

FEDERAL ENERGY RESEARCH

**An Analysis of Fiscal Year 1977
Program Funding Levels and Alternative
Budget Paths Through Fiscal Year 1986**

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PREFACE

Federal Energy Research analyzes the President's energy research, development, and demonstration budget for fiscal year 1977 and provides a discussion of the methodology and data underlying Background Paper No. 10, Energy Research: Alternative Strategies for Development of New Energy Technologies and Their Implications for the Federal Budget dated July 15, 1976

As such, this paper is intended primarily for Congressional staff use. It is hoped that the analysis of the President's energy research, development, and demonstration budget request for fiscal year 1977 contained herein will provide a useful way of looking at this important budget issue in subsequent years. Moreover, the alternative ten-year spending level projections developed in this paper have been structured to facilitate the assessment of the budgetary consequences for any number of alternative federal energy research policies or strategies.

In keeping with the mandate of the Congressional Budget Office (CBO) to provide nonpartisan analysis, this paper contains no recommendations. It was prepared by Kendrick W. Wentzel of CBO's Natural Resources and Commerce Division under the direction of Douglas M. Costle and Nicolai Timenes, Jr. Typing of the manuscript was done by Barbara Bishop.

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(IX)

SUMMARY

Energy research can be a time-consuming process stretching from initial conception of a new energy technology to demonstration at near-commercial scales. As defined for the purposes of this paper, energy research involves three distinct phases: research, development, and demonstration (R,D,&D). Scales of testing can range from experiments, through bench tests, process development units, pilot plants, to near-commercial demonstrations.

In the President's budget for fiscal year 1977, federal energy research amounts to \$3,078 million in budget authority and \$2,677 million in outlays. Almost 90 percent of this request is earmarked for activities conducted by the U.S. Energy Research and Development Administration (ERDA). Since detailed programmatic information is not customarily presented in the President's budget, it was necessary to develop a unique budget definition for federal energy research. Essentially, overall energy R,D,&D funding was broken down into eight direct energy technology areas (ERDA's fossil, solar, geothermal, conservation, fusion, fission, and other nuclear programs; and other federal agencies involved in the development of direct energy technologies) and two supporting areas (ERDA's environmental and basic energy sciences programs). This programmatic breakdown formed the basis for all analysis on energy R,D, &D conducted by the Congressional Budget Office.

The major effort in the fiscal year 1977 energy research budget is the fission power reactor development program, particularly the liquid metal fast breeder reactor subprogram (the largest single element of which continues to be the construction of the Clinch River Breeder Reactor). The most rapidly expanding program area consists of other nuclear programs designed largely to support this effort. ERDA conservation and solar energy programs have also achieved high growth rates; however, overall program funding levels for these two programs remain the lowest of the ten major program areas.

Energy research priorities implicit in the President's budget for fiscal year 1977 may be illuminated--though not established--by relative technology funding levels and relative emphasis accorded to major program areas during the administrative development of ERDA's energy R,D,&D budget. For instance, a substantial portion of the President's budget for fiscal year 1977 supports nuclear

technologies (60.9 percent of total budget authority for energy R,D,&D and 59.4 percent of outlays). On the other hand, an extremely small portion of the overall energy R, D,&D budget has been earmarked for demand-limiting or conservation technologies (only 3.9 percent of total budget authority and 3.4 percent of outlays). Examination of marginal cuts in budget authority among ERDA programs reveals that ERDA management chose to place relatively high emphasis on the next extra dollar for conservation research and development. In contrast, OMB has chosen to cut this area more deeply than any other ERDA program--a budgetary move compatible with the Administration's view that the private sector should take the lead in developing such technologies.

In designing a budget projection model for energy R, D,&D, the basic building block employed in this analysis was the energy research-related construction project for which the federal share of the total estimated cost in 1977 dollars is expected to be greater than or equal to \$50 million. A crucial underpinning of the building block approach is the ability to realistically assess probable spendout patterns for these big-ticket projects.

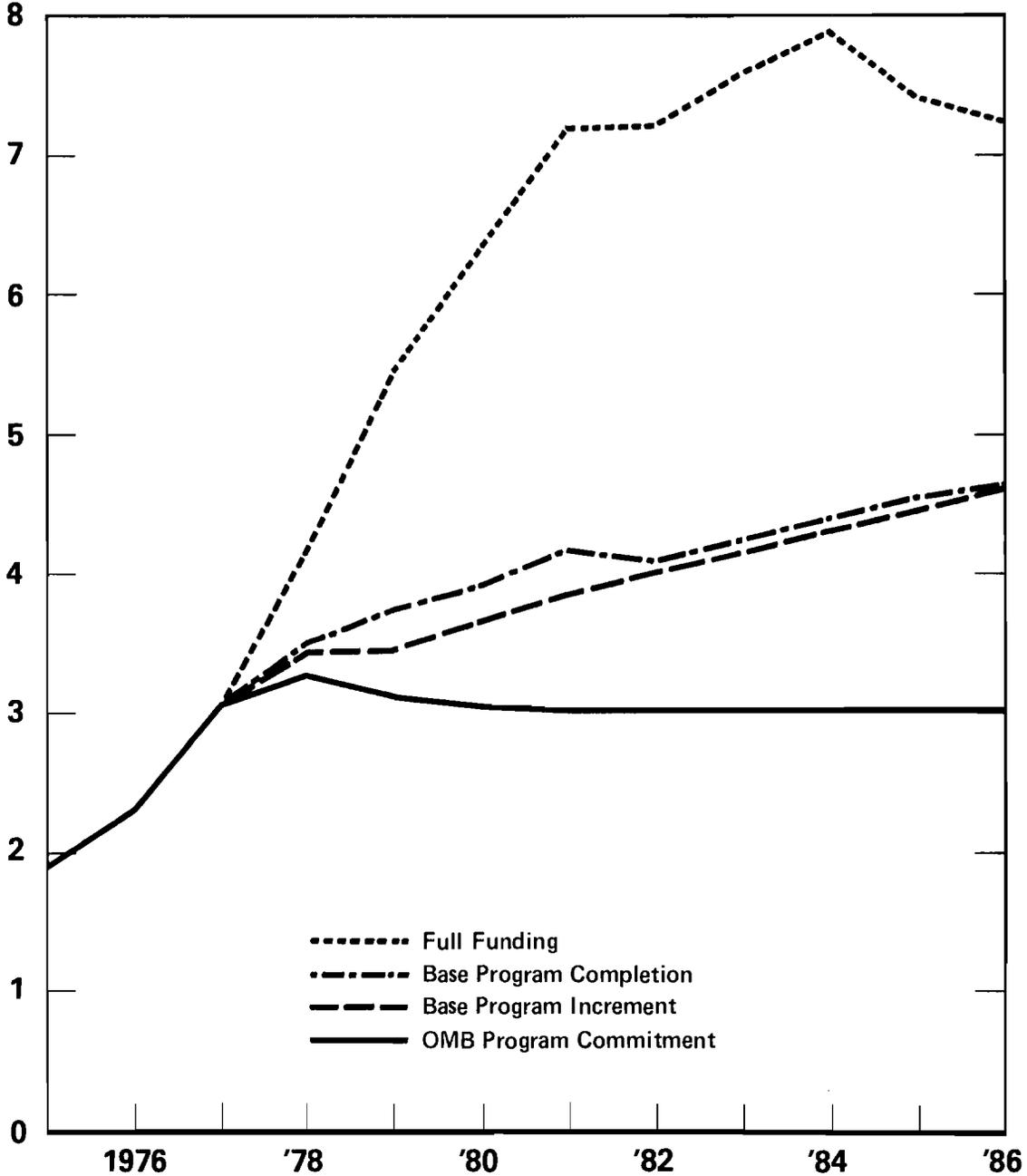
This paper presents the data bank from which the five alternative budget strategies presented in CBO Background Paper No. 10, Energy Research, were derived. Four spending levels were systematically developed for each of the ten major energy research program areas. The first level is based upon the OMB commitment projections contained in ERDA's fiscal year 1977 budget justification documents and is referred to as the OMB program commitment. The second level includes an increment for real growth of the base program and is called the base program increment projection. A third and higher spending level incorporates revised cost estimates for large-scale projects already included in the previous levels to obtain base program completion projections. The fourth and highest level is based upon full funding of all big-ticket items tentatively scheduled in the program implementation portion of ERDA's National Plan for Energy Research, Development, and Demonstration. For the purposes of this analysis, each spending level was projected to fiscal year 1986 for each major program area. These program projection levels were then combined to form alternative budget paths--for both budget authority and outlays. These aggregate paths are illustrated in Summary Charts 1 and 2. In addition, a comparison of ten-year cumulative totals, peak year, and largest annual appropriation request for each of these alternative

