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# How Solar Energy Was Treated In The AEC Chairman's Report, "The Nation's Energy Future"

B-178205

*BY THE COMPTROLLER GENERAL OF THE UNITED STATES*

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OCT. 18, 1974

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-176205

The Honorable James Abourezk
United States Senate

Dear Mr. Abourezk:

This is our report on how solar energy was treated in the AEC Chairman's report, "The Nation's Energy Future." We made our review in accordance with your request of April 1, 1974, as modified in subsequent meetings with your office.

As your office instructed, we (1) obtained and incorporated in the report the AEC Chairman's comments and (2) are sending a copy of this report to the AEC Chairman. A copy of the AEC Chairman's comments on our report is included as appendix IV.

We do not plan to distribute this report further unless you agree or publicly announce its contents.

Sincerely yours,

Elmer B. Staats

Comptroller General
of the United States

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ABBREVIATIONS

| | |
|---|---|
| AEC | Atomic Energy Commission |
| ERU | Energy Reorganization Unit |
| GAO | General Accounting Office |
| R&D | research and development |

COMPTROLLER GENERAL'S
REPORT TO
THE HONORABLE JAMES ABOUREZK
UNITED STATES SENATE

# HOW SOLAR ENERGY WAS TREATED IN THE AEC CHAIRMAN'S REPORT, "THE NATION'S ENERGY FUTURE"

B-178205

## DIGEST

### WHY THE REVIEW WAS MADE

Senator James Abourezk asked GAO to look into

--how recommendations on solar energy were developed in the report on "The Nation's Energy Future" and

--the public availability of recommendations of the solar energy review panel which was one of 16 panels set up to review specific areas of energy research and development (R&D) for that report.

On June 29, 1973, the President directed the Chairman, Atomic Energy Commission (AEC), to review Federal and private energy R&D activities and to report to him by December 1, 1973.

He asked the AEC Chairman to recommend an integrated energy R&D program--a 5-year, $10 billion Federal energy R&D program to supplement expected private R&D expenditures--and a fiscal year 1975 Federal budget for energy R&D.

### FINDINGS AND CONCLUSIONS

#### Development of AEC Chairman's report

The AEC Chairman established an Energy Reorganization Unit of AEC employees to help prepare that report. This unit coordinated three efforts to help develop the energy R&D program and assisted in drafting the report.

In the first effort, Cornell University brought together leading authorities from industry, the academic community, and Government to develop a broad energy policy and to study topics of importance in developing an energy R&D program, as follows:

--Fossil fuel.
--Short-term nuclear power.
--Advanced nuclear power.
--Energy R&D institutional patterns.

In the second effort, 16 panels of Federal officials assisted by consultants from the private sector

--reviewed over 1,100 proposals for programs in energy R&D and

--developed a 5-year energy R&D program at three alternative funding levels for their respective R&D areas which totaled: minimum, $12 billion; accelerated/orderly, $16.7 billion; maximum, $28.7 billion. (See p. 2.)

In the third effort, the AEC Chairman appointed an overview panel of 8 high-level Government officials to

--pull together the Cornell effort and the detailed program recommendations of the 16 panels and

--recommend for the Chairman's consideration a 5-year, $10 billion energy R&D program. (See p. 3.)

The Energy Reorganization Unit helped develop a report based on

the program the overview panel unanimously recommended to the AEC Chairman and the Chairman's changes to the overview panel's recommendations.

Reductions from review panels' recommended funding levels

Since the funding levels recommended by the 16 review panels ranged from $12 billion to $28.7 billion, the overview panel had to make major reductions to develop the $10 billion Federal energy R&D program the President sought.

The overview panel reduced the solar energy review panel's funding recommendation for solar R&D from a $1 billion accelerated orderly or $400 million minimum program level to a program level of $200 million.

The overview panel made the reduction primarily because of its judgment that

--solar energy basically had a long-term potential and energy technologies with short-term potentials should have higher priorities,

--the amount of energy expected from solar energy did not justify the solar energy review panel's recommendation, and

--the solar energy review panel's funding recommendation would expand solar energy R&D more rapidly than could be done efficiently. (See p. 11.)

Changes by the AEC Chairman from the overview panel's funding recommendations involved reductions of $600 million in nuclear R&D areas and increases of an equal amount in nonnuclear R&D areas.

The AEC Chairman did not change the funding for solar energy the overview panel recommended. Consequently, the funding for solar energy R&D recommended in the AEC Chairman's report--$200 million--is the same as the overview panel recommended. (See p. 10.)

Availability of solar energy review panel's recommendation

The public might have had access to recommendations of the review panel through AEC's

--environmental impact statements on nuclear reactors,

--public document room, and

--Technical Information Center.

However, because of the various reasons given below, the public access to this information was not readily attainable at the earliest practicable time.

--through environment impact statements

In the 13 environmental impact statements for present-generation reactors that AEC has issued since December 1, 1973, AEC did not mention the results of the solar energy review panel's report.

Neither did it substantively consider solar energy as an energy source because AEC had concluded that it was not a viable alternative to present-generation nuclear or fossil fuel powerplants.

In its draft statement for advanced reactors, AEC mentioned the solar energy review panel's report in its treatment of solar energy; however, the statement did not cite the panel's recommendations because of AEC's

conclusion that the panel's report supported the statement.

Opinions differ among non-AEC panel members as to whether treatment of solar energy in the draft impact statement supports or contradicts the presentation in the panel's report. (See p. 16.)

--through AEC's public document room

The official in charge of AEC's public document room told GAO the 16 review panel reports, including the solar energy report, had been available to the public since December 28, 1973.

Several of the 16 panel reports--but not the solar energy review panel's report--were requested and reviewed by members of the public as early as January 3, 1974. There is no record of the solar energy report's being given to the public before March 1, 1974, when Senator Abourezk was sent a copy.

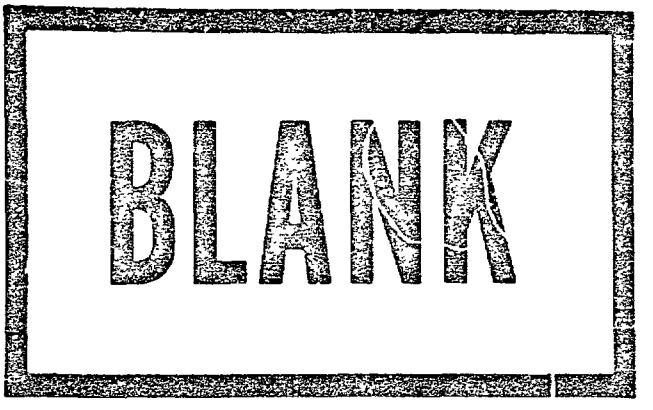
GAO noted problems in the document room's operation--such as failure to record the date when documents arrived or to record documents on a list frequently used by the public to obtain information. This contributed to possibly reducing public access to this information. AEC officials have been aware of these problems for some time and have been taking steps to correct them. (See p. 21.)

--through AEC's Technical Information Center

Although no records were available to indicate the date reports arrived, according to AEC, its Technical Information Center at Oak Ridge, Tennessee, received copies of the 16 review panel's reports before January 14, 1974.

Because copies AEC headquarters first sent the Center were not clear enough to reproduce, the solar energy report was not available to the public through the Information Center until May 15, 1974, and the other 15 reports were not available until May 31, 1974. (See p. 25.)

Tear Sheet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# CHAPTER 1

## INTRODUCTION

On June 29, 1973, the President, to help the Nation meet its vital energy needs, directed the Chairman of the Atomic Energy Commission (AEC) to review Federal and private energy research and development (R&D) activities and to report to him by December 1, 1973. The President asked the Chairman to recommend for the Nation an integrated energy R&D program--a 5-year, $10 billion Federal energy R&D program to supplement expected private R&D expenditures--and a fiscal year 1975 Federal budget for energy R&D.

