phase II Energy Policy" that has been circulating at the Department of Energy.

The report favorably discusses shale oil recovery on a rather larger scale with conventional technology. Mr. Kahn concedes that under his program, environmental problems would have to be dealt with on a grand scale. But he also points out "...nevertheless, the nation would be more secure than it is today."

Instead of a federally funded program, there are other options -- and this is one: the enclosed "Questions and Answers on Oil Shale Status Development and Tax Treatment" examines the Senate passed $3.00 per barrel tax credit plan.

This proposal involves no Federal funding for oil shale development and has no tax consequence until and unless shale oil production actually takes place. It will stimulate a variety of recovery and reclamation projects on private lands and the federal leases.

These may range from in situ and modified in situ to gas combustion, direct or indirect heated surface retorts. Private companies will assume the technological risks and financing alternatives.

The specific language of this proposal is shown in the enclosed pages from H.R. 5263, Section 1044, "Tax Credit for Production of Oil and Gas from Nonconventional Sources". Support for passage from the Administration to the House and Senate Conference Committee is recommended.

The Federal Non-nuclear Energy Research and Development Program could promote energy conservation and environmental improvement in the oil shale areas of the west. Besides already approved programs underway, three projects are recommended:

One, re-charter the Oil Shale Environmental Advisory Panel to assure the Federal Prototype Oil Shale Leasing Program is conducted with proper interagency, state and citizen monitoring.

Two, remove environmental uncertainties that seem to continually alter investment climate and production criteria.

Three, provide a non-Federal funded incentive for private development of oil shale through a $3.00 per barrel tax incentive.

Other complex environmental, socio-economic, technical, health and safety and general challenges affecting oil shale development are being addressed today by both the public and private sectors.

These will be with us until solved and the solving will bring on new challenges. However, the need today to aggressively pursue early modular commercial shale oil production should not be impeded by such research and demonstration programs. Thank you very much.

DR. REZNEK: Thank you.

QUESTIONS AND REMARKS

MR. SIEK: Jack, I heard last week that the Oil Shale Environmental Advisory Panel is funded.

MR. RIGG: It is?

MR. SIEK: One of your concerns evidently is answered. I don't think that is official but I was assured that it was funded. One other point that you didn't mention on the last page of your suggestions, and one that concerns us is that we all know the problems that we have been going through in evaluating and getting on line the modular phase of the various projects. One thing we are looking at now is the development of criteria to judge the success or failure of those modular phases.

I'm afraid if we don't start now to develop that kind of criteria that by the time these modular phases are completed we won't know whether it has been successful or not. So I think the development of such criteria are really necessary at this time for an orderly process.

MR. RIGG: Bob, how is that criteria? Is that above and beyond your --

MR. SIEK: Yes, I think someone is going to have to judge at the end of the modular phase exactly if the modular phase was successful or not successful, environmentally as well as economically.

MR. RIGG: Yes.

MR. SIEK: Those criteria I think are going to have to be available at that time. I think it is not too early to start that development.

MR. RIGG: Aren't they pretty well available now?

MR. SIEK: We don't think so. There may be some that we don't know of, but we really don't think those kinds of criteria are available at this time.

MR. RIGG: That is a good thought.

MR. MERSON: I suppose I ought to say something.

MR. RIGG: Yes, of course. I didn't know you were going to be here, but I'm delighted.

MR. MERSON: We don't have to debate some of these issues. We'll have a chance to talk about them, I am sure, over the next few months.

Of course, one of the problems, as you well know, is probably in the legislation itself, not necessarily in EPA policy with respect to non-attainment areas, both with fugitive dust as it affects particulate standards as well as with oxidants. Naturally with occurring oxidants, there is a requirement for EPA to designate these areas where the standards are exceeded as non-attainment areas.

I think we have tried to make clear, I hope to you -- we certainly have tried as much as we could to make clear that it doesn't make much sense to have an offset policy where you have naturally occurring pollutants as in these instances.

We are certainly trying to work with your industry, I think, to come up with a reasonable approach to oil shale development. I think you will recognize that we certainly haven't been hostile in dealing with the oil shale industry or at least since I've been in this office.

We've tried to process PSD permits and act in an expeditious manner. The thing that you are asking for in the final analysis though, in addition to a few fixes here and there dealing with things like oxidant standards, is some guarantee of long-range consistency on the part of EPA in dealing with the industry, and quite honestly I don't know whether that is possible.

We have a Congress; we have an agency; and I think as with everything else in government, it is hard to provide that assurance over a very long period of time. I think we can strive for it. I am just not sure that we can promise you that Congress isn't going to change the law next year or that there may not be compelling considerations on the part of the agency perhaps to adopt a different approach at some future time.

Maybe I have misunderstood you, but I am not sure there is any way that a Federal agency can provide that kind of long-term assurance. I think we try to minimize the yellow lights. I would agree --

MR. RIGG: I love that statement on the yellow lights because that is where so many of these things are. They are neither go nor stop.

MR. MERSON: Right.

MR. RIGG: So then somebody makes a decision to stop and then they find out -- well, that the environmental problems are such that they could have been go. So then they go to go and then -- well, the environmental constraints are such that we have to go to stop.

MR. MERSON: That is assuming a certain arbitrariness, I think, that while it may be present or appear to be present, I think, hopefully it doesn't characterize EPA's approach as I see it. I hope we are ready to deal with you in addressing particular problems as they arise. I am not sure, though, that we can ever offer you assurance of long-term consistency.

MR. RIGG: Well, the trouble with it is, of course, that you do have a certain "X" number of dollars to take to build one of these plants over a long period of time and you do your financing and everybody is satisfied that it will work and you get half-way through and then the rules change. It is difficult, needless to say.

MR. MERSON: We have some prototype projects going forward now, as you well know, in Colorado. Do you see on the horizon, other than the specific issue of perhaps the violation of the Ambient Air Quality Standards in terms of oxidants or particulates, do you see other clouds now that you think pose serious obstacles for the oil shale industry?

MR. RIGG: I don't because the obstacles, of course, are some that are mentioned in there, but when you step back and look at the program and you look at the size of the area, you have say 32 square miles out of 17,000 square miles you are playing with.

That acreage was selected a number of years ago so, in case a monumental and environmental disaster were to evolve over this program, you were subjecting yourself to such a small area that you would be able to control it.

Now, if I would say -- well, we'll go out and we will build 300 plants out there, then that is a whole new ballgame. Under the current situation, I think it is under satisfactory control. I think the Office of the Oil Shale Coordinator has good communications, from what I can find, with other agencies, with the State, and with the people involved.

One of the problems, four years ago, that I felt was a concern was the social problem -- the boomtown, the people problem. Whether that has been satisfactorily addressed yet or not, I do not know. I am still not satisfied in my own mind. I don't know whether it is the Federal agencies or the state or the local communities.

You get to stepping on a whole lot of toes when you get into that socio-economic place, because George has his little zoned area by a town there that he wants to do something with and it gets a little sensitive. You run into that, I know.

That is the only one that could be of some concern.

MR. MERSON: Yes.

DR. REZNEK: Regarding the earlier comment on interim steps, I would say that the policy of establishing pre-determined criteria for judging success of demonstration projects makes a lot of sense. Such a policy should be applied in all energy technologies, not just oil shale. A plant of a certain size can then be built to meet certain pre-stated, agreed-upon criteria. If the plant doesn't meet those, the environmental interests are not under pressure to justify requiring the expenditure of some large sum of money since the criteria were known from the beginning and not changed halfway through the construction period.

MR. RIGG: I am confident that the technology is there to satisfy these requirements. I think we have our basic criteria in many of these fields that are in water pollution and some of that field work on reclamation of spent shale over at the Paraho project has been quite good, quite excellent.

It confirms some of the theoretical desire of the original program, its theoretical objective. They have been already confirmed on spent shale disposal. It is a good idea.

DR. REZNEK: Any further questions? Thank you.

MR. RIGG: Thank you.

DR. REZNEK: Our next witness is Dr. Eli Salmon of Resources for the Future.

STATEMENT OF DR. ELIAHU J. SALMON
SENIOR RESEARCH ASSOCIATE
RESOURCES FOR THE FUTURES, INC.

DR. SALMON: It is a pleasure to be here. My name is Eli J. Salmon and I work for Resources for the Future, which is an organization specializing in research on the development, conservation, and use of natural resources and the improvement of the quality of the environment.

I am presently participating in a study of U.S. energy strategy for the future which is a comparative technical, economic, and environmental analysis of energy options. The study is funded by the Andrew W. Mellon Foundation and the Ford Foundation. The object is to formulate and evaluate alternative potential strategies for energy supply and use.

Within this study I have just completed a preliminary report on health and environmental impacts from various energy technologies. They included direct electricity generation from coal gasification and liquefaction including low Btu mine mouth electricity generation by combined cycles, and the production of liquid fuels by surface and in situ oil shale retorting.

The major health and environmental impacts were evaluated for the various energy technologies within the framework of complete energy systems.