Summary Chart 1.

Alternative Energy Research Budget Paths, 1977-1986

BUDGET AUTHORITY

(Fiscal Years, Billions of 1977 Dollars)

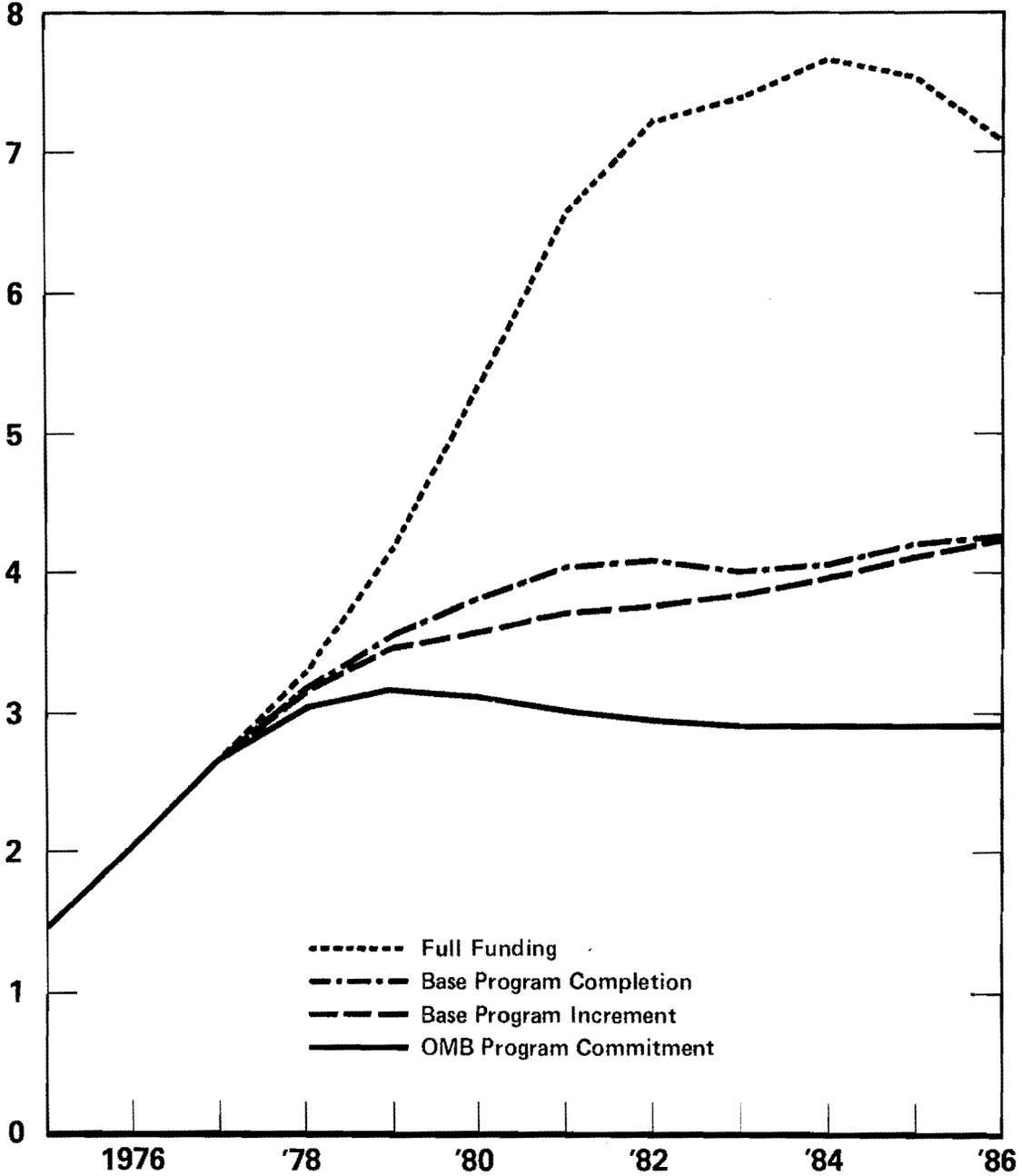


Summary Chart 2.

Alternative Energy Research Budget Paths, 1977-1986

OUTLAYS

(Fiscal Years, Billions of 1977 Dollars)



budget paths is presented in Summary Table 1 below.