To help prepare that report, the AEC Chairman established the Energy Reorganization Unit (ERU) of AEC employees. The ERU coordinated three separate efforts to help develop the energy R&D program recommended in the Chairman's report and assisted in drafting the report.

### WORKSHOPS ON MAJOR ENERGY R&D TOPICS

The first effort consisted of four workshops funded by AEC and organized under the direction of Cornell University to study topics of major importance in developing an energy R&D program. The workshops, which brought together leading authorities from industry, the academic community, and Government, studied the following topics.

--Fossil fuel.

--Short-term nuclear power.

--Advanced nuclear power.

--Energy R&D institutional patterns.

In hearings on December 11, 1973, before the Joint Committee on Atomic Energy on the December 1 report, the AEC Chairman said that the workshop reports were of major assistance in identifying and providing guidance on the major policy questions having to do with the overall thrust and direction of the energy R&D program the Nation needed over fiscal years 1975-79.

TECHNICAL PANELS ESTABLISHED
TO REVIEW PROPOSALS FOR
ENERGY R&D PROGRAMS

The Chairman initiated the second effort on August 7, 1973. From industry, Government, and educational organizations involved in energy R&D, she solicited proposals for programs which these organizations felt were necessary to develop a national capability for energy self-sufficiency or to support basic research that promised to give the Nation new options for meeting future energy needs.

The organizations solicited submitted over 1,100 energy R&D proposals, of which 92 were in six areas of solar energy research. The six areas--heating and cooling of buildings, solar thermal conversion, wind energy conversion, bioconversion, ocean thermal energy conversion, and photovoltaic conversion--are briefly described in appendix I.

As part of the second effort, ERU invited officials of various Federal agencies to participate on 16 technical review panels. Each panel was responsible for a specific energy R&D area. The panels were organized on September 28, 1973, to (1) review the 1,100 proposals, (2) develop alternative energy R&D program plans for their respective R&D areas, and (3) prepare justification documents to support budget proposals for such program plans.

ERU asked the panels to review the proposals using as their primary criteria of evaluation the (1) probable effects of the proposed energy R&D program plans on energy supply and demand and (2) unwanted effects associated with energy use. ERU instructed each review panel to recommend a 5-year R&D program at three alternative funding levels for their respective R&D areas--minimum, accelerated orderly, and maximum. These terms are explained on page 7.

The review panels were composed of 121 Federal employees from 36 departments and agencies. ERU assigned an AEC technical employee as secretary to each review panel, to provide technical and administrative support and to help the panel prepare its report. In addition, 282 consultants from the private sector assisted the review panels.

The solar energy review panel had 10 members. Its secretary and one other member were AEC employees. The Assistant Director for Research Application, National Science Foundation, chaired the panel.

ESTABLISHMENT OF AN OVERVIEW PANEL

The third effort involved (1) pulling together the broad policy overview of the Cornell workshops and the detailed program recommendations of the technical review panels and (2) recommending for the Chairman's consideration a 5-year, $10 billion energy R&D program. The Chairman, AEC, selected an overview panel of eight members to lead this effort. The overview panel met from October 24 to November 7, 1973. The panel comprised the following individuals--all Federal officials.

Chairman: Mr. Stephen A. Wakefield, Assistant Secretary for Energy and Minerals, Department of the Interior.

Mr. William E. Simon, Deputy Secretary of the Treasury.

Dr. Beatrice E. Willard, Member, Council of Environmental Quality.

Dr. Betsy Ancker-Johnson, Assistant Secretary for Science and Technology, Department of Commerce.

Dr. Stanley M. Greenfield, Assistant Administrator for Research and Development, Environmental Protection Agency.

Mr. William A. Anders, Commissioner, AEC.

Mr. Bruce T. Lundin, Director, Lewis Research Center, National Aeronautics and Space Administration.

Mr. John P. Abbadessa, Assistant General Manager, Controller, AEC.

DEVELOPING THE AEC CHAIRMAN'S REPORT

ERU assisted in drafting a report recommending various funding levels based on (1) the program the overview panel developed and (2) the Chairman's changes to the overview panel's recommended program. On November 18, 1973, ERU sent the draft report for comment to over 100 individuals, including the heads of many Government agencies, members of the Cornell workshops, the overview panel, the General Advisory Committee of AEC,[1] and the technical review panel chairmen. AEC officials, however, were able to identify for us at the time of our review only 75 of these individuals. (See app. II.)

[1]A committee whose nine members are appointed by the President to advise AEC on scientific and technical matters relating to materials, production, and R&D.

ERU received written comments on the draft report from 63 individuals. We could not determine how many of these comments were received before November 30, 1973--when the draft report was sent to the printer--because only 12 of the comments were stamped to indicate the date AEC received them. Each of these 12 had stamped dates indicating they were received before November 30.

The Staff Assistant to the AEC Chairman told us that the only way to tell when the replies had been received was by the stamped date. He had no specific explanation of why not all the comments had not been date stamped when they were received except that the workload on the report was heavy when the comments were being received.

The Staff Assistant said that, because of the short time available to obtain comments, the AEC Chairman and ERU got oral comments at meetings and in telephone conversations with some of the individuals who had been asked to comment on the draft report. However, he said that no records were made of these oral comments.

According to the Staff Assistant, the Chairman, AEC, finalized the report, entitled "The Nation's Energy Future," after reviewing the comments on the draft. The report was delivered to the President on December 3, 1973.

As the President requested, the report recommended:

1. A national energy R&D program. This comprised five tasks which the Chairman, AEC, felt must be worked on simultaneously for the Nation to regain and sustain energy self-sufficiency. The five tasks were:

--Conserve energy by reducing consumption and conserve energy resources by increasing the technical efficiency of conversion processes.

--Increase domestic production of oil and natural gas as rapidly as possible.

--Increase the use of coal, first to supplement and later to replace oil and natural gas.

--Expand the production of nuclear energy as rapidly as possible, first to supplement and later to replace fossil fuel.

--Promote, to the maximum extent feasible, the use of alternative energy sources--hydro, geothermal, and solar.

--Pursue the promise of fusion and central station solar power.

2. A 5-year, $10 billion Federal energy R&D program to supplement R&D expenditures expected from the private sector.

3. The fiscal year 1975 Federal energy R&D budget.

## CHAPTER 2

## MATTERS RELATED TO THE TREATMENT OF SOLAR ENERGY R&D IN THE CHAIRMAN'S REPORT

In his April 1, 1974, letter to GAO, Senator James Abourezk said he was concerned about the AEC Chairman's justification for recommending in her December 1, 1973, report that solar energy be funded at one-fifth the level the solar energy review panel recommended. In subsequent meetings with the Senator's office, we agreed to give him information on the following matters.

--The meaning of the various program funding levels (minimum, accelerated/orderly, and maximum) the review panels recommended.

--The funding levels for the various energy research and development areas the 16 review panels recommended and the reductions and/or increases to each the overview panel and/or the Chairman, AEC, made.

--The reasoning leading from the solar energy review panel's recommended funding levels to the funding level the December 1, 1973, report recommended.

--The basis for the December 1, 1973, report's recommended funding level for solar photovoltaic conversion activities and a summary of the content of proposals relating to solar photovoltaic R&D considered.

--The basis for AEC's considering solar energy in its draft liquid metal fast breeder reactor environmental impact statement and in any other environmental impact statements AEC issued since December 1, 1973, along with the views of several solar energy review panel members as to whether the draft environmental impact statement on the breeder reactor supported or contradicted the findings on solar energy in the solar energy review panel's report.