Each phase was considered, namely coal or oil shale mining, cleaning and processing, transportation, electricity generation or production of gaseous and liquid fuels from coal or oil shale, distribution of the electricity or fuels, and their utilization.

The health and environmental impacts from the various technologies were evaluated on the basis of model unit plants. These chosen electrical generation, coal conversion, or oil shale retorting systems were such that they produce the same quantities of useful energy to the final consumer.

Residential space heating was used to represent the utilization of the electricity or fuels. Both design and operational characteristics of the various unit plants were used to estimate the impacts.

The information was based on data from pilot plants and from other technologies or processes expected to produce similar impacts. I will now give you the major conclusions of the report.

A shift from crude petroleum and natural gas to greater utilization of coal is presently taking palce. Production of gaseous and liquid fuels derived from coal and oil shale may be viewed as a continuation of this trend and may be projected from the National Energy Plan.

The shift is taking place largely because of economic considerations, but also due to government policies.

The shift involves a potential for adverse impacts which may be largely controlled and mitigated to acceptable levels by judicious siting and design of the projected energy facilities, and strict compliance with environmental, health, and safety standards during their operation.

The major potential adverse impacts expected from energy systems involving electricity generation from coal, and production and utilization of fuels from coal and oil shale are transportation and mining accidental deaths and injuries; deaths and respiratory sicknesses of members of the general public; property and crop damages; damages and disturbances to plants and ecosystems from combustion products and their atmospheric transformation products; social strains and reduced quality of services to residents of small communities near energy facilities; and the possibility of far-future global effects from changes in agricultural and marine productivities and flooding of coastal areas as a result of CO_2 emissions, which some specialists believe might result in a long-term warming trend.

Current standards may not provide adequate protection from all adverse impacts. I want to go into this. This is particularly true in the areas of trace contaminants and some transformation products produced during the atmospheric transport of combustion products.

I've also mentioned a few and I'm going into more detail about the uncertainties that impair the confidence in which potential impacts can be assessed and where we need some more data and information. More extensive and reliable knowledge should be developed concerning types, quantities, and characteristics of potential emissions from coal conversion and oil shale retorting plants; major sources of pollution with special emphasis given to trace contaminants; the environmental behavior of combustion products and trace contaminants including their interactions and transport; the health, environmental, and socioeconomic effects of pollutants; improved containment and controls of pollutants including the interdependence among them; and the costs and tradeoffs likely to be involved in proposed standards and regulations.

Preliminary findings suggest that the major potential health and environmental impacts associated with the energy systems of producing gaseous and liquid fuels from coal and oil shale may be significantly smaller than those associated with the generation of electricity from coal.

The main reasons for the smaller impacts are greater overall energy efficiencies of the systems, which would require smaller quantities of coal to be mined and transported; shorter distances of transportation because of the projected locations of the energy facilities relative to the mines, or because of economic factors which limit the distances of transport; and smaller emissions of combustion products because only about 10 percent of the coal or oil shale undergoes combustion, and the fuels produced are cleaned of sulfur prior to utilization.

Even though these fuel conversion technologies appear to produce smaller health and environmental impacts, they will tend to be concentrated in regions other than those typical for the electric power industry which is geographically widely distributed.

It is therefore important to note that the characteristics of the site of energy facilities may be expected to affect their potential health and environmental impacts.

The important side characteristics to be considered are the density distribution of population, background levels of environmental pollutants and reactive chemical species, existence of fragile ecosystems which may be easily damaged by pollutants and more difficult to reestablish, regional precipitation patterns including annual amounts of rainfall and its spread throughout the year, and the availability of water for irrigation.

Precipitation patterns may affect the relative susceptibility to damages of the site ecosystems, while availability of irrigation water may influence the reclamation potential of the site.

The above site characteristics may involve two major tradeoffs among potential adverse impacts from energy systems.

The tradeoffs which need to be evaluated and balanced by decision-makers prior to siting are larger potential health impacts from energy facilities but smaller deterioration in health conditions, versus smaller potential health impacts but larger deterioration.

For example, the midwestern region of the United States is characterized by higher population densities and higher background levels of pollutants than the north central region where most of the high Btu and the oil shale retorting are expected to take place.

The siting of energy facilities in the midwestern region may be expected to result in larger numbers of associated deaths and sickness than those expected from facilities located in the north central region.

At the same time, adverse health impacts in the north central region are expected to be more noticeable by the area population and to encounter greater resistance because the rate of increase of the impacts is projected to be greater. At present the region is largely free from health impacts associated with energy facilities.

Larger potential adverse ecological and socioeconomic impacts but smaller health impacts, versus smaller ecological and socioeconomic impacts but greater health impacts.

For example, the north central region is characterized by desert ecosystems which are more sensitive to pollutants. There is scarcity of water for irrigation which inhibits potential reclamation of sites.

The existing communities are small in size and have little reserves of services like schools or of infrastructure like roads or sewage systems to accommodate sudden changes in population growth.

As a result, potential adverse ecological and socioeconomic impacts associated with the new energy facilities in the north central region are expected to be more serious than those projected for similar facilities in the midwest. At the same time, the potential adverse health impacts in the north central region are expected to be smaller.

Based wholly on environmental and human health considerations, and without regard to economic and cost factors, it is my personal view that present research on the most promising conversion and retorting processes should be carried forward expeditiously.

A long-range research program of health and environmental evaluation should be effectively integrated with the evolving technologies. Particular emphasis should be placed on evaluation and mitigation of possible carcinogenic risks from trace contaminants such as trace elements, higher polynuclear aromatic and organo-metallic compounds.

During the last three days we have been hearing again and again about the poor data base, great uncertainties involved in evaluations of the im pacts, and the many needs for research. I prefer to concentrate instead on the two areas which are usually neglected, namely cost effectiveness of controls and regulations, and better use of available information.

In each case I would propose to establish a review panel to consist of members of government, industry, and the scientific community. The panels should be responsible for overview evaluations and for making recommendations to the federal energy research and development program.

In support of cost effectiveness of controls and regulations, I refer to the report on Implications of Environmental Regulations for Energy Production and Consumption by the National Academy of Sciences, 1977.

The Committee on Energy and the Environment found that except for local situations, the economic and energy costs of environmental controls are small relative to GNP, gross energy supplies, or other cost factors like taxes, subsidies, and non-environmental regulations.

However, cost effectiveness of regulations surfaced as the real issue relevant to energy/environment tradeoffs. To some extent this is similar to the comprehensive approach that we have been hearing this morning, that we should really approach health and environmental impacts.

Coal transportation accidents provide an example which is relevant to these hearings on coal conversion, and which illustrates the lack of cost effectiveness of controls and regulations in this area. Present estimates and future projections expect coal transportation to cause quadruple the deaths and injuries associated with mining.

The only other potential adverse health impact from energy systems which may be of equal significance to transportation accidents is from pollution by combustion products. Yet, the health implications of transportation seem to be ignored when it comes to health and environmental regulations.

Another example is that of the emissions of benzo (a) pyrene and some other volatile organic compounds. The major sources have been identified as residential coal furnaces, coal refuse fires, and industrial processes. They have been neglected in the past.

I don't know what the costs of providing protection against coal transportation accidents of benzo (a) pyrene emissions would be. Consideration of the potential magnitude of the impacts clearly indicates that they deserve far more attention than they have received.

In respect to better use of potential sources of information on coal conversion and oil shale retorting, I would like to refer to some of the shortcomings.

Although several large-scale coal conversion facilities have been operated abroad, and about 20 pilot plants have operated in this country, no published data exist on measured emissions, their characterizations, and occupational exposures.

With one exception, there are no follow-ups on health impacts. A review panel may uncover, evaluate, and disseminate unpublished data. It may also play a role in encouraging future publication of such health and safety data.

A great deal of information regarding potential risks and adverse impacts from coal conversion and oil shale retorting facilities may be obtained by comparisons with processes or industries with similar pollutants and risks. Yet very little has been done in this area.

A review panel devoted to this subject may go a long way to remedy the situation. Thank you.

DR. REZNEK: Thank you. Are there any questions?

QUESTIONS AND REMARKS

MR. HERHOLDT: I have a question with something you raised on page 7. You talked about illustrating coal transportation accidents. You said, "Present estimates and future projections expect coal transportation to cause quadruple the deaths and injuries associated with mining."

DR. SALMON: Right.

MR. HERHOLDT: Quadruple. You are talking about underground transportation.

DR. SALMON: No, I am talking now about transportation from the mine because coal transportation is also important. It accounts for about 17 to 20 percent of mining accidents. I am talking about the transportation of the coal from the mine site to the consumer.

MR. HERHOLDT: Okay, are you assuming that the President's goal of a billion tons by 1985 is going to lead to quadrupling?

DR. SALMON: Not in comparison to present figures, if that is what you mean. Accidental deaths and injuries are expected to grow by about 50 percent in the case of an annual increase of coal production to one billion tons by 1985.