SUMMARY TABLE 1

A COMPARISON OF ALTERNATIVE ENERGY
RESEARCH BUDGET PATHS, 1977-1986
(fiscal years, billions of 1977 dollars)

| <u>Budget Path</u> | <u>Budget Authority</u> | | | <u>Outlays</u> | | |
|-------------------------------|---------------------------|----------------------|------------------------|---------------------------|----------------------|------------------------|
| | <u>Ten-year Total</u> | <u>Peak Year</u> | <u>Peak Amount</u> | <u>Ten-Year Total</u> | <u>Peak Year</u> | <u>Peak Amount</u> |
| 1. OMB Program Commitment | 30.7 | 1978 | 3.3 | 29.7 | 1979 | 3.2 |
| 2. Base Program Increment | 39.1 | 1986 | 4.6 | 36.6 | 1986 | 4.3 |
| 3. Base Program Completion | 40.5 | 1986 | 4.7 | 38.0 | 1986 | 4.3 |
| 4. Full Funding | 63.7 | 1984 | 7.9 | 59.0 | 1984 | 7.7 |

Based upon these projections, programmatic emphasis under a base program completion strategy is not expected to shift dramatically over the next decade. The fission reactor program would in all likelihood remain the single largest energy research program. Both the solar energy and geothermal programs would continue to receive relatively minor attention as a percent of the total energy research effort. The only change in relative program size of any significance would occur in conservation research and development as this program expands from ninth to fifth largest by fiscal year 1986--prompted in large part by increased Congressional concern with restraining energy demand.

Pursuit of a full funding strategy, on the other hand, could cause dramatic shifts in program mix in the coming decade. In particular, the solar energy program would rise rapidly from ninth to second largest of all major program areas between fiscal years 1978 and 1985. Moreover, the fossil energy program would decline from second to fifth largest by fiscal year 1986. As in the base program completion projection, however, the largest energy R,D,&D program would continue to be the fission reactor.

The single greatest implication of a full funding budget strategy for energy R,D,&D over the next ten-years would appear to be the rapidly expanding role of large-scale construction projects. Such a commitment to big-ticket items could almost triple between now and fiscal year 1981, when it would consume nearly half of the entire budget for energy R,D,&D. The inherent danger in such an expanding commitment to large-scale projects is that less and less program flexibility will remain to fully explore evolving or as yet untested energy technologies under future constrained federal energy research budgets.

CHAPTER I INTRODUCTION

What is Energy Research?

Energy research can be a time-consuming process stretching from initial conception of a new energy technology to demonstration at near-commercial scales. Many deliberate tasks must be performed to bring the uncertainties and risks of failure associated with a given technology within acceptable limits and to ensure ultimate product viability. These acts logically follow one another through various phases of development and scales of testing.

Phases of Development

Energy research as defined for the purposes of this paper includes three distinct phases: research, development, and demonstration (R,D,&D). Research efforts include both theoretical investigations and basic and applied laboratory work. Development is generally characterized by experimental design, fabrication, and performance evaluation; engineering development; bench testing; and gradual scale-up of components. The last phase consists of demonstration efforts on a scale large enough so that components approximate commercial size individually (but not necessarily in a commercially viable assembly).

Scales of Testing

Scales of testing can range from experiments, bench tests, process development units, and pilot plants of various sizes, through near-commercial demonstration plants. Physical size and cost of installation so named can vary significantly, depending on the nature of the process and the degree of development. Although reliability and quality assurance require extended performance evaluations at increasingly larger scales, it may not be necessary for each emerging energy technology to sequentially progress through every stage of scale-up.

What Constitutes Federal Energy Research?

Federal energy research (R,D,&D) is funded predominantly under subfunction 305 (energy), within function 300 (energy, environment, and natural resources), of the federal budget. In the President's fiscal year 1977 budget, it is referred to as "energy research and development," and amounts to \$3,078 million in budget authority and \$2,677 million in outlays. Although the President's budget does not present a detailed programmatic breakdown, it acknowledges

that in addition to research and development outlays for specific nuclear and non-nuclear technologies, the fiscal year 1977 budget request includes about \$450 million for supporting research in environmental effects and basic energy sciences.

Two interpretations currently exist as to what might logically be included for budgetary purposes under federal energy research. However, neither view permits precise duplication of the figures presented in the President's budget request. Accordingly, a new definition for federal energy research was developed specifically for this analysis, and is presented below following a brief discussion of the two existing viewpoints.

The OMB View

At about the same time that the President's fiscal year 1977 budget was released to the public, the Office of Management and Budget (OMB) published a document highlighting 70 major issues in the fiscal year 1977 budget.¹ One of these issues was the energy research, development, and demonstration program for the Energy Research and Development Administration (ERDA) and other federal agencies. A detailed accounting of the specific program outlays included under this energy R,D,&D formulation is presented in Table 1.² Footnotes facilitate comparison with alternative breakdowns. OMB incorporates outlays for supporting research and energy-related activities from federal agencies other than ERDA to arrive at a grand total of \$2,858 million for fiscal year 1977. OMB did not present similar tabulations for budget authority.

The ERDA View

More recently, in its updated national plan,³ ERDA published a program breakdown for federal energy research

1. Office of Management and Budget, Seventy Issues: Fiscal Year 1977 Budget, Washington, D.C., January 21, 1976.

2. Due to the large number of tables required by a methodology paper of this nature, all tables have been arranged at the end of each chapter for simplicity in presentation.

3. U.S. Energy Research and Development Administration, A National Plan for Energy Research, Development and Demonstration: Creating Energy Choices for the Future (1976), Vol. 1: The Plan (commonly referred to as ERDA 76-1).

and development. Relevant budget summaries from this document are presented in Table 2. Again, footnotes provide the basis for comparisons. The ERDA version yields \$3,359.8 million in budget authority and \$2,905.4 million in outlays. As in the earlier case, total federal energy research and development figures exceed those presented in the President's fiscal year 1977 budget. This is due largely to the fact that ERDA classifies indirect energy research efforts by other federal agencies as supporting research and development.

CBO Program Breakdown

For the purposes of this analysis, CBO has decided to utilize a programmatic definition for federal energy research that most closely approximates both the spirit and totals presented in the President's fiscal year 1977 budget under energy research and development. Therefore, only directly-related federal energy R,D,&D programs (including both nuclear and non-nuclear efforts) and ERDA supporting technologies (as embodied in the Environmental Research & Safety and the Basic Energy Sciences programs) have been included. Thus, supporting research by agencies other than ERDA has been excluded. A detailed summary of this definition is presented in Table 3. Such a breakdown yields \$3,080 million in budget authority and \$2,685 million in outlays.

Comparison of Alternative Views

As illustrated in Table 4, the programmatic breakdown derived specifically for this analysis comes closest to duplicating the figures presented in the fiscal year 1977 budget request.