--The circumstances surrounding the transmittal of the review panels' reports to AEC's public document room and the difficulties Senator Abourezk had in trying to to get copies of such reports from the public document room.

The information we developed on the above areas is presented in the following sections on the (1) development of the Chairman's funding recommendation for solar energy and (2) availability to the public of the solar energy review panel's funding recommendations.

## INFORMATION RELATING TO DEVELOPING AEC CHAIRMAN'S FUNDING RECOMMENDATIONS

In this section we trace the 16 review panels' initial funding recommendations through the overview panel's review to the AEC Chairman's draft and final reports. We also discuss the overview panel's reasons for reducing the solar energy review panel's accelerated/orderly and minimum funding recommendations from $1 billion and $400 million, respectively, to $200 million. Further, we point out how the funding recommendations for the six areas of solar energy technology were developed and summarize the input to one of those areas, photovoltaic electric power.

### Meaning of program levels recommended by review panels

On September 28, 1973, ERU sent each review panel chairman instructions explaining what each was to do. ERU instructed each review panel chairman to develop a 5-year energy R&D program at three alternative funding levels for their respective energy R&D areas, defined as follows:

> Minimum--The minimum level of effort at which a viable R&D program could be maintained.
>
> Accelerated/orderly--Level of effort designed to pursue the objectives of the program fairly vigorously but efficiently, without telescoping steps and extra parallel efforts characteristic of crash programs.
>
> Maximum/crash--The maximum rate at which an accelerated program could usefully proceed with acceptable costs and schedule, environmental, and technical risks if high-priority funding were available.

### Changes made to review panels' funding recommendations

The 16 review panels developed the first set of funding recommendations on the basis of their evaluation of the energy R&D proposals submitted for their energy areas. The third, fourth and fifth columns of the table on the next page show the funding recommendations in each panel report.

| Panel number | Program | [illegible] | Accelerated/ orderly | Maximum | Overview panel recommendation | December 1 report | Funding reductions from accelerated/ orderly to overview | | Funding reductions from accelerated/ orderly to December 1 report | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Actual | Percent | Actual | Percent |
| | | (millions) | | | | | | | (millions) | |
| 1 | Resource assessment | - | 288.5 | - | 150 | 150 | -138.5 | -48 | -138.5 | -48 |
| 2 | Coal and shale mining | 32.0 | 550.0 | 887.0 | 325 | 325 | -225.0 | -40.9 | -225.0 | -40.9 |
| 3 | Fuel transportation, distribution, and storage | - | 152.4 | - | - | - | - | - | - | - |
| 4 | Energy transportation, distribution, and storage | 108.1 | 139.2 | 228.5 | - | - | - | - | - | - |
| 4a | Panels 3 and 4 combined | - | [a]291.6 | - | 200 | 200 | -91.6 | -31.4 | -91.6 | -31.4 |
| 5 | Coal and shale processing and combustion | 1,093.0 | 2,156.0 | 6,481.0 | 1,220 | 1,295 | -936.0 | -43.4 | -861.0 | -39.9 |
| 6 | Conversion techniques | - | 1,815.7 | - | 655 | 725 | -1,160.7 | -63.9 | -1,090.7 | -60.1 |
| 7 | Advanced oil and gas production from fossil fuels | 609.1 | 609.1 | 934.0 | 310 | 310 | -299.1 | -49.1 | -299.1 | -49.1 |
| 8 | Geothermal | 176.0 | 297.0 | 485.0 | [b]185 | 185 | -112.0 | -37.7 | -112.0 | -37.7 |
| 9 | Solar and other energy sources | 409.9 | 1,056.7 | - | 200 | 200 | -856.7 | -81.1 | -856.7 | -81.1 |
| 10 | Fission reactor | 4,090.3 | 4,441.7 | 5,420.8 | 4,390 | 4,090 | -51.7 | -1.2 | -351.7 | -7.9 |
| 11 | Fusion energy | 1,194.3 | 2,067.9 | 5,679.6 | 1,750 | 1,450 | -317.9 | -15.4 | -617.9 | -29.9 |
| 12 | Conservation | 369.0 | 525.0 | 749.0 | 150 | 150 | -375.0 | -71.4 | -375.0 | -71.4 |
| 13 | Advanced transportation | 295.9 | 893.3 | 1,628.0 | 405 | 505 | -488.3 | -54.7 | -388.3 | -43.5 |
| 14 | Environment | 631.0 | 894.0 | 1,413.0 | (b) | (c) | - | - | -244.0 | -27.3 |
| 15 | Multidirectional research | 270.0 | 500.0 | 1,000.0 | (b) | (c) | - | - | -200.0 | -40.0 |
| 16 | Systems analysis | 196.5 | 340.0 | 449.5 | 60 | 60 | -280.0 | -82.4 | -280.0 | -82.4 |
| (d) | Synthetic fuels pioneer program | - | - | - | - | [e]355 | | | | |
| - | Manpower development | - | - | - | - | - | | | | |
| | Total | [e]$12,000.7 | $16,726.5 | [e]$28,588.7 | $10,000 | $10,000 | | | | |

[a]This is the total of the accelerated programs of panels 3 and 4 and is not included in column totals, to avoid double counting.

[b]Overview panel did not include funds for these two programs in its $10 billion recommendation to Chairman.

[c]The Chairman, AEC, did not include funds for these programs in her $10 billion program. The Chairman, AEC, recommended a $1 billion program to supplement the $10 billion program. The supplemental program recommended $650 million for environmental R&D, $300 million for multidirectional research, and $50 million for manpower development. The review panel funding recommendations are compared with the $650 and $300 million.

[d]Funds for this area, added to the program by the AEC Chairman, were taken from the fission, fusion, and conversion techniques programs.

[e]Where subpanels did not report minimum or maximum programs, funding levels for accelerated/orderly programs were substituted.

Five panels did not recommend the three funding levels ERU requested. Four recommended only an orderly program, and one recommended minimum and orderly programs. The totals for the funding recommendations contained in the 16 review panel reports were:

| | |
|---|---|
| Minimum (note a) | $12.0 billion |
| Accelerated/orderly | 16.7 billion |
| Maximum/crash (note a) | 28.7 billion |

[a]Where a minimum or maximum was not given for an energy R&D area, the accelerated/orderly funding level was used to compute the total.

The solar energy review panel report recommended only two funding levels, an orderly program totaling over $1 billion and a minimum program totaling over $400 million. The chairman of the solar energy review panel told us that he had not recommended a maximum-crash program because the orderly program contained all the activities which the panel believed could be prudently pursued at the time. However, he said that in 2 or 3 years there may be enough favorable results in solar energy development to justify crash funding in three areas of solar energy technology; namely, wind energy conversion, ocean thermal energy conversion, and bioconversion.

The overview panel reviewed the 16 review panels' funding recommendations and, with the help of ERU, developed a 5-year, $10 billion energy R&D program which it recommended to the Chairman, AEC. The sixth column of the table on the preceding page shows the overview panel's recommended program.

The five overview panel members we spoke with told us how the panel had developed its funding recommendations. In summary, the panel relied on the (1) ERU to provide technical and administrative assistance and to prepare R&D funding levels allotting the $10 billion which gave the overview panel a starting point from which to consider individual review panel recommendations, (2) chairmen of the 16 review panels, (3) reports of the 16 review panels, (4) extensive discussions among the overview panel members, and (5) personal background and expertise of the individual members of the overview panel.