I have looked during my study into coal mining and transportation deaths for various coal energy systems producing equal amounts of useful energy. Accidental deaths for the coal mining portions are expected to remain about the same as at present, or even to decrease, depending mainly on the assumptions concerning future mixes of surface to underground mining. It is the accidental deaths from the transportation of the coal (combined occupational and general public) that are expected to exceed those of mining deaths by a factor of 3 to 4, depending on the energy technologies and the coal mining mixes.

MR. HERHOLDT: You know that roof falls are the major accident causes in mining as opposed to coal transportation. Right?

DR. SALMON: I am talking now about transportation from the mining site to the consumer. This is what I am including in transportation here. I am saying quadruple.

MR HERHOLDT: Sir, --

DR. SALMON: Mining is any accident surface or deep mining which have caused occupational injuries and fatalities to miners.

MR. HERHOLDT: All right. I'm still a little shocked that you indicate that there is a significant thrust on all levels, state and federal, to reduce the accidents from mining or associated with mining, and to come up with the statement that regardless of these efforts that there is going to be a quadruple.

DR. SALMON: By the way, this is an estimate of MITRE which was done for the Department of Energy in looking at the National Energy Plan, and there were various other estimates that was a concern of the President's Commission on the Utilization of Coal which looked into 1985. They didn't really comment on this specific thing, but they partly looked into it.

I can give you references and literature to it, and as I said I have tried to evaluate it based on present knowledge. This is what it looks like. That was shocking to me, too.

MR. HERHOLDT: It is definitely shocking.

DR. SALMON: Right.

MS. HANMER: What is your analysis of the coal conversion technology based on western projects that are proposed for the west.

DR. SALMON: My evaluations of the health and environmental implications of coal conversion technologies are done in two ways. The main evaluation is on the basis of unit energy systems that produce equal amounts of useful energy. There is also an evaluation of national and regional impacts from anticipated levels of coal conversion.

On the basis of unit energy systems I ended up with the fact that 3,390 megawatt coal electric or low Btu gas combined cycles power plants with FGD producing 2,540 megawatts of electric power are equivalent on the basis of useful energy to a high Btu gasification plant producing 250 million cubic feet per day of gas, or to a coal liquefaction plant producing 52,000 barrels of oil per day.

The health impacts from mining and transportation depend mainly on the overall energy efficiencies of the various technologies, and also on the location of the energy conversion plants relative to the mines. Lower overall efficiencies of energy systems mean greater requirements for coal that needs to be mined, transported, and processed. Greater requirements of resources will produce proportionately greater health and environmental impacts from mining and distribution, which are very significant in the case of coal conversion and coal electricity production.

Occupational hazards are greater during coal conversion than during electricity production. I have looked at similar industries, particularly coal coking where we have similar temperatures and similar pollutants to those from coal conversion. In the case of coal liquefaction, I have also looked into petroleum refining. The estimates of occupational health impacts during coal conversion have turned out to be small relative to the mining and transportation impacts.

On the basis of present knowledge, the major health impacts to the general public (other than from coal transportation) and the major environmental impacts, result mainly from the emissions of combustion products. Because coal coversion involves significantly smaller emissions of combustion products for a unit of useful energy relative to the generation of electricity from coke, and because the liquid and gaseous fuels from coal conversion are cleaned from sulfur prior to utilization, we may expect that coal conversion technologies will produce smaller health and environmental impacts than the generation of electricity from coal.

Little information is available on effects of trace contaminants from coal conversion on the health of the general public and on the environment. Based on comparison with coking, the effects from trace contaminants are estimated to be small, relative to those from the emissions of combustion and transformation products. Also, coal conversion is expected to be responsible for only a small portion of emissions of trace contaminants relative to residential coal furnaces, industrial processing and vehicular exhausts.

DR. REZNEK: Could you compare briefly the overall efficiency of oxidation versus the synthetic fuel?

DR. SALMON: Yes. I ended up with an overall efficiency. In the case of the electrical power plant with FGD, I ended up with about 30 percent overall efficiency. It was broken down and I can give you the numbers.

In the case of the mine mouth low Btu, I ended up with about 32 percent. In the case of high Btu gasification, it was about 42.6 percent. The coal liquifaction was about 39.4 percent.

DR. REZNEK: These are the unit processing percentages.

DR. SALMON: Pardon. This is all the way through, starting from the mining and ending up with the utilization. If you want to I can bring you any one of these plans if you want to see what this energy is made up of.

Well, let's take the high Btu gas for instance. I had 97.5 percent for transportation, assumed about 2.5 percent is lost. This is partly lost and partly expended for transporting the coal. Thermal conversion efficiency is 60 percent. Transmission and oil distribution efficiency is about 97.1 percent. Here, utilization efficiency is about 75 percent. I've used residential space heating for that and that gave me the overall efficiency. I tried to explain why I've used --

MR. MERSON: Do you have oil shale in that too?

DR. SALMON: Yes.

MR. MERSON: What are your figures?

DR. SALMON: Which one would you like, the surface or the in situ?

MR. MERSON: How about both?

DR. SALMON: In the case of surface shale retorting the overall energy efficiency of 40.4 percent is made up of 99.9 percent for transportation, 65 percent for thermal conversion, 98.8 percent for oil distribution, and 63 percent for utilization in residential space heating.

In the case of in situ retorting of shale, the corresponding efficiencies are 34.2, 100, 55, 98.8 and 63 percent.

MR. MERSON: You say on page 7 that cost effectiveness of controls and regulations surface as the real issue relevant to energy/environment. Do they surface as the real issue because we don't know how cost effective they are or because there really is a doubt that the environmental regulations are in fact cost effective?

There is some strong evidence to believe that they are not cost effective.

DR. SALMON: Cost effectiveness of regulations appears to be a really important issue, and often, EPA's regulations are not cost effective. This is very understandable and the reasons for it have come up during discussions of the Committee on Energy and the Environment of the National Academy of Sciences.

The responsibility of regulating and controlling hazards is fractured among several governmental and local organizations, and it is further fractured within EPA itself. As a result, there is often lack of a comprehensive evaluation and response to hazards.

For example, in reviewing occupational deaths and injuries from coal energy systems, EPA cannot concentrate on the major source of health impacts which is transportation accidents. Too many other organizations are involved in this area. As a result, EPA is often forced to deal with less major sources of impacts because the major sources are either outside the agency or are much more difficult to deal with.

Just a short story demonstrating cost effectiveness--this is about an Air Base Commander who was asked, "How successful were you in reducing accidental fatalities among pilots?". His reply was that as long as the pilots continue to arrive at the air base in cars, his expensive program of making the airport and airplanes safer encountered only limited success. Under these circumstances, it will make good sense to shift the major effort of the air base safety program to road and automobile accident prevention, including inducements of pilots to live at the base.

MR. MERSON: Thank you.

DR. REZNEK: Any further questions?

Thank you.

DR. SALMON: Thank you.

DR. REZNEK: Our next witness is Dr. Thomas Sladek from the School of Mines.

STATEMENT OF DR. THOMAS SLADEK
SENIOR PROJECT ENGINEER, ENERGY DIVISION
COLORADO SCHOOL OF MINES RESEARCH INSTITUTE

DR. SLADEK: Thank you, Dr. Reznek. I am going to keep my remarks very brief this afternoon. Perhaps it will help you get back on schedule. It may help me catch the airplane that is waiting for me at Dulles Airport.

Actually, a lot of what I intended to say has already been covered by Jack Rigg, so rather than go over that ground again, I'll highlight something that I think was touched on in his talk that I think deserves some emphasis.

I talked yesterday for Dr. Reznek and of course some other panelists about the concept of development of fuels from agricultural commodities by fermentation -- the production of fuel to ethanol -- and my talk today is on oil shale technology, which is quite a different subject, and there is a very interesting contrast between these two potential sources of transportation energy.

They are both very old technologies. People have been fermenting crops to ethanol for at least 8,000 years and people have been trying to recover oil from shale since the mid-fourteenth century.

The contrast comes in when you consider that the technology for producing fuels from agricultural commodities is commercially available. You can buy a fermentation plant off the shelf and have it on stream in about a year and a half to three years, depending upon where it is going and how large you want it to be.

In contrast, oil shale technology is not highly developed; it is not ready for a commercial industry and the main point of my talk, I think, is that some additional demonstration work does need to be carried out in a specific area of oil shale development.

All oil shale processing technology now being considered for near term commercialization involves recovering the hydrocarbons from the oil shale by applying heat. There are other processing possibilities but these are not nearly as advanced. I think DOE is taking some looks at these things and some of them are simply alternative ways of getting heat into oil shale.

There are several ways of heating oil shale to recover the oil. Heating may be done aboveground in processing units called retorts. This is the most traditional approach to recovery oil from shale.

Several very modern retorts have been developed in the last 20 or 30 years and the leading candidates at this point in time are the Bureau of Mines' gas combustion retort and its successor, the Paraho retort; several retorts developed by Union Oil Company including the type A which is similar to the gas combustion retort and the types B and SGR. The Tosco - II is a retort which has probably received more attention than any of the others in terms of field demonstrations.