TABLE 1

GRAND TOTAL ENERGY R,D,&D FOR ERDA AND
OTHER FEDERAL AGENCIES: THE OMB VIEW

The following table summarizes the energy research, development, and demonstration program for ERDA and other federal agencies:

| Program Activities | (Outlays in millions of dollars) | | | | Percent Change |
|------------------------------------|----------------------------------|------------|-------------------|------------|----------------|
| | FY 1976 | | FY 1977 | | |
| | \$ | % | \$ | % | |
| ERDA, Total..... | 1412 | 64 | 1975 | 69 | + 40 |
| Non-Nuclear, Total..... | (519) | (24) | (710) | (25) | (+ 37) |
| Fossil..... | 333 | 15 | 442 | 15 | + 33 |
| Solar..... | 86 | 4 | 116 | 4 | + 35 |
| Geothermal..... | 32 | 2 | 46 | 2 | + 44 |
| Conservation..... | 56 | 2 | 91 | 3 | + 63 |
| Environmental Control..... | 12 | 1 | 15 ^{a/} | 1 | + 25 |
| Nuclear, Total..... | (893) | (40) | (1265) | (44) | (+ 42) |
| Fusion..... | 224 | 10 | 304 | 11 | + 3 |
| Fission..... | 521 | 23 | 709 ^{b/} | 24 | + 3 |
| Fuel Cycle/Safeguards..... | 59 | 3 | 144 ^{c/} | 5 | + 1 |
| Enrichment R&D..... | 89 | 4 | 108 ^{d/} | 4 | + 1 |
| EPA (Environmental Control)... | 87 | 4 | 75 | 3 | - 4 |
| NRC (Safety Research)..... | 94 | 4 | 116 | 4 | + 23 |
| DOI (Mining)..... | 52 | 2 | 64 | 2 | + 23 |
| Other..... | 14 | 1 | 9 | -- | - 36 |
| <u>Total Direct Energy R&D</u> | <u>1659</u> | <u>75</u> | <u>2239</u> | <u>78</u> | <u>+ 35</u> |
| <u>Supporting R&D</u> | | | | | |
| ERDA..... | 373 | 17 | 403 ^{e/} | 14 | + 8 |
| EPA..... | 40 | 2 | 47 | 2 | + 18 |
| NSF..... | 93 | 4 | 139 | 5 | + 50 |
| <u>Total Supporting R&D</u> | <u>506</u> | <u>23</u> | <u>589</u> | <u>21</u> | <u>+ 16</u> |
| <u>Energy Related</u> | | | | | |
| DOI (Mine Health/Safety).... | 29 | 2 | 30 | 1 | + 3 |
| <u>GRAND TOTAL.....*</u> | <u>2194</u> | <u>100</u> | <u>2858</u> | <u>100</u> | <u>+ 30</u> |

*In addition, the FY 1977 budget identifies funds to accelerate the commercialization and demonstration of energy technologies through loan guarantees: Geothermal Resources Development Fund, FY 1977 outlays of \$4.4 million; and Synthetic Fuels Commercial Demonstration Fund, FY 1976 outlays of \$3.0 million.

SOURCE: OMB, Seventy Issues, pages 52-53.

Commentary Footnotes for Fiscal Year 1977

- A subprogram of ERDA's Environmental Research and Safety Program.
- Incorporates \$24.7 million in outlays from ERDA's Reactor Safety Facilities subprogram (under Environmental Research and Safety) as part of Fission Power Development.
- Excludes \$30.1 million in outlays for Uranium Resource Assessment.
- Includes \$68.3 million in outlays for U-235 Process Development and \$39.2 million in outlays for Advanced Isotope Separation.
- Presumably includes \$198.5 million in outlays for Biomedical and Environmental Research (from ERDA's Environmental Research and Safety Program) and \$204.4 million in outlays for ERDA's Basic Energy Sciences Program.

TABLE 2

TOTAL FEDERAL ENERGY RESEARCH
AND DEVELOPMENT: THE ERDA VIEW

| | Federal Energy R&D (in millions) | | | | | |
|-------------------------------------|----------------------------------|------------------|------------------|------------------|------------------|------------------|
| | FY 75 | | FY 76* | | FY 77 | |
| | BA | BO | BA | BO | BA | BO |
| Direct Energy R&D | | | | | | |
| ERDA | \$1,317.0 | \$1,011.0 | \$1,657.0 | \$1,427.0 | \$2,435.0 | \$2,009.0 |
| DOI | 89.9 | 54.2 | 104.0 | 93.3 | 98.3 | 96.3 |
| EPA | 80.8 | 18.2 | 56.8 | 76.6 | 55.4 | 76.6 |
| NRC | 58.9 | 51.7 | 87.5 | 76.9 | 104.0 | 98.2 |
| NASA | 0.8 | 0.8 | 1.7 | 1.0 | -0- | 0.8 |
| Subtotal | 1,547.4 | 1,135.9 | 1,907.0 | 1,674.8 | 2,692.7 | 2,280.9 |
| Supporting R&D | | | | | | |
| ERDA | 362.0 | 313.0 | 403.0 | 373.0 | 430.0 | 404.0 |
| DOI | 33.2 | 30.9 | 59.0 | 56.7 | 66.8 | 65.2 |
| EPA | 53.2 | 5.0 | 43.2 | 43.4 | 41.6 | 43.4 |
| NRC | 2.3 | 2.1 | 9.6 | 9.1 | 5.3 | 5.0 |
| NSF | 103.2 | 65.9 | 114.6 | 74.2 | 123.4 | 106.9 |
| Subtotal | 553.9 | 416.9 | 629.4 | 556.4 | 667.1 | 624.5 |
| Total Federal Energy R&D | \$2,101.3 | \$1,551.9 | \$2,536.4 | \$2,231.2 | \$3,359.8 | \$2,905.4 |

* Funds for FY 76 Transition Quarter are not included.

| ERDA Energy R&D Budget (Outlays in millions) | | | | ERDA Energy R&D Budget (Authority in millions) | | | |
|---|----------------|----------------|---|---|----------------|----------------|---|
| FY 75 | FY 76† | FY 77 | FY 76 to FY 77 percent change* | FY 75 | FY 76† | FY 77 | FY 76 to FY 77 percent change* |
| Direct Energy R&D | | | | Direct Energy R&D | | | |
| Nuclear Fuel Cycle and Safeguards | \$ 120 | \$ 163 | \$ 282 ^{a/} | 73 | \$ 118 | \$ 173 | \$ 347 ^{a/} |
| Conservation | 21 | 55 | 91 ^{b/} | 64 | 36 | 75 | 120 ^{b/} |
| Geothermal | 21 | 32 | 50 ^{b/} | 57 | 28 | 31 | 100 ^{b/} |
| Fusion | 151 | 224 | 304 ^{c/} | 36 | 183 | 250 | 392 ^{c/} |
| Fission | 538 | 522 | 709 ^{c/} | 36 | 567 | 602 | 823 ^{c/} |
| Solar | 15 | 86 | 116 | 35 | 42 | 115 | 160 |
| Fossil | 138 | 333 | 442 | 33 | 335 | 398 | 477 |
| Environmental Control Tech. | 7 | 12 | 15 ^{d/} | 24 | 8 | 13 | 16 ^{d/} |
| Subtotal | 1,011 | 1,427 | 2,009 | | 1,317 | 1,657 | 2,435 |
| Supporting Research | | | | Supporting Research | | | |
| Basic Energy Sciences | 165 | 188 | 205 | 9 | 191 | 210 | 227 |
| Environmental Research | 148 | 185 | 199 ^{e/} | 7 | 171 | 193 | 203 ^{e/} |
| Subtotal | 313 | 373 | 404 | | 362 | 403 | 430 |
| Total ERDA Energy RD&D | \$1,324 | \$1,800 | \$2,413 | | \$1,679 | \$2,060 | \$2,865 |

† Funds for FY 76 Transition Quarter are not included.