To develop the overview panel's funding recommendations, each member prepared an overall R&D program allotting the $10 billion to the 16 energy R&D areas the review panels

studied. The table below shows the funding levels for solar energy R&D that each panel member recommended.

| Overview panel members | Recommended funding for solar energy (millions) |
|---|---|
| Assistant Secretary for Energy and Minerals, Department of the Interior | $150 |
| Deputy Secretary of the Treasury | 300 |
| Member, Council of Environmental Quality | 600 |
| Assistant Secretary fo. Science and Technology, Department of Commerce | 150 |
| Assistant Administrator for Research and Development, Environmental Protection Agency | 240 |
| Commissioner, AEC | 150 |
| Director, Lewis Research Center, National Aeronautics and Space Administration | 350 |
| Assistant General Manager, Controller, AEC | 150 |

Through discussions of each of the panel members' funding levels and voting on various funding levels for each of the energy R&D areas, the panel reached a consensus funding level for the R&D areas to fit within the $10 billion program. Three panel members we spoke with said the consensus recommendation of $200 million for solar energy, as well as the other recommended funding levels, had the unanimous approval of the overview panel members.

The AEC Chairman changed the overview panel's funding recommendations for several energy R&D areas in preparing her draft report, but she did not change the funding recommendation for solar energy. On November 18, 1973, ERU sent copies of the draft report for comment to over 100 people. After receiving these comments, the AEC Chairman made several changes to the draft but made no changes to the funding level for solar energy. Changes the AEC Chairman made from the overview panel's funding recommendations involved primarily reductions of $600 million in nuclear R&D areas and increases of an equal amount in nonnuclear R&D areas.

Overview panel's rational for reducing the solar energy review panel's recommended funding level

Since the total of the funding levels the 16 review panels recommended ranged from $12 billion to $28.7 billion, the overview panel had to make major reductions to develop the $10 billion Federal energy R&D program the President requested.

The solar energy review panel recommended that solar energy R&D be funded at a minimum level of over $400 million or at an accelerated/orderly level of over $1 billion over a 5-year period. The five overview panel members with whom we talked said that they had evaluated the review panel's funding recommendations against the following criteria.

--Time frame of projected results.
--Energy contribution expected to be made.
--Historical funding levels.
--Effects on environment.
--Participation by industry.

After making this evaluation, the overview panel recommended a reduced level of $200 million. The five overview panel members we spoke with said the first three criteria listed above had led to the panel's recommending reducing the solar energy panel's recommendation for solar energy R&D.

The overview panel members from Interior and AEC said they had emphasized those programs with short-term payoffs. ERU defined "short term" as the period from 1975 to 1985. The AEC Assistant General Manager, Controller, expressed his view that, although one area of solar energy--heating and cooling of buildings--had short-term potential, the other five areas of solar energy technology seemed to have potentials more in the mid- or long-term--1985 to 2000, and 2000 on, respectively. Therefore, he said, solar energy received a lower priority than, for example, coal.

Commerce's overview panel member told us that the energy contribution which solar energy could make was too small to justify the amounts the solar energy review panel had recommended.

The overview panel chairman, the AEC Assistant General Manager, Controller, and the Commerce and the Environmental Protection Agency panel members told us that the solar

energy review panel's funding recommendations provided for larger increases in the existing solar energy program than they believed could be efficiently absorbed. Solar energy R&D was funded at $4.2 million in fiscal year 1973. At the time the December 1, 1973, report was being developed, total Federal funding for solar energy R&D was expected to be $13.2 million in fiscal year 1974. The review panel recommended a $50.5 million minimum and a $106.4 million accelerated/orderly program for fiscal year 1975. The table on the next page compares the actual funding for fiscal year 1973, the funding expected for fiscal year 1974, and the fiscal year 1975 recommendations of the December 1, 1973, report for the 16 energy areas.

How the funding recommendation for photovoltaic conversion was arrived at

Of the 92 solar energy R&D proposals ERU received in response to the AEC Chairman's August 7, 1973, request, 12 related to photovoltaic conversion--a process in which solar cells directly convert solar energy into electricity. These 12 proposals were submitted by the National Science Foundation, National Aeronautics and Space Administration, Department of Defense, National Bureau of Standards, and AEC. Photovoltaic techniques can be used to provide electricity at a central station or at the point of use.

A solar energy review panel member said that a group of technical consultants on photovoltaic conversion had helped the panel develop a 5-year program for photovoltaic research. The panel, he said, had not relied heavily on the 12 proposals because the panel's objective was to develop a 5-year program and not to recommend which proposals should be funded. The panel's 5-year funding recommendation for photovoltaic conversion research, he said, was not a selection from or composite of the submitted proposals but was based on the panel members' own judgments.

The proposals contained programs aimed at

--reducing the cost of solar cells from $50 a watt to a cost range of $0.35 to $0.50 a watt by 1979 and from $0.10 to $0.30 a watt by 1986,

--determining the design for a central power station by 1979,

--initiating testing on a system which can be built into homes to provide 1 kilowatt or electricity at $0.15 a kilowatt-hour,

| Panel number | Program area | Actual funding FY 1973 (note a) | Expected funding FY 1974 (note a) | Funding recommended in Dec. 1, 1973, report FY 1975 (note a) | Increase of recommended FY 1975 funding over expected FY 1974 funding | |
|---|---|---|---|---|---|---|
| | | | | | Actual | Percent |
| | | (millions) | | | | |
| 1 | Resource assessment | $ 7.2 | $ 8.3 | $ 20.0 | $ 11.7 | 141.0 |
| 2 | Coal and shale mining | 5.9 | 9.9 | 45.0 | 35.1 | 354.5 |
| 3 | Fuel transportation, distribution, and storage | (b) | (b) | - | - | - |
| 4 | Energy transportation, distribution, and storage | (b) | (b) | - | - | - |
| 4a | Panels 3 and 4 combined | 5.8 | 6.5 | 27.0 | 20.5 | 315.4 |
| 5 | Coal and shale processing and combustion | 78.5 | 134.8 | 230.0 | 95.2 | 70.6 |
| 6 | Conversion techniques | 19.5 | 33.3 | 66.3 | 33.0 | 99.1 |
| 7 | Advanced oil and gas production from fossil fuels | 12.8 | 11.2 | 31.7 | 20.5 | 183.0 |
| 8 | Geothermal | 3.8 | 11.1 | 40.0 | 28.9 | 260.4 |
| 9 | Solar and other energy sources | 4.2 | 13.2 | 32.5 | 19.3 | 146.2 |
| 10 | Fission reactors | 395.8 | 517.3 | 731.7 | 214.4 | 41.4 |
| 11 | Fusion energy | 74.8 | 98.7 | [c]145.0 | 46.3 | 46.9 |
| 12 | Conservation | 6.8 | 15.5 | 19.9 | 4.4 | 28.4 |
| 13 | Advanced transportation | 19.8 | 22.7 | 73.0 | 50.3 | 221.6 |
| 14 | Environment | (b) | (b) | 105.9 | 105.9 | - |
| 15 | Multidirectional research | (b) | (b) | 43.0 | 43.0 | - |
| 16 | Systems analysis | 5.3 | 6.8 | 10.0 | 3.2 | 47.1 |
| - | Synthetic fuels pioneer program | (b) | (b) | 100.0 | 100.0 | - |
| - | Manpower development | (b) | (b) | 5.0 | 5.0 | - |
| | | $640.2 | $889.3 | $1,726.0 | $836.7 | 94.1 |

[a]Figures for fiscal years 1973, 1974, and 1975 are from the Dec. 1, 1973, report. They reflect the information the AEC Chairman's staff had available while developing the report.

[b]Not provided in the Dec. 1, 1973, report.

[c]This includes only the civilian portion of an ongoing laser fusion program. Additional funds, totaling $329 million for the 5-year period, are included in the national security section of the AEC budget.