Some limited amount of testing has been done with a retort somewhat similar to the Tosco - II which is called a Lurgi-Ruhrgas.

The above ground retorts have the advantages of obtaining high yields of oil from the oil shale. They have many disadvantages in that they require massive mining operations, large surface facilities, a large labor force, and voluminous quantities of water for processing the oil shale, for upgrading the shale oil and for disposing of the spent shale generated in the retort.

The principle problem as far as I can tell is the disposal of the spent shale. The retorts will create about 2 tons of burned rock for each barrel of oil which is recovered from the raw material. The problems inherent from aboveground retorting generated an interest in an alternative concept called in situ retorting.

This interest began in the mid '60's and has continued to date. This concept is similar to the aboveground processing except the oil shale is not mined; it is broken underground and is retorted in situ or in place by applying heat to the rubbled portion of the formation.

The advantages of in situ retorting are that minimal mining is required, that few surface facilities are needed, that the labor needs are lower, and the water requirements are lower, and primarily that there is no spent shale disposal problem because the spent shale stays underground where it was in the first place.

The disadvantages of the pure in situ technique are the difficulty in obtaining a reasonably fractured body of shale so that the heat can be brought into contact with the shale material. It is also very difficult to control the retorting process once it begins and the recovery of oil from the shale under ground is very small, certainly much smaller than what one gets from an aboveground retort.

A compromise position is being developed. It is called modified or mine-assisted retorting. This process involves mining of perhaps 10 to 30 percent of the material in the underground volume that is destined to become a retort. The remaining shale in the retort area is fractured by explosives and the rubbled mass is ignited and retorted for recovery of oil and gas.

This concept is not particularly new either. It was tried by the Germans during World War II and in the United States has been developed by Garrett Research and its successor company, Occidental Petroleum.

Modified in situ processing is now a major budget item in the Department of Energy. It is being developed in laboratory and field tests in Wyoming by the Laramie Energy Research Center and commercially in Colorado by Occidental Petroleum on tract CB and by Rio-Blanco on tract CA.

Modified in situ has many apparent advantages but it also has many disadvantages that are often overlooked. A key issue, and really the subject of my presentation, is what happens to the oil shale that is mined to provide the void volume that is needed to get the retort going.

The quantity of mined material can be anywhere from 10 percent of the retort volume, which is a very optimistic and very low figure, up to 20 percent, which might represent the actual void volume in the retorted area, and considerably higher if you consider the oil shale that has to be removed to provide passageways for the mining operation and for creation of underground facilities.

The shale is a very valuable resource. It should not be wasted by simply dumping it on the surface. Although it is much more environmentally stable than spent shale there are still some good opportunities for environmental degradation if you just dump this stuff out on the ground.

A portion of the shale could be returned to the mined out area, but I think that would be kind of foolish because if you have already mined it and hauled it and broken it and taken it to the surface, you would be silly to put it back underground without at least recovering some of the oil.

In all likelihood the shale removed from the mine and from the retort volume will probably be retorted aboveground in retorts similar to those mentioned earlier.

There has been the stated position of the Department of Energy that aboveground retorting is adequately developed and is ready for commercial operation. I think a lot of this opinion goes back to the days in which the Bureau of Mines was developing gas combustion retort.

Their work was completed in the late 1960's. They developed the retort to the point where it could process perhaps 300 tons of shale per day. The government then said that the technology was ready and all we had to do was to make larger units.

I cannot agree that aboveground retorting is ready to go into a full sized commercial oil shale industry. The Lurgi retort has been tested with oil shale at a rate of just a few tons of shale per day. The gas combustion, Paraho, and Union B retorts have been tested at a few hundred tons per day, and the Union Oil A and the Tosco - II retorts have been tested at up to 1,000 tons per day.

In contrast, commercial retorts -- these are single modules -- will have capacities of from 8,000 to 12,000 tons per day. This commercial size is one to four orders of magnitude larger than the largest units tested to date.

I doubt that the engineering, economic, and environmental data which were obtained from the small pilot scale field tests of the retorts are adequate for an assessment of industry which uses much larger processing units.

I would suggest that the government needs to encourage additional development and demonstration of aboveground retorting processes. I would like to see this type of effort emphasized in the DOE program. How this would be done, I don't know. I would think that a logical approach would involve a cost-shared development and demonstration program which could be conducted perhaps at one of the existing lease tract sites or at one of the many points in Colorado.

It should feature single, full-sized modules of the more highly developed retorts. I would hate to see just one of them demonstrated at this site. I think there are some advantages to considering a single mine which would supply shale to a variety of oil shale retorts, and then perhaps a single common refinery which would process the oil produced by those units.

I think that this is the only way that an oil shale industry and the impacts of that industry can be evaluated without promulgating permanent adverse effects on the environment of the Rocky Mountain states.

I think there is too much risk associated with going out and constructing a full going industry before 1985. I think that along with the development and testing of the modified in situ concept, we should also be testing the aboveground retort. Hopefully, if the oil shale industry, at that point when the demonstration programs have been completed, does appear to have some promise, then these two processing technologies can be brought together and produce a high degree of resource recovery with a minimum impact on the environment.

That is all I have to say. I'd be happy to answer any questions.

DR. REZNEK: Thank you.

QUESTIONS AND REMARKS

DR. REZNEK: The cost of even those demos is not going to be insignificant.

DR. SLADEK: No.

DR. REZNEK: If it proves environmentally unacceptable, who takes the loss?

DR. SLADEK: Well, I think that is the function of the cost-sharing program. It means we're sharing the risk between the private developers who have a great deal to gain if the oil shale industry does get off the ground and the government which has a great deal to gain in terms of being able to evaluate an industry before it is installed.

DR. REZNEK: Are there ground water supplies of potable quality above or below any of the oil shale levels?

DR. SLADEK: There are potable aquifers within the oil shale regions, but they are not extensive as far as I know. One of the problems associated with the in situ retorting is the possibility of contaminating these potable aquifers with unpotable aquifers which exist in surrounding strata.

Once you have created a retort which extends from a potable aquifer to an unpotable one you have essentially created one aquifer at two levels. The water quality is bound to suffer in the good one.

MR. HERHOLDT: One of the problems associated with in situ coal gasification is how to terminate the reaction.

DR. SLADEK: Yes.

MR. HERHOLDT: So the heat is transferred to the surface.

DR. SLADEK: Yes.

MR. HERHOLDT: Okay. What kind of problems like this are associated with the in situ retorting of oil shale?

DR SLADEK: The problem of mine fires, which are so common in the east. I guess there are several hundred of these things burning in the Appalachian coal regions at any time. It is something, I think, that deserves some attention.

I would expect it to be much less of a problem in oil shale development because of oil shale being much less combustible than coal. It oxidizes extremely slowly in the presence of air, whereas coal oxidizes very rapidly.

I don't see that as being a major problem, because oil shale is a quite impermeable material. It is not widely fractured, and air does not readily penetrate the formation. It would probably be difficult to maintain sufficient oxygen flow to keep that underground retort fire going after the artificial oxygen had been cut off.

MR. HERHOLDT: Is any of this heat transferred to the surface?

DR. SLADEK: There certainly would be. I'm sure there would be localized heating, particularly over a large in situ retort. It would depend on how deeply the retort was buried.

The oil shale interval in the Piceance Basin in Colorado runs up to 3,000 feet, so obviously if you set this whole thing on fire there would definitely be some surface heating. If your retort was several hundred feet underground, I wouldn't expect that the temperature rise at the surface would be all that substantial.

MR. MERSON: I guess my question goes back to your feeling that we really need further Federal participation in an aboveground retort demonstration project here. I guess I am concerned about the degree of Federal involvement in the oil shale industry.

We have the prototype pollution program now. You have CA and CB essentially coming in with an attempt to prove some new technologies; admittedly, both those could decide to go with modified in situ processes.

We have four other tracts that are available for lease. I don't know whether any of them have been leased -- the ones in Utah and Wyoming -- at this point. You have Union apparently saying that it's ready to go if the $3.00 tax credit is approved by the Congress and the Administration.

They feel that they are willing to take that risk in terms of demonstrating an aboveground retort process. I assume that Colony might well do the same if the economics are similar for them.

I am just wondering at this point why you think it is necessary to have some further subsidy for an aboveground process.

DR. SLADEK: I'm not sure of the actual magnitude of the Federal participation that would be required. I have heard the statement made several times that the aboveground retorting processes are ready for commercialization, and as an engineer with some experience in process development, I get a little nervous when we talk about order of magnitude scale-ups from essentially small pilot plant scale-ups to full commercial size.

It is not good engineering practice and, in an environmentally sensitive industry like oil shale development, I think it can be disastrous to do so.

Your question about the oil companies or the retort developers being ready to go with this -- with the next step -- I think is very encouraging. I don't know that the DOE needs to provide them with any additional financial incentives to get that going.