* Percentage change calculated prior to rounding outlays.

† Funds for FY 76 Transitional Quarter are not included.

* Percentage change calculated prior to rounding authority.

SOURCE: ERDA 76-1, The Plan, page 10.

Commentary Footnotes for Fiscal Year 1977

- Specifically includes \$36.5 million in budget authority and \$30.1 million in outlays for Uranium Resource Assessment. These figures also include \$95.9 million in budget authority and \$68.3 million in outlays for U-235 Process Development plus \$43.8 million in budget authority and \$39.2 million in outlays for Advanced Separation Technology (both of which are listed under Uranium Enrichment Activities in the ERDA budget).
- Considers the \$50 million in budget authority and \$4.4 million in outlays from the Geothermal Loan Guarantee program as part of geothermal energy R,D,&D efforts.
- Incorporates \$33.3 million in budget authority and \$24.7 million in outlays from the Reactor Safety Facilities subprogram (under Environmental Research and Safety) as part of Fission Power Development.
- A subprogram of the Environmental Research and Safety Program.
- Includes only those funds requested for Biomedical and Environmental Research under the Environmental Research and Safety Program. Moreover, ERDA has excluded the related Operational Safety subprogram from consideration as part of federal energy R,D,&D.

TABLE 3
TOTAL FEDERAL ENERGY RESEARCH:
A CBO COMPILATION

| | <u>Fiscal Year 1977</u> | |
|---|-------------------------|-------------------------|
| | <u>Budget</u> | <u>Authority Outlay</u> |
| I. Direct Energy Technologies: | | |
| A. ERDA Fossil Energy Dev. Program | 477 | 442 |
| B. ERDA Solar Energy Dev. Program | 160 | 116 |
| C. ERDA Geothermal Energy Dev. Program ^{a/} | 50 | 46 |
| D. ERDA Conservation R&D Program | 120 | 91 |
| E. ERDA Fusion Power R&D Program | 392 | 304 |
| F. ERDA Fission Power Reactor Dev. Program | 790 | 684 |
| G. Other Direct Energy Nuclear Programs | | |
| 1. ERDA Fuel Cycle R&D Program | 179 | 147 |
| 2. ERDA Nuclear Mat'ls. Security and Safeguards Program | 28 | 27 |
| 3. ERDA Uranium Enrichment Process Dev. | 96 | 69 |
| 4. ERDA Advanced Isotope Sep. Tech. | 44 | 39 |
| H. Other Agency Direct Energy Related Programs | | |
| 1. Nuclear Regulatory Commission | 104 | 98 |
| 2. Department of Interior | 98 | 96 |
| 3. Environmental Protection Agency | 55 | 77 |
| 4. Nat'l. Aeronautics & Space Administration | 0 | 1 |
| Total Direct Energy | 2,593 | 2,237 |
| II. Supporting Technologies: | | |
| A. ERDA Environmental Research & Safety Program | | |
| 1. Biomedical and Environmental Research | 202 | 198 |
| 2. Operational Safety | 9 | 6 |
| 3. Environmental Control Technology | 16 | 15 |
| 4. Reactor Safety Facilities | 33 | 25 |
| B. ERDA Basic Energy Sciences Programs | | |
| 1. Nuclear Science | 93 | 94 |
| 2. Materials Sciences | 78 | 58 |
| 3. Molecular, Mathematical, and Geo-Sciences | 54 | 50 |
| 4. Other Capital Equipment for Nat'l. Labs | 2 | 2 |
| Total Supporting Energy Research | 487 | 448 |
| TOTAL FEDERAL ENERGY RESEARCH | 3,080 | 2,685 |

a. Excluding the Geothermal Loan Guarantee Program since it is intended primarily as an incentive for commercialization rather than as a stimulant for research, development, or demonstration.

TABLE 4
COMPARISON OF ALTERNATIVE VIEWS REGARDING
TOTAL FEDERAL ENERGY R,D,&D FOR FISCAL YEAR 1977
(millions of dollars)

| <u>Alternative Views</u> | <u>Budget Authority</u> | <u>Outlays</u> |
|--------------------------------|-----------------------------|----------------|
| The President's Budget Request | 3,078 | 2,677 |
| OMB's Seventy Issues | -- | 2,858 |
| ERDA's National Plan | 3,359.8 | 2,905.4 |
| CBO Program Breakdown | 3,080 | 2,685 |

CHAPTER II
THE PRESIDENT'S ENERGY
RESEARCH BUDGET FOR FISCAL YEAR 1977

This chapter presents a detailed assessment of the President's overall energy research program for fiscal year 1977--encompassing all federal energy research, development and demonstration activities as defined in Chapter I. As such, this chapter will provide four perspectives of the federal energy research budget for fiscal year 1977: (1) a brief overview including historic comparison of major program funding levels; (2) current program emphasis; (3) implicit priorities; and (4) a summary of big-ticket items.

Overview

Since it was not possible to duplicate the exact figures presented in the President's fiscal year 1977 budget by adding individual program funding levels for energy R,D,&D, the in-depth analysis contained in this chapter has been based upon the CBO programmatic structure developed in Chapter I. This breakdown for federal energy research yields total funding requests of \$3,080 million in budget authority and \$2,685 million in outlays for fiscal year 1977, (or well within 1 percent of the President's actual budget request). Overall, this amounts to a 32.9 percent increase in budget authority and a 30.6 percent increase in outlays over estimated fiscal year 1976 totals. Distribution of fiscal year 1977 federal energy research funds by agency is illustrated in Table 5 as a percent of total funding. In addition, Tables 6 and 7 present historical programmatic comparisons for budget authority and outlays, respectively. Included are actual fiscal year 1975 amounts, fiscal year 1976 and transition quarter estimates, and administrative development of program budgets for fiscal year 1977 where applicable.¹

1. Only ERDA makes available budget history tables for comparing division requests with those submitted to the OMB and to the Congress. For a more detailed breakout, see U.S. Energy Research and Development Administration, FY 1977 Budget History Tables--the so-called Holifield Tables.

Collectively among fiscal year 1977 ERDA energy research programs--both direct and supporting--the various divisions requested about \$1,561 million in budget authority and \$942 million in outlays more than were finally approved by OMB. Similarly, the ERDA administrator requested approximately \$1,097 million in budget authority and \$700 million in outlays more than were finally approved by OMB for all ERDA energy research programs. Comparable figures were not available for other federal agencies.