--demonstrating the promise of new cell materials by 1979, and

--developing standards and measurement equipment and facilities by 1977-79.

The solar energy review panel's funding recommendations for the six areas of solar energy research, including photovoltaic conversion, were as follows:

| Areas of solar energy research | Minimum | | Accelerated/orderly | |
|---|---|---|---|---|
| | FY 1975 | FY 1975-79 | FY 1975 | FY 1975-79 |
| | (millions) | | | |
| Heating and cooling of buildings | $ 8.1 | $ 86.9 | $ 17.8 | $ 204.3 |
| Solar thermal conversion | 15.8 | 145.1 | 31.1 | 275.2 |
| Wind energy conversion | 3.8 | 26.9 | 8.5 | 106.2 |
| Ocean thermal energy conversion | 4.0 | 41.3 | 8.6 | 99.5 |
| Photovoltaic conversion | 10.3 | 57.2 | 28.3 | 247.7 |
| Bioconversion | 8.5 | 52.5 | 12.1 | 123.8 |
| Total | $50.5 | $409.9 | $106.4 | $1,056.7 |

When the overview panel recommended that solar energy be funded at $200 million, rather than at the higher levels the solar energy review panel recommended, ERU directed the solar energy review panel chairman to modify his panel's original funding recommendations to fit within the $200 million program. The chairman of the solar energy review panel--the Assistant Director for Research Applications at the National Science Foundation--told us that, in redoing the review panel's funding recommendations, he had used as a guide a budget which the National Science Foundation had previously developed for fiscal years 1974-78, which is shown below.

| Areas of solar energy research | FY 1975 | FY 1974-78 |
|---|---|---|
| | (millions) | |
| Heating and cooling of buildings | $ 6.0 | $ 27.6 |
| Solar thermal conversion | 6.9 | 42.0 |
| Wind energy conversion | 1.7 | 21.3 |
| Ocean thermal energy conversion | 1.9 | 30.8 |
| Photovoltaic conversion | 5.9 | 44.8 |
| Bioconversion | 5.5 | 26.0 |
| Total | 27.9 | 192.5 |

The review panel chairman said he had modified the National Science Foundation's budget by increasing funds for heating and cooling of buildings and wind energy conversion, in keeping with the priorities which the review panel had estaolished for these two areas because of their potential to contribute to energy supply in the short term. He said he had decreased funding for other solar research to reflect the review panel's priorities while keeping within the $200 million limit the overview panel had established.

The funding levels for the six areas of solar energy research presented in the December 1, 1973, report are as follows:

| Areas of solar energy research | FY 1975 | FY 1975-79 |
|---|---|---|
| | (millions) | |
| Heating and cooling of buildings | $12.8 | $ 50.0 |
| Solar thermal conversion | 5.0 | 35.5 |
| Wind energy conversion | 6.2 | 31.7 |
| Ocean thermal energy conversion | 1.9 | 26.6 |
| Photovoltaic conversion | 4.2 | 35.8 |
| Bioconversion | 2.4 | 20.4 |
| Total | $32.5 | $200.0 |

## PUBLIC ACCESS TO SOLAR ENERGY REVIEW PANEL'S RECOMMENDATIONS

This section deals with (1) AEC's treatment of solar energy in its reactor environmental impact statements, (2) the availability of the solar energy review panel's report in AEC's public document room, and (3) the availability of the report from AEC's Oak Ridge, Tennessee, Technical Information Center.

Treatment of solar energy in AEC's environmental impact statements

The Environmental Policy Act of 1969 (42 U.S.C. 4332) requires AEC to develop statements assessing the environmental impact of nuclear reactors. The act also requires AEC to discuss in these statements reasonable alternatives which are available to meet the projected electricity demand which the proposed reactors are to satisfy.

There are two classes of nuclear reactors for which environmental impact statements must be prepared: present-generation reactors, such as light water reactors, and experimental reactors, such as breeders, which are still under development. AEC's regulatory organization prepares the environmental impact statements for the present-generation reactors. AEC's General Manager organization has prepared impact statements for experimental reactors.

According to an AEC regulatory official, AEC interprets the act as requiring AEC to treat, in its impact statements, only those alternatives which it considers viable. Since AEC regulatory has concluded that solar energy is not a viable alternative to present-generation nuclear reactors, it has not provided a detailed analysis of solar energy in its consideration of alternative powerplants. In the 13 draft and final light water reactor--present-generation reactors--impact statements AEC regulatory issued between December 1, 1973, and April 31, 1974, solar energy is either not mentioned or mentioned merely as a future source of energy along with several other alternatives, such as fusion and tidal energy.

In March 1974 the AEC General Manager issued, for comment by interested parties, a draft impact statement for the liquid metal fast breeder reactor--a new class of reactors scheduled for commercial application in the late 1980s.

The draft environmental impact statement, issued for the entire liquid metal fast breeder reactor program rather than for a single reactor, discussed solar energy in the section dealing with alternatives. AEC discussed the projected impact that solar energy would have on total energy supply. Although the draft environmental impact statement mentioned the solar energy review panel's report in its treatment of solar energy, the statement did not cite any information from the review panel's reports.

The draft environmental impact statement concludes that:

> "The outlook appears to be that solar energy has little potential as an economical, major source of electricity for several decades. In fact, the only proposed solar application that potentially could play a significant energy role in this century is as thermal energy for buildings. Although this use could be important, the impact on total electrical production is likely to be minor, at least until the year 2000. Thus, the conclusion is drawn that the use of solar energy will not materially reduce the need for alternative electrical energy sources in the foreseeable future."

The review panel's report points out that the widespread application of solar energy could help toward increasing our future energy supplies. The panel report states that:

> "The goal of the Solar Energy Program is to develop and demonstrate economically competitive and environmentally acceptable Solar Energy Systems at the earliest practical time. For each of the six subprograms, (1) Heating and Cooling of Buildings, (2) Solar-thermal Conversion, (3) Wind Energy Conversion, (4) Ocean-thermal Conversion, (5) Bioconversion, and (6) Photovoltaic Conversion, the objective is to develop proof-of-concept experiments and demonstration projects which will allow industry and user agencies to begin the aggressive commercialization of each of the technologies thus assuring its widespread technologies it is estimated that 10 to 30% of the Nation's required input BTUs can be provided by solar energy by the year 2000 and as much as 50% by the year 2020."

(See app. III for a more detailed description of the review panel's projected impact.)

The AEC officials responsible for developing the fast breeder reactor program draft environmental impact statement told us they had not included in the statement a specific discussion of the solar energy review panel's report because an AEC member of the solar energy review panel told them that, in general, the review panel's report supported the conclusions on solar energy in the draft environmental impact statement. These AEC officials did not ask any solar

energy review panel's non-AEC members whether the review panel's report supported or contradicted the conclusions on solar energy in the impact statement.

We asked seven of the eight[1] non-AEC members of the solar energy review panel for their views on the question: "Is the treatment of solar energy in the draft impact statement supported or contradicted by the presentation on solar energy in the solar energy panel report?"

One panel member said that the treatment of solar energy in the draft impact statement was supported by the presentation in the panel's report. A second member said:

> "From my brief review of the Draft Environmental Impact Statement (EIS), it is evident that the two groups approached the study with different objectives and different assumptions concerning future events. Thus, the conclusions and recommendations are not consistent, nor would I expect them to be under these circumstances."

A third panel member said that he fully concurred with the second panel member's response.