It might be only a matter of cooperating with them on seeing that the R&D that has to go on to support these programs are integrated into the DOE effort. Alternatively, perhaps leasing a specific area in the basins for a retort demonstration site is something that could be contemplated that wouldn't involve direct capital outlay from the government, but might accomplish the same objective.

MR. MERSON: Thank you.

DR. REZNEK: Are there any further questions?

DR. REZNEK: Thank you.

DR. SLADEK: Thank you.

DR. REZNEK: Our next witness is Dr. David Stricos who is the Principal Utility Research Analyst for the New York State Public Service Commission.

STATEMENT OF DR. DAVID STRICOS
PRINCIPAL UTILITY RESEARCH ANALYST
NEW YORK STATE PUBLIC SERVICE COMMISSION

DR. STRICOS: Thank you, Mr. Chairman. Good afternoon and good afternoon members of the panel. My name is David Stricos and I am with the Office of Research of the New York State Public Service Commission.

My duties with that agency include the monitoring of R&D that is supported or conducted by the State's electric utility companies. The R&D spending plans of those companies indicate that a growing fraction of our utility R&D budgets will be devoted to the development of advanced coal conversion technologies, with particular interest having been shown in the demonstration of one or more coal liquefaction processes.

In view of the contemplated increasing participation of New York State utilities in these research efforts, I have looked at some of the pros and cons of these utility research investments.

I am pleased to share my findings with you, through this hearing process, with the understanding that the views expressed are my own and do not necessarily reflect the policies of the New York State Public Service Commission. I'll get that plug in there.

New York State, as you probably know, is heavily dependent on imported oil to meet its energy needs. In 1977, about 60 percent of New York's electric generating capacity, and about 44 percent of its electric energy requirements, was provided by oil-fired generating stations.

We are striving to reduce this dependence on oil in a number of ways, one of which is the promotion of research on promising coal conversion technologies. It is important to note in this regard that, while each of our electric utility companies contributes to national research programs such as that of the Electric Power Research Institute, each company has the responsibility also to define and develop its own research program.

Thus, an individual utility's decision to support a particular research effort will, as it should, depend upon that company's perception of its own research needs.

It is helpful then to look at a real case situation; and, for this purpose, I will look at coal liquefaction research as it might be applicable to New York City and the Consolidated Edison Company.

To do so, it is necessary to touch on (1) Con Edison's system planning needs, (2) new technology developments and (3) the economics of power supply for the Con Edison system.

SYSTEM PLANNING CONSIDERATION

Con Edison's existing generating capacity of about 10,000 MW consists of 6900 MW of oil-fired steam electric capacity, 2,200 MW of combustion turbine capacity and 870 MW of capacity from its Indian Point-2 nuclear plant.

These figures show that the company depends on oil for more than 90 percent of its generating capacity. Each year, in fact, the company requires about 35 million barrels of residual oil, 40 percent of utility use statewide to fuel its steam electric plants and 1.3 million barrels of distillate oil, 60 percent of utility use statewide, for its combustion turbine facilities.

Most of this oil is imported and, at an average cost of $2.40/mm Btu, represents an annual investment by the company of about $525 million.

The company's long range plans indicate a continuing dependence on imported oil. The retirement of some of the larger oil fired stations begins in the late 1990's, but by the year 2000 there would still be 3800 MW of oil fired capacity.

The company's current gas turbine units undoubtedly will have been retired by 2000, but these units may be replaced before that time, perhaps by units designed to burn fuels other than distillate oils.

In-City generation currently amounts to 7800 MW or 78 percent of Con Edison's total capacity. The company's generation expansion plans, however, point to a greater reliance on new out-of-City facilities -- the PASNY Greene County plant, Hydro Quebec, Prattsville and Cornwall pumped storage facilities and another future nuclear unit.

The company's plans clearly call for a shift from predominately in-City to predominately out-of-City generation over the next fifteen to twenty years.

Opportunities to maintain or expand current levels of in-City generation or to burn fuels other than oil appear to pose severe environmental problems. The company has an agreement with the City not to build new generating facilities within the City; but more to the point, space limitations and environmental constraints make such a prospect unlikely.

The 1977 Amendments to the Clean Air Act, for example, call for the "best available control technology" in reducing power plant emissions. The EPA has proposed, consistent with those amendments, that sulfur oxide emissions must be reduced by an amount equivalent to 90 percent removal of the sulfur from coal.

City and State imposed limits for new plants would require scrubbers and would limit emission to 0.2 lbs/mm Btu or the equivalent of 0.25 percent sulfur coal. The company, in compliance with these coal burning requirements, must of course have an acceptable plan for disposing of wastes such as fly ash and sulfur bearing materials and must have available sufficient space for its stack gas clean up systems as well as for its coal handling and storage facilities.

These kinds of considerations all but preclude the direct burning of large quantities of coal in utility boilers within much of the City and lead inevitably to the company's current long range system plan calling for continued reliance on oil and a growing reliance on upstate generating facilities.

Such a long range system plan may be the company's only available response, given the constraints under which it must operate, but it is a plan that runs counter to what would appear to be reasonable objectives for the company -- more in-City generation and lesser dependence on imported oil.

The planned increased reliance on upstate generating facilities is going to place new strains on the company's transmission system and raises new concerns about the cost and reliability of New York City's electric supply.

It is hardly necessary to add that continued reliance on imported oil puts the company and the City in a vulnerable position with regard to possible interruptions of fuel supply or rapid cost increases such as occurred in 1973.

The dilemma clearly calls for an examination of other options that might become available to the company such as those that might be presented through the development of new technologies.

NEW TECHNOLOGY DEVELOPMENT

To address the question of reliable electrical supply in the face of declining in-City generation, the company has entered into R&D projects to provide new in-City generation capacity, to provide for greater transmission capacity and to reduce peak load demands.

The company's most notable R&D effort on in-City generation is the fuel cell. A 4.8 MW fuel cell is to be installed on the Con Edison system, 15th Street, by this fall. The company plans to participate also in the demonstration of commercial sized, 26 MW, fuel cell plants to be built in the early 1980's.

However, even an optimistic schedule would result in only 260 MW of fuel cell capacity in the City by 1990-1995. Another company R&D effort directed towards in-City generation is the use of refuse as a fuel.

Refuse utilization projects must be pursued, but they are difficult to implement and probably of limited impact. The company is also pursuing a gas turbine exhaust heat reingestion study that might add several hundred megawatts of in-City capacity by increasing the output of existing barge mounted gas turbines.

The company's transmission R&D effort was also developed in response to precisely the questions raised here. Because of the retirement of existing plants and the inability to site new capacity within the City, the company indicates that transmission requirements might increase by about 12 percent per year over the next several years.

Bulk power transmission over a high voltage DC system offers the prospect of satisfying this need reliably and in an environmentally acceptable way. The company is, therefore, engaged in a major R&D effort aimed at developing a DC link which is essential for bringing the DC power into the City.

The company's need for new generation or transmission capacity is, of course, related to the company's peak loads. A growing portion of the Company's R&D dollar is therefore going into load management efforts intended to reverse the trend of recent years that saw increasing peak loads and deteriorating load factors.

Most of the incentive for customers to manage loads is expected to be provided through rate design, and the development and field testing of time-of-use, interruptible and demand rates will be supported, in part, through the R&D program.

Research is being directed also towards the development and testing of related "hardware" items such as load limiting devices, energy storage systems and remote metering and control devices.

Coal gasification and liquefaction research has, in the past, been a relatively small component of the company's research program, but the company is considering much larger investments in the future, especially for the demonstration of a coal liquefaction process.

The company's incentive for such research, to help provide an additional future alternative to the burning of imported oil, obviously coincides with national objectives of reducing our vulnerability to foreign suppliers of a critical commodity and of making fuller use of a more abundant domestic energy resource.

If a commercial coal conversion industry is established, these objectives will have been realized. The company, thereby, will have helped develop a more reliable fuel source (I look upon coal derived domestic fuel as more reliable a supply than imported oil -- in spite of the rather serious disruptions being experienced by the domestic coal industry) and will have helped provide an environmentally acceptable approach to the expansion of in-City generation.

I would now look briefly at specific coal liquefaction technologies that are being considered for relatively near term scale up; the H-Coal process, the Exxon Donor Solvent process and Solvent Refined Coal.

The H-Coal process is expected to produce a fuel containing about 0.3 percent sulfur, the maximum allowable for oil fired facilities in New York City, at a cost of about $4.00 to $5.00/mm Btu in 1977 dollars as compared to current coal costs of about $1.40/mm Btu and current oil costs of $2.40/mm Btu.

Commercialization of the process is not expected before the late 1980's, probably in the early 1990's. If successfully pursued, utility fuel produced by a number of commercial plants serving Con Edison might have a significant impact on the City's electric supply by the year 2000.

The projected fuel cost and commercialization dates for the Exxon Donor Solvent process are about the same as for the H-Coal process.

Solvent Refined Coal produced at the Tacoma, Washington facility originally contained about 0.9 percent sulfur. Recently, however, the refining process was modified so as to produce a liquid fuel, SRC-II, containing about 0.3 percent sulfur and potentially suitable for use as a utility fuel in New York City.