Current Program Emphasis

A brief comparison of the relative emphasis placed upon the ten major energy research program areas in the fiscal year 1977 budget as measured by percent of total energy research effort, dollar increase in program size over fiscal year 1976 levels, and rate of program growth since fiscal year 1976 is illustrated in Table 8. These percentages and changes are ranked in Table 9. Caution is necessary in interpreting these tables; the state of technology, aggressiveness and capacity of the private sector, and the availability and cost of research opportunities, as well as relative subjective priorities, are determinants of funding levels.

The dominant effort in the fiscal year 1977 energy research budget is the fission power reactor development program--primarily as a result of the rapidly maturing liquid metal fast breeder reactor subprogram of which the largest single element continues to be the construction of the Clinch River Breeder Reactor. Moreover, the most rapidly expanding program area in the fiscal year 1977 energy research budget consists of other nuclear programs designed largely to support this effort. Conservation and solar energy programs have also achieved high growth rates this year; however, overall program funding levels for these programs remain the lowest of the ten major program areas.

Implicit Priorities

A number of energy research priorities implicit in the fiscal year 1977 energy research budget can be illuminated --though not established--through an analysis of relative technology funding levels among energy research programs, and a comparison of ratios of program funding requested by ERDA division heads, agency management, and OMB.

Relative Technology Funding Levels

In pursuit of an energy future with an important role for intensive electrification, the fiscal year 1977 energy research budget reflects a strong commitment to advanced nuclear technologies. As a percent of total energy research, the total fiscal year 1977 nuclear effort amounts to 60.9 percent of budget authority and 59.4 percent of outlays. Sixty-three percent of budget authority for total direct energy research and 61.2 percent of outlays are committed to direct nuclear technologies. A specific breakdown of nuclear-related federal energy research for fiscal year 1977 is presented in Table 10.

Projects undertaken primarily to expand energy supplies consume about 74.2 percent of total budget authority for energy R,D,&D and 72.4 percent of associated outlays. On the other hand, demand-limiting technologies constitute approximately 3.9 percent and 3.4 percent, respectively, of total energy research efforts. (The balance is devoted to supporting technologies.) Similarly, 30 percent of total budget authority and 30.8 percent of total outlays are devoted to non-renewable resource technologies while 43.6 percent and 41 percent, respectively, are earmarked for essentially inexhaustible technologies. Specific programmatic content for these additional technology measures is presented in Table 11.

A comparison of relative funding levels among all technology measures including nuclear is illustrated in Table 12 both as a percent of total and direct energy research.

Ratio Comparisons of Requested to Approved Funds

Another indication of the Administration's priorities is provided by ratio comparisons of requested to approved funds among the various ERDA programs.

The President's request is the final stage in administrative budget design, leading from division to agency to OMB to Congress. Each year with the annual budget submission, ERDA informs Congress of levels of funding initially requested within the agency by each of its program divisions, the levels that ERDA subsequently requested within the Administration, and the levels finally submitted to Congress in the President's budget. These funding levels are summarized in three sets of tables--one each for ERDA line-item construction projects, operating expenses, and

capital equipment--and are collectively referred to as the Holifield Tables.

Since ERDA programs constitute around 90 percent of all federally-funded energy R,D,&D, this budget history summary can provide useful insight into the internal development and overall direction of our present national energy research efforts. In particular, it may be possible through the use of ratio comparisons to illuminate the evolution of current research priorities as the ERDA energy research budget progresses from the initial program division requests, through the ERDA administrator, and finally, to OMB to be incorporated into the President's request. Two ratios will be examined for each major energy-related ERDA program area in an attempt to illustrate the pattern of successive marginal budget cuts. The first is the ratio of funding levels recommended by the ERDA administrator to those originally requested by the responsible program divisions. The second is the ratio of funding approved by OMB to that advanced by the ERDA administrator for each major program area. Of these two ratios, the second is probably the most interesting because it highlights the tradeoffs and changes made at the margin under a more or less fixed budget constraint to conform with the overall relative emphasis accorded research and other possible federal actions in the various program areas. Both sets of ratios are presented in Table 13. The smallest ratios reflect the deepest program area cuts at the margin.

As can be seen, potential differences in implicit research program priorities exist between ERDA and OMB in several areas. For example, ERDA's marginal cuts for budget authority in the conservation program area are the second smallest relatively contrasted with OMB's marginal cuts which are the deepest of any major program area presented. Such major differences represent, at least in part, a view by the Administration that price in the private sector--rather than government technology--offers the greatest potential for a reduction in energy demands. Potential differences also lie in the other nuclear programs area where OMB placed considerably lower emphasis at the margin relative to other programs than did the ERDA administrator who cut this program area less than any other for both budget authority and outlays. Lastly, OMB chose to reduce the budget request for the fission program less than all other programs as opposed to ERDA cuts that were relatively more substantial.

Big-Ticket Items

A number of large-scale construction projects are included in the fiscal year 1977 energy research budget-- some of which have been traditionally carried under program operating expenses as opposed to specific line items in the ERDA capital budget. Specific examples include fossil energy pilot plants and the Clinch River Breeder Reactor. Table 14 summarizes all big-ticket items incorporated into the fiscal year 1977 energy research budget whose federal share of total estimated cost is expected to equal or exceed \$50 million. Also included in this category are those projects for which existing authorization extends only to architectural and engineering work, but whose eventual total estimated cost is expected to exceed \$50 million if a final decision is made to continue with construction. Big-ticket items represent 17.1 percent of total budget authority and 13.6 percent of total outlays requested for energy R,D,&D in fiscal year 1977.

TABLE 5
 DISTRIBUTION OF FISCAL YEAR 1977
 FEDERAL ENERGY RESEARCH BY AGENCY
 (percent of total funding)

| <u>Agency</u> | <u>Budget Authority</u> | <u>Outlays</u> |
|--|-----------------------------|----------------|
| Energy Research and Development Administration (ERDA) | 91.7 | 89.9 |
| Nuclear Regulatory Commission (NRC) | 3.4 | 3.7 |
| Department of Interior (DOI) | 3.2 | 3.6 |
| Environmental Protection Agency (EPA) | 1.8 | 2.8 |
| National Aeronautics and Space Administration (NASA) | 0 | * |

* Less than 0.05 percent resulting from budget authority in prior years. The Administration proposes no new funding directly to NASA; that agency will, however, continue to do work on energy funded through other agencies, especially ERDA.

NOTE: Numbers may not add to 100 percent due to rounding.