A fourth member said:

> "Generally, the EIS supports the Subpanel IX Report, but there are sections of the EIS that appear to distort the potential for solar energy to contribute to the nation's energy supply. The sections are listed below.
>
> "1) A.5.3.2 Photovoltaic Conversion
>
> References to solar energy proponents are not defined. While some solar energy proponents do not present the shortcomings of solar technology we believe that responsible proponents do present realistic assessments (e.g. The National Science Foundation).
>
> "2) A.5.5 Present and Projected Application
>
> The Department of the Interior's (DOI) December, 1972 report is based on data that was

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[1]One member was in Asia at the time we made our request.

compiled prior to evidence being available that an expanded R&D effort would be taking place in the solar energy area which could modify the DOI forecast.

"3) A.5.7.2 External Cost

Since this section is concerned somewhat with cost, to mention only gold as a possible candidate for collector coatings could possibly be misleading because of the cost connotation associated with gold. Other candidates for solar collector coatings, probably just as valid contenders as gold, are hafnium, molybdenum, silver, and aluminum.

"4) A.5.8 Overall Assessment of Role in Energy Supply

Since this section provides the overall assessment of the role of solar energy in the nation's energy supply scenario, a more complete perspective could have been portrayed if some of the areas previously mentioned were addressed here and conclusions drawn. The particular areas viewed as impacting the nation's energy supply but not discussed in this section are (1) the potential of solar energy for fuel savings, and (2) the potential of solar energy for decreasing dependence on foreign sources of fuel."

A fifth member said:

"* * * In my judgement there is no clear cut unqualified answer. First the solar state-of-the-art is insufficient to prove or disprove economic feasibility. Thus, conclusions regarding the future usefulness and timing of terrestrial applications of solar energy have to be largely judgemental. Secondly, the two documents were prepared with different, and in a sense, conflicting end purposes in mind. The subpanel IX report was prepared by solar energy protagonists and was aimed at justifying and explaining a proposed major new program effort in all phases of solar energy. On the other hand, the impact statement was prepared by nuclear protagonists and was aimed at assessing alternate approaches to the LMFBR [liquid

metal fast breeder reactor] concept for electric power generation only. The combination of meager data and different end purpose has resulted in two documents which could give quite different impressions to the reader. One could say that the subpanel IX report is optimistic and the impact statement is pessimistic with both drawing on mostly the same basic information.

"Bearing the above background information in mind, I believe it fair to say that the impact document does not support the subpanel IX report and that further, it is not reasonable to expect such support until there is convincing evidence that practical systems can be built. If such were the case a major terrestrial solar energy R&D program as advocated by the subpanel IX report would not be needed."

A sixth member said "The treatment of solar energy in the LMFBR EIS appears to be somewhat 'out of date' with current approaches to the utilization of solar energy and should be updated."

A seventh member said:

"The Draft presents factual, historical and technical information on each of the various solar energy systems. This information is supported by the information presented in the Sub-Panel IX report. However, I find the viewpoint expressed in the Draft of the LMFBR Impact Statement to be more pessimistic about the potential of solar energy systems than the viewpoint expressed in the Sub-Panel IX Report. For this reason, in direct answer to your question, I conclude that the Draft is generally not supported but is contradicted by the presentation of solar energy in the Sub-Panel IX Report.

"At present, the future costs and rate of growth of solar energy are uncertain. For this reason, the future prospects for solar energy are a matter of opinion, the range of opinion extending from highly optimistic to highly pessimistic. The report of Sub-Panel IX is on the optimistic side, and the AEC's Draft takes a pessimistic view. Neither view can be evaluated as right or wrong. The

technology program planned for solar energy will at a later date permit evaluation of the true potential of solar energy."

Availability of solar energy review panel's report from AEC's public document room

Senator Abourezk's solar energy researchers and a member of the Senator's staff told us they had had problems getting the solar energy review panel's report from AEC. They explained that on at least two occasions in the week preceeding February 20, 1974, they tried to get a copy of the report from AEC's public document room but were told by AEC employees there that such a report was not in the room. In a February 20, 1974, letter to AEC, Senator Abourezk requested a study in AEC's possession entitled "The Solar Energy Subcommittee Report" under the provisions of the Freedom of Information Act (5 U.S.C. 552). In a March 1, 1974, letter, AEC told Senator Abourezk that the report it believed he referred to in his February 20 letter was one of 16 subpanel reports prepared for the Chairman's overview committee's use in developing a report the President requested to recommend an integrated energy R&D program for the Nation. A copy of that report was enclosed with the letter.

We talked to various people in AEC and reviewed available documents to establish when the 16 technical review panels' reports arrived at the public document room. The Administrative Director of ERU had documents indicating that he had sent 4 copies of each of the 16 subpanel reports to the AEC headquarters library on December 14, 1973. He said he had orally instructed the librarian to hold the reports until he found out from the Chairman's office whether the reports should be made public. The Administrative Director told us he received approval from the office of the chairman on December 26, 1973, to release the report. He said he had orally directed the librarian on that date to send a copy of the 16 reports to the public document room.

Although the public document room's staff told us that the 16 review panels' reports had been in the document room since about December 28, 1973, they could not determine precisely when they arrived because the reports were not date stamped or logged in on a list of accessions, although they should have been.

The public document room's staff had documents indicating that, as early as January 3, 1974, they had made available several review panel reports to several individuals representing industry and State and local governments. They did not, however, have any documents indicating that they had made the solar energy review panel's report available.

We talked to all the public document room's staff members who dealt with in-person requests from the public. None could remember ever not providing the solar energy review panel's report to anyone who asked for it. In commenting on the problem the Senator's staff had in obtaining the solar energy review panel's report from the document room, a clerk told us he remembered someone from the Senator's office coming to the public document room to see the report and he also remembered making it available to him for review on the premises.

Senator Abourezk asked us to look into a magazine article which reported that a clerk in AEC's public document room had said that he remembered giving a copy of the solar energy review panel report to a member of the Senator's staff. All the members of the public document room's staff who deal with in-person requests told us that they had not talked to any reporters on this subject.

According to an AEC study of the public document room, the list of accessions on which the review panel's reports should have been recorded is frequently used and relied upon by the public to obtain information. For certain documents, this list of accessions is the only record that these documents are in the room.

In several meetings between April 29 and August 21, 1974, the chief of the public document room explained to us why the 16 review panel's reports were not date stamped or recorded on the accession list, as follows.

> The 16 subpanel reports were received at the public document room a day or so before December 28, 1973, in two boxes without any instructions as to what should be done with them or any indication of who had sent them. The reports were not the usual type of material sent to the public document room, and none of the employees then available was certain that these 16 volumes of reports had not been sent to the public document room in error. (Occasionally mail-handling errors result in documents' being received at the public document room that must be redirected. At the time it was thought that this might also be the case with these 2 boxes of

16 volumes.) Because of the above, the 16 reports were not date stamped or logged in on the actual date they were received.

Sometime between the time the reports arrived in the public document room and December 28, 1973, an AEC employee (the chief could not recall the name of this employee or the AEC division he represented) telephoned the chief of the public document room and stated that the 16 subpanel report volumes should be made available for public inspection. Immediately after this telephone message, the chief told the clerk on duty to place the 16 volumes on the shelf for public access, and he turned his attention to other immediate problems. The chief could not recall precisely why they had not been date stamped and logged in on the date of the telephone message since it was the clerk's normal practice to do this. He explained, however, that there was only one clerk in the document room on that day and that the room was experiencing a rather heavy workload on that day and that, because of these reasons, the clerk most likely had simply failed to date stamp them or to log them in.