Once again, the fuel is projected to cost $4.00 to $5.00/mm Btu. Con Edison, as part of its R&D program, is considering the test burning of the liquid fuel. If this can be done, Con Edison will have gained useful first-hand experience with this coal derived oil substitute.

Coal gasification offers yet another coal derived fuel that might be competitive with liquefied products and could become available in about the same time frame. There are a large number of "first generation" gasification technologies that have operated on a small scale for many years, but only a few, such as the Winkler, and Koppers-Totzek and the Lurgi processes are considered reasonable candidates for large scale operation.

The pressing need to obtain clean fuels from coal, and perceived deficiences in the older processes, has spawned a flurry of activity on "second generation" gasification technologies including the Hygas, Synthane, Carbon Dioxide Acceptor Bi-gas and Molten Solt processes.

The Lurgi process is still the front running candidate for scale up of a coal gasification facility, and the product cost is again expected to be in the range of $4.00 to $5.00/mm Btu.

The electric utility companies have a stake in the development of these coal gasification technologies, and the industry should and will continue to support coal gasification R&D.

I believe, however, that the electric companies' principal interest is in the development of low Btu gasifiers to be coupled with high efficiency combined cycle units and in the production of a hydrogen rich gasification product for eventual use with fuel cells.

Much of the research support for coal gasification is being mobilized by the gas industry. This is to be expected since the prime use of the product is likely to be the augmentation of pipeline gas supplies to meet such needs as home heating and the fueling of critical industries.

I should point out also that the potential market for coal liquefaction products is similarly diverse. While the electric utility industry sees these products as possible alternatives to imported oil, the petrochemical industry may see them as potentially valuable feedstocks for the preparation of a wide variety of organic materials from gasoline to nylon.

The petrochemical industry might, therefore, be expected to pick up a share of coal liquefaction R&D costs and to compete with electric utilities for the liquefaction products.

ECONOMICS OF POWER SUPPLY FOR THE CON EDISON SYSTEM

An evaluation of potential coal gasification or liquefaction technologies must consider the cost of the fuel produced relative to the cost of alternative fuels.

We are told that clean gaseous or liquid fuels derived from coal will have similar costs in a range from $4.00 to $5.00/mm Btu in 1977 dollars, a range that equates to oil costing $24.00 to $30.00 a barrel. Projections of this type have a habit of being optimistic, but they are at least a starting point.

In looking at Con Edison's needs, these costs are to be compared with the cost of oil to the company. During 1977, the company paid an average of about $2.40/mm Btu or about $14.50 a barrel.

Given today's prices, therefore, synthetic fuels, if they were available at the estimated prices, would cost the company twice what they are now paying for oil.

It is interesting to note, in conjecturing on future oil prices, that the prices paid by utilities for residual oil have changed very little since 1974. Considering that the posted price of Arabian light crude increased 17 percent from January, 1974, to December, 1977, while the Wholesale Price Index for Industrial Commodities increased 43 percent, we might well expect substantial price increases in the near future.

The New York utilities have projected an average annual increase of 7.6 percent in the price of residual oil between now and 1985. Our staff expects the larger increases to occur between 1982 and 1985 but believes the average increase projected by the utilities is reasonable.

If we assume a regular 7.6 percent annual increase in the price of oil from today's $14.50 a barrel and a regular 5 percent (i.e. tracking inflation) increase in the price of coal derived fuels from today's hypothetical $25.00 a barrel, oil would be priced at $24 a barrel in 1985 while coal derived fuels would be priced at $35 a barrel.

By 1990, the figures would be $35 and $45 a barrel respectively and, by the year 2000, both oil and the coal derived fuels would cost $73 a barrel.

We need not take these numbers seriously, but the exercise suggests that, over time, with oil price increases modestly outstripping those for synthetic oil, we could find oil and its synthetic alternatives approximately competitive by the year 2000.

Another factor to be considered is the magnitude of the company's energy sales over the next ten to twenty years. Con Edison's total electric sales amounted to 32,630 GWH in 1976; with the loss of about 5,500 GWH of government sales to the Power Authority of the State of New York, the company's sales were around 28,500 GWH in 1977.

The company forecasts a sales decline to 27,650 GWH in 1980 and then sales increases to about 35,000 GWH in 1990 and 40,000 in 1995. Without faulting those forecasts, it is perhaps helpful to note that an extension of short term energy sale trends (1974-1977) among the various service classifications leads to energy sales forecasts of 31,000 GWH in 1990 and 32,500 in 1995.

Imposing the further constraint of constant per capita electric energy usage leads to projected energy sales of about 25,000 GWH throughout this forecast period.

The important point is that Con Edison forcasts its energy sales to grow from 28,500 GWH in 1977 to about 40,000 GWH by 1995, a modest average annual increase of about 1.5 percent and that there is considerable uncertainty associated with that forecast.

The company, in accordance with its energy sales forecasts, has not put forth a particularly aggressive generation expansion plan; and, at least over the next ten years, will lean more heavily on purchased power to meet increased energy requirements.

It is well to note that the company must devote much of its attention, during this period of essentially stable energy sales, to the important relatively near term objectives of reducing its peak loads, improving the system load factor, maintaining a dated underground distribution system and upgrading a heavily strained transmission system.

These efforts will continue to compete for the corporate dollar in general and the R&D dollar in particular.

Finally, we might consider a possible future situation where Con Edison must choose between (1) continuing the operation of in-City generating facilities using only solvent refined coal as a fuel and (2) constructing new out-of-City coal fired facilities.

The economic choice in 1985 (assuming the liquefaction technology had been demonstrated) could look something like the following:

Electric Energy Costs - 1985

	New Out-of-City Coal Facility (Mills/kWh)	Continued In-City Generation Using Liquefied Coal (Mills/kWh)
Capital Costs	29	-
O&M	8	5
Fuel	23	59
	60	64

These figures (my own guesses) indicate that the company, in 1985, would find it more economical to rely on a new out-of-City coal-fired facility than to burn liquefied coal in existing in-City plants -- even if there were no capital costs involved in modifying or modernizing the existing facility.

If we now escalate coal costs at 7.6 percent per year and all other costs, including liquefied coal, at 5 percent per year, we would have the following cost picture in the year 2000:

Electric Energy Costs - 2000

	New Out-of-City Coal Facility (Mills/kWh)	Continued In-City Generation Using Liquefied Coal (Mills/kWh)
Capital Costs	60	-
O&M	17	10
Fuel	69	123
	146	133

These figures suggest that, by the year 2000, the use of liquefied coal for continued in-City generation would be the economic choice, but only if the capital costs required to upgrade the in-City facility are less than about 20 percent of the capital cost of a new facility.

In-City generation might have a larger edge if much higher transmission costs, perhaps for a DC system, were associated with a new increment of out-of-City generation. The important conclusion, however, is that, given presumably reasonable fuel cost trends, a coal liquefaction technology, if successfully pursued, could eventually provide Con Edison with an economic option to out-of-City generation.

These overviews show us that Con Edison relies on imported oil to fuel 90 percent of its capacity and that three-fourths of that capacity is located within the city.

The company, as evidenced by its long range plans, is headed towards a continued heavy reliance on oil and on an increasing dependence on out-of-City generation. Conventional technologies offer little or no hope of diminishing the company's dependence on oil, nor do they offer a reasonable prospect for locating very much new capacity in the City.

New technologies, including the fuel cell and coal conversion technologies, can only begin to alter these trends in the 1990's and will have no major impact on the Con Edison system much before the year 2000.

Among the coal converison technologies, coal liquefaction appears to be at least as promising as coal gasification, and is a logical choice for electric utility support. Among the coal liquefaction processes being developed, the H-Coal, Exxon Donor Solvent and Solvent Refined Coal processes are at roughly comparable stages of development.

At this point, there are compelling reasons for the company to support each of these advanced technologies.

Con Edison's interest in coal liquefaction is based not on expected sales growth but on the need to provide for itself possible options to the continued dependence on oil and to the growing reliance on out-of-City generation.

The purpose of the coal liquefaction research now under consideration is to demonstrate the technology at commercial scale by the 1990's. If the economics are then favorable, that is if the cost of liquefied coal is about equal to that of imported oil, a coal liquefaction industry would be expected to develop, and Con Edison would be expected to avail itself of the product.

If, on the other hand, liquefied coal continues to cost more than imported oil, there would appear to be no way short of a federal subsidy, or some novel cost sharing plan, by which a coal liquefaction industry could ever develop.

Since we cannot now reliably predict that oil and liquefied coal will be competitive, we cannot now be certain that Con Edison will benefit substantially from the successful demonstration of a coal liquefaction technology.

The corollar , of course, is that if the technology is not pursued, we would lose a option that might have proven extremely valuable.

Another item that must be considered is the final use to which the end products of coal conversion will be put. It is conceivable that the oil or gas produced from coal might find higher market priorities than the boiling of water to produce electricity.