TABLE 6
 HISTORICAL COMPARISON OF FEDERAL
 ENERGY RESEARCH EFFORTS BY MAJOR PROGRAM
 Budget Authority
 (millions of current dollars)

| Program | 1975 | 1976 | TQ | FY 1977 Budget Request | | |
|--------------------------------|--------|----------|----------|------------------------|-------|-------|
| | Actual | Estimate | Estimate | Division | ERDA | OMB |
| <u>Fossil Energy</u> | 335 | 398 | 105 | 816 | 721 | 477 |
| <u>Solar Energy</u> | 42 | 115 | 34 | 300 | 255 | 160 |
| <u>Geothermal</u> | 28 | 31 | 12 | 102 | 90 | 50 |
| <u>Conservation</u> | 36 | 75 | 17 | 255 | 235 | 120 |
| <u>Fusion Power</u> | 183 | 250 | 80 | 588 | 513 | 392 |
| <u>Fission Reactor</u> | 567 | 602 | 137 | 1,022 | 901 | 790 |
| <u>Other Nuclear -</u> | | | | | | |
| Nuclear Fuel Cycle | 36 | 69 | 21 | 336 | 336 | 179 |
| Nuclear Safeguards | 10 | 17 | 4 | 34 | 34 | 28 |
| Process Development | 47 | 55 | 15 | 116 | 114 | 96 |
| Advanced Isotope Separation | 24 | 32 | 10 | 63 | 53 | 44 |
| TOTAL OTHER NUCLEAR | (117) | (173) | (50) | (549) | (537) | (347) |
| <u>Other Agency Direct -</u> | | | | | | |
| NRC | 59 | 87 | -- | NA | NA | 104 |
| DOI | 90 | 104 | -- | NA | NA | 98 |
| EPA | 81 | 57 | -- | NA | NA | 55 |
| NASA | 1 | 2 | -- | NA | NA | 0 |
| TOTAL OTHER AGENCY DIRECT | (231) | (250) | (--) | (NA) | (NA) | (257) |
| <u>Environmental -</u> | | | | | | |
| Biomed. & Environ. | 171 | 192 | 49 | 310 | 289 | 202 |
| Operational Safety | 4 | 8 | 2 | 17 | 13 | 9 |
| Environ. Control Tech. | 8 | 13 | 4 | 41 | 41 | 16 |
| Reactor Safety | 0 | 0 | 0 | 62 | 34 | 33 |
| TOTAL ENVIRONMENTAL | (183) | (213) | (55) | (430) | (377) | (260) |
| <u>Basic Energy Sciences -</u> | | | | | | |
| Nuclear Science | 100 | 108 | 23 | 109 | 108 | 93 |
| Materials Sciences | 48 | 53 | 16 | 126 | 103 | 78 |
| Molecular Sciences | 42 | 48 | 14 | 84 | 77 | 54 |
| Other Equip. for Labs | 1 | 2 | 1 | 3 | 3 | 2 |
| TOTAL BASIC ENERGY SCIENCES | (191) | (211) | (54) | (322) | (291) | (227) |
| TOTAL FEDERAL ENERGY RESEARCH | 1,913 | 2,318 | -- | NA | NA | 3,080 |

SOURCE: Based upon budget data provided by the U.S. Energy Research and Development Administration.

TABLE 7
 HISTORICAL COMPARISON OF FEDERAL
 ENERGY RESEARCH EFFORTS BY MAJOR PROGRAM
 Outlays
 (millions of current dollars)

| <u>Program</u> | 1975 | 1976 | TQ | FY 1977 Budget Request | | |
|------------------------------------|---------------|-----------------|-----------------|------------------------|-------------|------------|
| | <u>Actual</u> | <u>Estimate</u> | <u>Estimate</u> | <u>Division</u> | <u>ERDA</u> | <u>OMB</u> |
| <u>Fossil Energy</u> | 138 | 333 | 64 | 614 | 570 | 442 |
| <u>Solar Energy</u> | 15 | 86 | 26 | 230 | 202 | 116 |
| <u>Geothermal</u> | 21 | 32 | 9 | 79 | 71 | 46 |
| <u>Conservation</u> | 21 | 56 | 14 | 185 | 166 | 91 |
| <u>Fusion Power</u> | 151 | 224 | 65 | 426 | 386 | 304 |
| <u>Fission Reactor</u> | 538 | 522 | 158 | 833 | 777 | 684 |
| Other Nuclear - | | | | | | |
| <u>Nuclear Fuel Cycle</u> | 32 | 59 | 18 | 214 | 214 | 147 |
| <u>Nuclear Safeguards</u> | 7 | 15 | 4 | 31 | 31 | 27 |
| <u>Process Development</u> | 62 | 61 | 14 | 80 | 78 | 69 |
| <u>Advanced Isotope Separation</u> | 19 | 28 | 8 | 51 | 46 | 39 |
| TOTAL OTHER NUCLEAR | (120) | (163) | (44) | (376) | (369) | (282) |
| <u>Other Agency Direct</u> | | | | | | |
| NRC | 52 | 77 | -- | NA | NA | 98 |
| DOI | 54 | 93 | -- | NA | NA | 96 |
| EPA | 18 | 77 | -- | NA | NA | 77 |
| NASA | 1 | 1 | -- | NA | NA | 1 |
| TOTAL OTHER AGENCY DIRECT | (125) | (248) | (--) | (NA) | (NA) | (272) |
| <u>Environmental -</u> | | | | | | |
| <u>Biomed. & Environ.</u> | 148 | 185 | 48 | 258 | 246 | 198 |
| <u>Operational Safety</u> | 4 | 7 | 2 | 13 | 10 | 6 |
| <u>Environ. Control Tech.</u> | 7 | 12 | 4 | 33 | 33 | 15 |
| <u>Reactor Safety</u> | 0 | 0 | 0 | 34 | 26 | 25 |
| TOTAL ENVIRONMENTAL | (159) | (204) | (54) | (338) | (315) | (244) |
| <u>Basic Energy Sciences</u> | | | | | | |
| <u>Nuclear Science</u> | 79 | 91 | 25 | 109 | 108 | 94 |
| <u>Materials Sciences</u> | 44 | 50 | 14 | 88 | 77 | 58 |
| <u>Molecular Sciences</u> | 41 | 46 | 12 | 75 | 69 | 50 |
| <u>Other Equip. for Labs</u> | 1 | 1 | 1 | 2 | 3 | 2 |
| TOTAL BASIC ENERGY SCIENCES | (165) | (188) | (52) | (274) | (257) | (204) |
| TOTAL FEDERAL ENERGY RESEARCH | 1,453 | 2,056 | -- | NA | NA | 2,685 |

SOURCE: Based upon budget data provided by the U.S. Energy Research and Development Administration.