Sometime around 4 p.m. on Sunday, March 31, 1974, an individual in the Office of the Secretary of AEC called the chief at his home and asked whether the 16 subpanel reports were on file in the public document room and when they had been received. From his personal knowledge, the chief said they were on file in the public document room for public access. The caller asked the chief to verify the date of placement in the public document room and to give this information to an individual in the Office of the Chairman, AEC, the following morning (Monday, April 1, 1974). After checking the following morning, the chief became aware that the panel reports were not date stamped or logged in on the accession list. He said that the reports had not been logged in at that time (April 1, 1974) because he felt that either backdating the receipt of the reports (on the accession list and stamping the date on the reports) or logging them is as of the day they were notified to make them available for public inspection would not be proper because it could appear that the public document room records had been altered to correct a simple original omission. For the same reasons, neither he nor his clerks had date stamped the reports or logged them in on the accession list after we brought this matter to his attention on April 18, 1974.

The reports were not logged in until we brought the omission to the attention of the Assistant Secretary for the Commission on May 21, 1974. On May 22 he directed the chief of the public document room to log in the reports. The reports were logged in on May 23 with the following notation.

> "This material was received in the AEC public document room prior to December 28, 1973, but through an oversight was not stamped in or recorded in the daily accession list of documents heretofore. The daily accession list for December 28, 1973, has been amended accordingly."

After finding that the review panel reports had not been logged in when they should have been, we checked to see whether this situation was unique. It was not. Of 17 documents we checked, 6 had not been logged in that should have been. The chief of the document room agreed that the six documents should have been listed on the accession list and could not explain why they were not. The document room chief told us that there were no written procedures for operating the document room, including logging in material.

We discussed the lack of procedures and the unlogged documents with the Assistant Secretary of the Commission. His office is responsible for operating the document room. The Assistant Secretary said he was aware of the problems in operating the document room and that (1) in October 1973 a special consultant had started reviewing the operation of the public document room and (2) in June 1974 AEC contracted with a private company to develop a filing system that would give the public more ready access to the material. The Assistant Secretary said also that AEC was developing standard operating procedures for the document room.

As a result of the problems the Senator's staff had in obtaining material from the public document room and the problems which we pointed out in the room's operation, the Assistant Secretary directed the chief of the document room to immediately develop and follow interim operating procedures. The Assistant Secretary also directed document room personnel, until AEC receives the results of the contract study on the document room, to log in all incoming material and to attempt to log in all material which should have been logged in.

Availability of solar energy review panel's report from the Oak Ridge Technical Information Center

The Oak Ridge Technical Information Center's mission is to arrange and assist in transferring technical information from multiple points of origin to multiple points of use. It carriers out this mission by publishing Nuclear Science Abstracts which provide the only comprehensive abstracting and indexing coverage of international nuclear science literature. An Oak Ridge Technical Information Center official said that the Information Center received a set of review panels' reports sometime before January 14, 1974.

An Information Center official told us that, because of problems in obtaining clear copies of the report, the solar energy review panel's report was not available to the public through his organization until May 15, 1974, and the other 15 reports were not available until May 31, 1974.

The chief of the AEC library explained to us why reproducible copies of the 16 review panels' reports had not been sent to the Oak Ridge Technical Information Center. He told us that in an October 1973 meeting he explained to someone involved in developing the report (he could not remember the person's name) that copies of the review panels' reports should be made available to the Information Center. He further explained that the reports sent to the Information Center should be clear and reproducible. ERU's Administrative Staff Director sent the library several sets of the 16 panel's reports and instructed him to send a set to the public document room.

The chief of the AEC library said he had not checked whether the set of reports which the library sent the Information Center met AEC regulations for clarity, because (1) he had explained in the October 1973 meeting that the Information Center required clear copies and (2) it was not his usual practice to check the clarity of reports being sent to the Information Center because AEC regulations placed this requirement on the organizations responsible for developing the reports. He said he had sent the set of reports to the Information Center without knowing that some of them were not clear enough to reproduce.

The Administrative Staff Director told us that when he sent the review panels' reports to the library he had instructed the library to put copies in the public document room. He was unaware that the library would send copies to the Information Center.

He told us that he had sent reproduced sets of reports to the library because these were all that were available to him. The chairmen of the review panels kept the originals and sent the Administrative Staff Director copies which were then used to make other copies for the people working on the report.

The Administrative Staff Director said that he found out from the Staff Assistant to the Chairman that there was public interest in the review panels' reports and that they should be made available to the public through the document room.

## CHAPTER 3

## SCOPE OF REVIEW

To develop the information needed to answer Senator Abourezk's request, we held discussion with (1) members of the AEC Chairman's staff who directed the development of the Nation's Energy Future report, (2) AEC and other Federal employees who participated in various stages of the development of the report, (3) the Congressional Relations Staffs of AEC and the National Science Foundation, (4) the AEC divisions responsible for developing the environmental impact statements for the liquid metal fast breeder reactor and for the light water reactors, (5) the staff of AEC's public document room, and (6) members of the solar energy review panel.

We also reviewed (1) the AEC Chairman's report, "The Nation's Energy Future," the 16 review panels' reports that contributed to it, and other documents and transcripts of testimony developed in preparing the report, (2) that portion of the draft liquid metal fast breeder reactor environmental impact statement dealing with solar energy, and (3) the solar energy sections of all light water reactor impact statements issued between December 1, 1973, and April 1974.

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APPENDIX I

# BRIEF DESCRIPTIONS OF THE SIX AREAS OF SOLAR ENERGY RESEARCH

## Heating and cooling of buildings

Water is heated by solar radiation as it flows through special panels which can be part of the roof of a building or constructed on or near a building. The heated water is used to heat or, with further processing, cool the building and to provide its hot water. The technique can be used in institutional, industrial, and residential buildings.

## Solar thermal conversion

Solar radiation brings a liquid to a boil which produces steam which drives a turbine to generate electricity. Space heating of buildings is a potential byproduct of the process.

## Wind energy conversion

Machines, such as windmills, extract energy from the wind to produce electricity.

## Bioconversion

Energy is created by one of three methods: (1) the conversion of organic wastes, (2) the production and combustion of materials, such as trees, grasses, water plants, and algae, and (3) the production of hydrogen by photosynthetic and other photochemical processes.

## Ocean thermal energy conversion

The natural temperature difference between the sun-heated surface and the deeper cold water of oceans could be used to operate a heat engine which produces electricity. The warm surface waters would be passed through heat exchangers which boil a fluid, such as propane or ammonia, to drive huge turbines coupled to generators. The cold deeper water would be pumped up and circulated through the heat exchangers to condense the working fluid.

## Photovoltaic conversion

Solar energy is converted directly to electricity in

solar cells. The principle used is that, in some solid-state material--i.e., silicon and cadmium--light absorption generates free electrical charges. The types of electric plants that would use this process include (1) power units for buildings, (2) terrestrial central power stations, and (3) central power stations orbiting the earth.

APPENDIX II

LIST OF ADDRESSEES FOR

DRAFT OF DECEMBER 1, 1973, REPORT

Mr. Carl Bagge
President, National Coal Assn.

Mr. William O. Baker
Vice President
Bell Telephone Labs., Inc.

Dr. Hans Bethe
Physics Department
Cornell University

Dean Harvey Brooks
Applied Science
Harvard University

Dr. Sol Buchsbaum
Bell Labs

Dr. John E. Cantlon, Provost
Michigan State University

Mr. John Corcoran
President, Consolidation
Coal, Inc.

Mr. Gordon Corey
Vice Chairman, Commonwealth
Edison

Mr. L. Floyd Culler, Jr.
Assistant Director
Oak Ridge National Laboratory

Mr. Edmund Cranch
Dean, College of Engineering
Cornell University

Mr. W. Kenneth Davis
Vice President, Thermal Power
Bechtel Power Corporation

Mr. Lloyd Elkins
Amoco Production Co.