A critical need for gas as a home heating fuel or the ability of the petrochemical industry to make use of higher cost feedstocks in a particular process might induce the federal government to redirect commercial utilization of the products -- after the electric utility companies have financed much of the research.

The ultimate fate of coal conversion processes, particularly as they relate to Con Edison, could be affected also be developments in other unrelated technologies. The development of floating nuclear power plants, the exploitation of offshore oil and gas reserves, changes in environmental requirements or improvements in pollution abatement equipment could eliminate or at least diminish the need for a coal conversion technology. Again, however, developments in these areas can not be assured.

It seems to me that the key word in this or any other assessment of coal liquefaction R&D has to be "uncertainty". We cannot be certain that a given liquefaction process will operate successfully at full scale, and there is considerable uncertainty associated with any of today's predictions of product cost or date of commercial availability.

The same uncertainties, of course, apply to potential alternative technologies to coal liquefaction. There is much uncertainty in our longer range forecasts of energy sales, oil costs and the like, and we can only feebly predict future environmental requirements.

One lesson here, I think, is that we ought to continue our efforts to obtain the best possible long range forecasts, in spite of the difficulties involved, because those forecasts have an important influence on decisions that must be made now.

Overall, I conclude that coal liquefaction R&D is a sound area for future research by New York State's utilities, and I endorse their ongoing preliminary efforts to identify processes suitable for support during the demonstration phase.

Coal liquefaction may never be commercially implemented since the cost of imported oil is and may well continue to be too low to make coal liquefaction commercially viable.

However, the successful demonstration of a coal liquefaction process would provide the nation and our electric utility companies with what might prove to be a most important and valuable option for the future.

That concludes my presentation.

DR. REZNEK: Thank you.

QUESTIONS AND REMARKS

DR. REZNEK: We heard testimony yesterday that New York, with the highest priced electricity in the country, is the area where it pays to do solar heating right now. Also, if there is an archetypical city where there is an in-town power plant and a source of trash, it's New York. Is Con Ed investing in either solar heating or the use of municipal waste?

DR. STRICOS: Yes, they are in both, but aren't very active. We have about 350 different research projects supplied by our companies and Con Edison does have a rather vigorous R&D program that amounts to about $20 million annually.

They have begun a number of efforts in the use of solid waste, but of course New York City does have about 20,000 tons of solid waste per day. I personally have become a little disenchanted with it because of the frustration I have felt.

I worked with the company and with others in trying to plan for a sizable use of refuse within the city. It is a frustrating problem, very difficult to implement because of all the different parties that must be brought together to make it happen -- from the environmental requirements within the city, from the city planners themselves, the citizens who don't want garbage trucks running down the streets -- so I think it is difficult and frustrating to try to make it happen.

Also, as I look at it I see it as limited in scope to this extent. Just the numbers themselves when you take all the waste and convert it all to energy, you end up with something in the neighborhood of 5 to 10 percent of the city's needs.

I don't scoff at that and I do think it is important, but it is limited to that extent; whereas, these other technologies of liquefaction at least have the potential for meeting a significant part of their needs. But solar -- I won't go into too deeply -- you must have heard of the abortive Wind System of New York City. It was just a fiasco from the word go. It was not a good system and there were all sorts of problems with it, but the company has begun some serious work in installing solar heaters -- solar hot water heaters. There are a number of installations around the city. They are active.

Statewide, I think as far as our Commission is concerned, we find our particular role, an important role for us, only partly to promote the technology, but rather to see that if and when solar energy technologies grow in disperse fashion, that they grow in a manner that is compatible with the existing system and that the existing system promotes responsible growth for the solar facilities.

We are trying to encourage individual use of solar in residences through the election of rates which tend to encourage the individual customers to provide their own -- supplement their own needs and also to the point of allowing the customers to sell either the solar or wind energy back to the utility company.

There is one point I may mention briefly of the solar is that we have simultaneously put in place these rate tariffs, we try to promote the storage systems in conjunction with the solar facilities for all the obvious reasons regarding the utility's peak loads and trying to avoid future problems when large numbers of solar installations come on line and draw power only at the peak period so we try to foresee that problem.

DR. REZNEK: Are there further questions?

MR. HERHOLDT: Yes, I would like to ask this. Is the involvement of the New York State Public Utility Commission -- did that come about through New York State's investment in Con Ed? This is kind of off the subject, granted.

DR. STRICOS: No, not at all. Con Ed did recently sell two of its largest plants -- Indian Point-3 and Astoria-6 -- to the Power Authority of the State of New York so that they are now state-owned facilities rather than being owned by Con Edison.

MR. HERHOLDT: Right.

DR. STRICOS: The Public Service Commission has for a long time been the official state body which regulates the electric utility companies in the state and this has continued in spite of that sale of those plants to the state. The plants that were sold to the state are no longer under our jurisdiction because that is a state authority and we don't set rates for the state authorities.

Our involvement with Con Ed, of course as a regulatory body we are involved, but in the case of R&D beginning back in the early 70's we did very aggressively get the companies involved in R&D setting targets of about 1 percent of revenues for R&D by the companies in ecouraging their participation in Federal programs and the state programs and insisting that they each establish in the house their own R&D capabilities. It is part of our job to monitor the several R&D efforts of the company.

DR. REZNEK: Do the utilities also obtain Federal R&D money?

DR. STRICOS: There are some federal funds. Whether this goes to utilities -- I guess you could say that it goes to utilities. I can give you one predominant example of our cooperation with the EPA. We are in the midst of a flue gas desulfurization demonstration project, the scrubber process, and supported by the EPA. It was an EPA proposal and there are substantial funds coming into the state in support of that demonstration project.

DR. REZNEK: I am only too aware of our project. Any other questions? Thank you very much.

DR. STRICOS: Thank you.

DR. REZNEK: Our next witness is Mr. Jackson Browning. He is the Corporate Director of Health, Safety and Environmental Affairs, Union Carbide Corporation.

STATEMENT OF MR. JACKSON BROWNING, CORPORATE DIRECTOR HEALTH, SAFETY AND ENVIRONMENTAL AFFAIRS, UNION CARBIDE CORPORATION

MR. BROWNING: Good afternoon, I was not aware until I arrived here the extent of the involvement of Union Carbide in the proceedings. As I have not checked my points of view with others who have appeared before you, I'm not sure that they are even consistent, but I hope the discussion will be helpful.

I am Jackson B. Browning, Corporate Director of Health, Safety and Environment, Union Carbide Corporation. I welcome the opportunity to participate in today's dialogue and commend you for undertaking an overview of the role of government and its interface with those interested in environmental protection and the development of non-nuclear technologies.

First I would like to comment on the role of government in these matters, what it presently is and what it should be in the matter of environmental and energy research. The Federal government today seems to be addressing both energy and environment on the kind of either-or-basis that promotes conflicts, instead of solutions.

We haven't solved our differences or even established the processes needed to do so. We have institutionalized them by setting up separate jurisdictions to handle each of what in the real world are interrelated problems.

Not unnaturally, each of these institutions tries to bolster its position -- to get the edge for either environment or energy -- by cultivating constituencies, Administration, Congress or electorate, to support its position.

We seem, therefore, to have established mechanisms in government that create and perpetuate environmental and energy differences, but no real mechanism for resolving them.

As a result, we often see conflict instead of progress and gain of one goal at the expense of another. Under these circumstances, conflicts between the Department of Energy (DOE) and the Environmental Protection Agency (EPA) seem inevitable as each tries in good conscience to carry out separate mandates.

Although energy and environmental goals are strongly interrelated, the government mechanisms we have set up to achieve them are not.

For example, conversion to our major non-nuclear energy resource, coal, an essential energy goal, could be delayed or stopped in its tracks by current Clean Air Act considerations.

I'm sure that both EPA and DOE agree that coal conversion is an essential ingredient in a national energy plan and that the new no-significant-deterioration and best-available-control-technology legislation can, under current interpretations, determine how far and how fast we can move to convert to coal.

But the agreement stops there. We have environmental specialists pushing for the environmental goals; energy specialists pushing for energy goals; and no apparent mechanism for taking the broader view that might productively resolve these differences.

Obviously, the fault, if there is one, lies not with EPA or DOE but with a legislative approach that departmentalizes and thus isolates the achievement of twin goals of energy and environment. If Congress passes energy legislation that doesn't give full consideration to environmental impact or environmental legislation that doesn't fully consider energy impact, progress in one area will inevitably come at the expense of the other.

The result will be continued conflicts of the kind that stifle needed progress.

With a problem-solving mechanism in place, much of this conflict can be resolved and the nation can get on with its business of producing and developing needed energy supplies and a clean environment, too.

We believe that a National Overview Commission on Energy and Environment could be a useful starting point for establishment of such a mechanism. To get away from present institutionalized differences and to take a balanced view of the twin problems, it would seem most productive to have that commission composed of outstanding people who have neither environmental nor energy axes to grind.