Mr. J. Lee Everitt
President
Philadelphia Electirc Company

Dr. John S. Foster
Vice President, TRW Systems

Dr. William Gouse, Jr.
Department of Interior

Mr. Ernst Habicht
Environmental Defense Fund

Dr. Fred Holloway
Exxon Corporation

Mr. C. Howard Hardesty, Jr.
Executive Vice President
Continental Oil

Mr. Shearon Harris
Chairman, President
Carolina Power & Light

Dr. Milton Levenson
Electric Power Research Institute

Dr. H. G. MacPherson

Mr. John O'Leary, Directorate of
Licensing, AEC

Mr. Leif H. Olsen
Senior Vice President and Economist
First National City Bank

Dr. Thomas O. Paine
Vice President
General Electric Corportion

APPENDIX II

Mr. Eric H. Reichl
Consolidation Coal Co.

Dr. Arthur M. Squires
Department of Chemical Engineering
City College of New York

Dr. Chauncey Starr
Electric Power Research Institute

Dr. John Teem, Assistant General Manager for Physical Research and Laboratory Coordination, AEC

Dr. Alvin Weinberg
Oak Ridge National Laboratory

Mr. Lombard Squires, Chairman
General Advisory Committee

Dr. Rolf Eliassen, Member
General Advisory Committee

Dr. Herbert Friedman, Member
General Advisory Committee

Dr. Evans V. Hayward, Member
General Advisory Committee

Dr. Hubert Heffner, Member
General Advisory Committee

Mr. Michael M. May, Member
General Advisory Committee

Mr. Howard G. Vesper, Member
General Advisory Committee

Dr. James H. Sterner, Member
General Advisory Committee

Dr. Walter H. Zinn, Member
General Advisory Committee

The Honorable Aubrey J. Wagner
Chairman
Tennessee Valley Authority

Mr. Harry Perry
National Economic Research Associates, Inc.

The Honorable Earl W. Butz
Secretary of Agriculture

The Honorable James R. Schlesinger
Secretary of Defense

The Honorable John N. Nassikas
Chairman
Federal Power Commission

The Honorable Rogers C. B. Morton
Secretary of the Interior

The Honorable Russell E. Train
Administrator
Environmental Protection Agency

The Honorable Frederick B. Dent
Secretary of Commerce

The Honorable Arthur F. Sampson
Administrator of General Services

The Honorable James C. Fletcher
Administrator
National Aeronautics and Space Administration

The Honorable Claude S. Brinegar
Secretary of Transportation

The Honorable James T. Lynn,
Secretary of Housing and Urban Development

The Honorable John A. Busterud
Acting Chairman
Council on Environmental Quality

Mr. Stephen A. Wakefield
Assistant Secretary for Energy and Minerals
Department of the Interior

Dr. Betsy Ancker-Johnson
Assistant Secretary for Science
and Technology
Department of Commerce

Dr. Beatrice Willard
Council on Environmental Quality

Mr. William E. Simon
Deputy Secretary of the Treasury

Commissioner William A. Anders
AEC

Mr. John P. Abbadessa, Assistant
General Manager, Controller
AEC

Mr. Bruce Lundin, Director
Lewis Research Center
National Aeronautics and Space
Administration

The Honorable Stanley M. Greenfield
Assistant Administrator for R&D
Environmental Protection Agency

Dr. Paul Donovan
National Science Foundation

Mr. Hames Harold
Geological Survey
Department of the Interior

Mr. William Schmidt
Bureau of Mines
Department of the Interior

Mr. Joseph H. Seelinger
Maritime Administration
Department of Commerce

Mr. F. F. Parry
Office of the Assistant Secretary
Energy and Minerals
Department of the Interior

Mr. William Crentz
Bureau of Mines
Department of the Interior

Mr. Robert E. English
Chief, Power Systems Division
Lewis Research Center
National Aeronautics and Space
Administration

Dr. Edward Fleming, Assistant Director
Division of Applied Technology
AEC

Mr. Gerald Johnson, Director
Division of Applied Technology
AEC

Mr. Alfred J. Eggers, Jr.
Assistant Director for
Research Application
National Science Foundation

Dr. Herbert J. C. Kouts, Director
Division of Reactor Safety Research
AEC

Dr. Robert Hirsch, Director Division of
Controlled Thermonuclear Research
AEC

Dr. John H. Jibbons, Director
Office of Energy Conservation
Department of the Interior

Dr. Ernest N. Petrick
Chief Scientist
U.S. Army Tank-Automotive Command

Dr. Edward C. Creutz
Assistant Director for Research
National Science Foundation

Dr. Steven J. Gage
Council on Environmental Quality

APPENDIX III

SOLAR ENERGY REVIEW PANEL'S PROJECTIONS

OF THE IMPACT OF THE SIX AREAS OF SOLAR ENERGY

TECHNOLOGY ON ENERGY PRODUCTION

HEATING AND COOLING OF BUILDINGS

1. Could have a variety of commercial products in the marketplace by about 1979.

2. Could supply approximately 30 percent of the energy needed for heating and cooling of buildings by 2000 and 50 percent by 2020.

SOLAR-THERMAL CONVERSION

1. Could have systems in commercial application in 1983-88 time frame at the earliest.

2. Could provide 40,000 megawatts of electricity by 2000 and ultimately could supply 30 percent of the Nation's electrical energy and 50 percent of the Nation's energy for residential, commercial, and industrial needs.

WIND-ENERGY CONVERSION

1. Could operate a cost effective 10 megawatts of electricity system by 1979.

2. Could demonstrate a 100 megawatts of electricity system by 1981.

3. Could be made to increase the Nation's electrical capacity from $3 \times 10^8$ kilowatt-hours a year in 1981 to $10^9$ kilowatt-hours a year in 1985, to $10^{10}$ kilowatt-hours a year in 1990, to $1.5 \times 10^{12}$ kilowatt-hours a year by 2000, depending on the system costs achieved by this technology compared to the costs of fossil and nuclear fuels and plants and social pressures for a cleaner environment and more energy.

BIOCONVERSION

1. Could demonstrate conversion plants of up to 100 tons a day capacity as well as developing high-yield energy crops by 1980.

2. Could have production of hydrogen by photosynthetic and biochemical methods by 1980.

3. Could have an eventual production capability range as high as 50 percent of the current gas requirement.

OCEAN THERMAL-ENERGY CONVERSION

1. Could demonstrate the practical feasibility of converting ocean thermal energy into electricity by 1985.

PHOTOVOLTAIC CONVERSION

1. Produce economically competitive (cost of 10 mills per kilowatts per hour) electric power by 1990.

2. Produce more than 7 percent of the required U.S. electrical generating capacity by 2000.

3. Ultimately provide 10 to 20 percent of the Nation's electrical power requirements.

APPENDIX IV

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

SEP 23 1974

Mr. Henry Eschwege
Director, Resources and
Economic Development Division
U. S. General Accounting Office

Dear Mr. Eschwege:

SUBJECT: GAO DRAFT REPORT, "INFORMATION ON CERTAIN MATTERS PERTAINING TO SOLAR ENERGY IN THE AEC CHAIRMAN'S REPORT, 'THE NATION'S ENERGY FUTURE'"

This will confirm for your records that I have reviewed the subject draft report. The report was also reviewed by senior staff of AEC.

I appreciate the opportunity to review the draft report and your consideration of our comments which were directed primarily to a more complete treatment of the subject matter in the "digest" of the report. I have in mind particularly (1) the disclosure of the need on the part of the overview panel to make significant reductions in the review panels' funding requests in order to meet the Presidential constraint of a $10 billion Federal energy R&D program and (2) the disclosure of the changes I personally made from the overview panel's funding recommendations involving primarily reductions of $600 million in nuclear R&D areas and increases of an equal amount in non-nuclear R&D areas.

Sincerely,

Chairman