The recent National Coal Policy Project (NCPP) is evidence that we can productively resolve energy and environmental conflicts, instead of perpetuating them.

As a first step in breaking down the adversary relationship between those pursuing separate goals of energy and environment, it suggests an approach that legislators and regulators might well consider. It's an approach that allows us to work toward solving problems -- not enshrining differences.

The second issue I would like to address is the need for government to foster development and use of new energy and pollution-control technologies. At Union Carbide, we support development of all alternatives to the use of oil and gas, whether "hard" technologies, such as coal and nuclear, or "soft" ones, such as wind and solar.

But we believe that the common thread in the development of any of these and in concurrent protection of the environment is technological innovation.

We also have good reason to believe that today's legislation and regulation tend to discourage needed innovation. The Clean Air Act of 1970 and last year's amendments are a case in point.

They are based on forcing technology -- not encouraging it. It was a hold-their-feet-to-the-fire approach based on the non-sequitur that if the nation can put a man on the moon, a company can control all types of emissions whether technology exists or not.

Obviously, this approach ignores the fact that it took the resources of an entire nation, not those of private industry, to put that man on the moon and that it took complete suspension of cost-benefit considerations -- a luxury that only tax-supported institutions can afford.

The Clean Air Act forces technology but does little or nothing to encourage development of new technology, as a look at (k) (1) (A) of Section III demonstrates. This section outlines provisions designed to "encourage the use of an innovative technological system ...of continuous emission reduction," which seem to do more road-blocking than encouraging.

The process is complicated and time-consuming and the decision highly discretionary. The EPA Administrator may, not shall, grant a waiver of New Source Performance Standards during tryout of a new technology.

He may do so only with consent of the governor of the state involved. And he may do it if after notice and opportunity for public hearing, he determines a number of things.

You have to prove to him that the proposed system has not been adequately demonstrated; that it will operate effectively; that it will achieve greater continuous emission reduction than required under standards that would otherwise apply or that it would achieve at least equivalent reduction at lower cost. And that's only a small part of what the applicant has to demonstrate or prove.

Instead of incentives for technological innovation, (k) (1) (A) is actually a long list of hurdles with no assurance that you will actually be able to try your new technology when you reach the end of the obstacle course. Remember, the Administrator doesn't have to grant the variance if you meet all these conditions. He may grant it if he wants to.

It's no wonder that the Air Pollution Task Force of the National Coal Policy Project concluded that "industry does not have sufficient incentive under present legislation to attempt the implementation of new pollution control technologies which may be more effective or less costly than proven technologies."

As the task force points out, under current legislation, the company is required to retrofit if the new technology fails to achieve NSPS. "As a result," it concludes, "the company is likely to pay more because it tried new technology than if it had simply used proven technology to meet NSPS."

For industries interested in achieving required pollution control at lower cost and for environmentalists interested in achieving improved pollution control, the Clean Air Act seems to offer little help.

Obviously, a change is needed and the National Coal Policy task force suggests one possibility: promote development of better and less costly control technologies by granting EPA authority to allow a limited number of exceptions from NSPS and Best Available Control Technology requirement of the Act, but not from compliance with National Ambient Air Quality Standards. It further suggests that only technologies with "a reasonable chance of success" qualify for this variance.

Just as we have made a national commitment to cleaning up our environment and are about to make one to developing non-nuclear fuel resources, we now need a firm commitment to encouraging development and use of new technologies that will do both jobs as well, if not better, than today's "proven" technologies, and that will do so at the lowest possible cost to consumers and taxpayers.

What we seem to have at the present time is a regulatory approach to energy and environment that seeks to force new technologies, but fails to encourage them; that acknowledges the relationship between energy and environmental goals, but fails to address it; and that gives each piece of the interrelated action to separate and independent agencies, but provides no real mechanism to resolve differences between them.

The result for corporations, like Union Carbide, with a serious commitment to both energy and environment, is conflicting signals from Washington that make it more difficult and more costly to get on with the job.

When it comes to energy and environment, the nation can't afford confusing directions or the present policy of institutionalizing our differences. Both legislation and regulation need to be written and administered with the realization that energy and environment are part of the same organic system. What you do to one element affects the other.

Thank you.

DR. REZNEK: Thank you.

Are there questions or comments?

QUESTIONS AND REMARKS

DR. REZNEK: Your theme was one that I have thought about and spent a great deal of time working on. One fact that you forgot to mention is that the waiver is for a maximum of 7 years, after which time you must retrofit. You did mention retrofit, however.

The question of how to bring about a structure, be it Federal or non-Federal, which actually produces an on-going improvement of pollution controls in an energy system is a subject that has bothered me for quite some time. The regulatory approach of the Clean Air Act is one way to do it.

I am glad to hear a representative of industry suggest that perhaps the nature of that Federal or non-Federal structure is a true industry concern as is the development of public policy on how to advance pollution controls simultaneously with energy development. I would just like to add my endorsement of your effort and encourage you to continue it in whatever public arena you can and to work to establish a public policy which will recognize industry's legitimate role and support, foster and reward the legitimate improvements in that area.

MR. BROWNING: I might just respond briefly to that. The thing that we have most difficulty with, and this is not a critisim -- I'm partly public, too -- but in the public arena it is dealing with this matter of risk and we do it in corporate research when we set out to design a process for making product A, we usually find that we have to make some compromise or trade-off in the raw materials that we use and the side products that we make and energy consumption and the like.

We're used to trading these things off -- one against the other. When we get into the arena of energy and environment it is hard for the public bodies to assume the risk or run some of the risks that the process might in the initial stages have more detrimental environmental effects than one would like.

Obviously, we can't afford to accept the continuing increase in environmental risks. We have to go the other way, turn the corner at some point, but to get there, I would suggest to you that there needs to be some mechanism for permitting acceptable risks in these early developmental stages. That is really the burden of my message.

DR. REZNEK: Yes. Mr. Siek.

MR. SIEK: What you are suggesting I think most of us have thought of, and have sympathy with industry, but it reminds me of the old Atomic Energy Commission where regulatory and promotion were in the same agency.

MR. BROWNING: Yes.

MR. SIEK: With the Atomic Energy Commission, the JCAE which tried to look at both sides of regulation and promotion failed miserably. I'm not too sure how you accomplish the goals that you are proposing. I understand them, but the system is such that it is difficult to find a method of how to separate the regulatory from the promotion or at least temper the two and bring them together, but it is an excellent point.

MR. BROWNING: If it were an easy solution, I would have written that paper. I do think that an understanding of this in all arenas is necessary from the legislative side, the regulatory side, industry and then the various constituencies--- the environmentalists, the energy people who want energy at any price. They start from there and then begin to compromise. All of these people have to understand the problems involved in reaching that solution.

Some of the mechanisms we've had might have worked better had we understood how to make them work. We're not going to get to it, I don't believe, by coming up with a magic organizational solution. It is going to have to come through an understanding of the goals we want to achieve and a dedication on the part of people on both sides of the regulatory table towards moving us in that direction.

DR.REZNEK: In the current system, risk is assumed entirely by industry. If a company initiates development of a new process with the hope that this new process would represent an environmental advancement, but, at the end of its waiver, the new process fails utterly, which is to say, even conventional end-of-the-pipe retrofit systems can't be made to work, the company would have to take the loss. The possiblity of such a loss has a chilling effect on innovation of whole processes.

Perhaps there should be some system where the risk is shared or the consequences of failure are mitigated in some way. For example, the facility could be allowed to continue operating on the condition that it pay a fine representing the total operating expenses, including prorated capital costs, for a pollution system equavalent to BAT. This would eliminate any competitive advantage in failure. And, of course, there would have to be some provision for eventually achieving the desired pollution reduction.

If a proposal for this sort of system were presented by an industry spokesman, perhaps it would serve to unblock the current situation.

MR. BROWNING: Well, to carry this in just a little more detail with the suggestion of the National Coal Policy Council, and I didn't outline the whole proposal here, it was very much along that line.

What we were saying in effect was that the industry would have to demonstrate to the EPA administrator the reasonableness of the proposition and the fact that it might very well have a chance for success. It would have to achieve 80 percent of the NSPS before qualifying for any kind of forgiveness.

Once it got to that level and also met in the Ambient Air Quality Standards -- you always have to be within that -- there was a schedule of fines to be paid so that you wouldn't get off any cheaper than you would have if you hadn't gone with the regular approving technology, but you could use such things as high stacks for example, or cleaner coal, things of this nature to make up for your deficiency, but you're assuming you are in good faith and someone who has really tried to advance technology with the administrator's agreement who has a good shot at it, then under those circumstances you don't penalize this industry by having them go back and retrofit and you might end up with an improvement in environmental control.

DR. REZNEK: Are there any other questions?

DR. REZNEK: Thank you very much.

MR. BROWNING: Thank you.

DR. REZNEK: That concludes the hearings for the day unless there is any other witness.

DR. REZNEK: Thank you very much. As I said, the record is open for three weeks. (Whereupon, at 4:20 p.m. the hearings were concluded.)

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