TABLE 8

PROGRAM EMPHASIS IN THE FEDERAL ENERGY
RESEARCH BUDGET FOR FISCAL YEAR 1977
(funding changes in millions of 1977 dollars)

| Major Program Area | Budget Authority | | | Outlays | | |
|---------------------------------------|---|-------------------------------|-------------------------------------|---|-------------------------------|-------------------------------------|
| | FY 1977 as Percent of Grand Total | Dollar Change Over FY 1976 | Percent Increase Over FY 1976 | FY 1977 as Percent of Grand Total | Dollar Change Over FY 1976 | Percent Increase Over FY 1976 |
| <u>I. Direct Energy Technologies:</u> | | | | | | |
| A. Fossil Energy | 15.5 | + 79 | 19.8 | 16.5 | +109 | 32.7 |
| B. Solar Energy | 5.2 | + 45 | 39.1 | 4.3 | + 30 | 34.9 |
| C. Geothermal | 1.6 | + 19 | 61.3 | 1.7 | + 14 | 43.8 |
| D. Conservation | 3.9 | + 45 | 60.0 | 3.4 | + 35 | 62.5 |
| (ERDA Non-Nuclear Subtotal) | (26.2) | (+188) | (30.4) | (25.9) | (+188) | (37.1) |
| E. Fusion Power | 12.7 | +142 | 56.8 | 11.3 | + 80 | 35.7 |
| F. Fission Reactor | 25.6 | +188 | 31.2 | 25.5 | +162 | 31.0 |
| G. Other Nuclear | 11.3 | +174 | 100.6 | 10.5 | +119 | 73.0 |
| (ERDA Nuclear Subtotal) | (49.6) | (+504) | (49.2) | (47.3) | (+361) | (39.7) |
| H. Other Agencies | 8.3 | + 7 | 2.8 | 10.1 | + 24 | 9.7 |
| TOTAL DIRECT | 84.2 | +699 | 36.9 | 83.3 | +573 | 34.4 |
| <u>II. Supporting Technologies:</u> | | | | | | |
| A. Environmental | 8.4 | + 47 | 22.1 | 9.1 | + 40 | 19.6 |
| B. Basic Energy Sciences | 7.4 | + 16 | 7.6 | 7.6 | + 16 | 8.5 |
| TOTAL SUPPORT | 15.8 | + 63 | 14.9 | 16.7 | + 56 | 14.3 |
| <u>III. GRAND TOTALS:</u> | | | | | | |
| TOTAL ENERGY RESEARCH | 100.0 | +762 | 32.9 | 100.0 | +629 | 30.6 |

TABLE 9
PROGRAM RANKINGS FOR FISCAL YEAR 1977

| <u>Major Program Area</u> | <u>Budget Authority</u> | | | <u>Outlays</u> | | |
|---------------------------|--|---------------------------------------|--|--|---------------------------------------|--|
| | <u>FY 1977 as Percent of Grand Total</u> | <u>Dollar Change Over FY 1976</u> | <u>Percent Increase Over FY 1976</u> | <u>FY 1977 as Percent of Grand Total</u> | <u>Dollar Change Over FY 1976</u> | <u>Percent Increase Over FY 1976</u> |
| Fossil Energy | 2 | 4 | 8 | 2 | 3 | 6 |
| Solar Energy | 8 | 6 | 5 | 8 | 7 | 5 |
| Geothermal | 10 | 8 | 2 | 10 | 10 | 3 |
| Conservation | 9 | 7 | 3 | 9 | 6 | 2 |
| Fusion Power | 3 | 3 | 4 | 3 | 4 | 4 |
| Fission Reactor | 1 | 1 | 6 | 1 | 1 | 7 |
| Other Nuclear | 4 | 2 | 1 | 4 | 2 | 1 |
| Other Agencies | 6 | 10 | 10 | 5 | 8 | 9 |
| Environmental | 5 | 5 | 7 | 6 | 5 | 8 |
| Basic Energy Sciences | 7 | 9 | 9 | 7 | 9 | 10 |

TABLE 10
 NUCLEAR-RELATED FEDERAL ENERGY
 RESEARCH FOR FISCAL YEAR 1977
 (millions of dollars)

| <u>Program or Subprogram</u> | <u>Requested Budget Authority</u> | <u>Requested Outlays</u> |
|---|---------------------------------------|------------------------------|
| <u>Fusion Power</u> | 392 | 304 |
| <u>Fission Reactor</u> | 790 | 684 |
| <u>Other Nuclear:</u> | | |
| Fuel Cycle R&D | 179 | 147 |
| Mat'ls. Security & Safeguards | 28 | 27 |
| Process Development | 96 | 69 |
| Advanced Isotope Separation | 44 | 39 |
| <u>Other Agencies:</u> | | |
| Nuclear Regulatory Commission | 104 | 98 |
| TOTAL DIRECT NUCLEAR | <u>1,633</u> | <u>1,368</u> |
| <u>Environmental:</u> | | |
| Biomedical & Environmental ^{a/} | 60 | 58 |
| Operational Safety ^{a/} | 9 | 6 |
| Environmental Control Tech. ^{a/} | 10 | 8 |
| Reactor Safety Facilities | 33 | 25 |
| <u>Basic Energy Sciences:</u> | | |
| Nuclear Science | 93 | 94 |
| Materials Science ^{a/} | 21 | 19 |
| Molecular, Math., and Geo-Sciences ^{a/} | 18 | 16 |
| TOTAL SUPPORTING NUCLEAR | <u>244</u> | <u>226</u> |
| TOTAL NUCLEAR EFFORT | <u>1,877</u> | <u>1,594</u> |

SOURCE: Based upon data extrapolated from ERDA, Budget Estimates -Fiscal Year 1977, Books II and III, and subsequent correspondence with ERDA.

a. It is often quite difficult to allocate efforts within these programs between nuclear and non-nuclear technologies.

TABLE 11
OTHER MEASURES OF ENERGY
TECHNOLOGY EMPHASIS FOR FISCAL YEAR 1977
(millions of dollars)

| <u>Program or Subprogram</u> | <u>Requested Budget Authority</u> | <u>Requested Outlays</u> |
|--|---------------------------------------|------------------------------|
| <u>Supply-Oriented Technologies:</u> | | |
| Fossil Energy | 477 | 442 |
| Solar Energy | 160 | 116 |
| Geothermal | 50 | 46 |
| Fusion Power | 392 | 304 |
| Fission Reactor | 790 | 684 |
| Other Nuclear-- | | |
| Fuel Cycle R&D | 179 | 147 |
| Process Development | 96 | 69 |
| Advanced Isotope Separation | 44 | 39 |
| Other Agencies -- | | |
| Dept. of Interior | 98 | 96 |
| | <hr/> | <hr/> |
| TOTAL | 2,286 | 1,943 |
| <u>Demand-Limiting Technologies:</u> | | |
| Conservation | 120 | 91 |
| | <hr/> | <hr/> |
| TOTAL | 120 | 91 |
| <u>Non-Renewable Resource Technologies:</u> | | |
| Fossil Energy | 477 | 442 |
| Fission Reactor (other than Breeder) | 50 | 50 |
| Other Nuclear -- | | |
| Fuel Cycle R&D (Other than Breeder) | 159 | 132 |
| Process Development | 96 | 69 |
| Advanced Isotope Separation | 44 | 39 |
| Other Agencies -- | | |
| Dept. of Interior | 98 | 96 |
| | <hr/> | <hr/> |
| TOTAL | 924 | 828 |
| <u>Essentially Inexhaustible Technologies:</u> | | |
| Solar Energy | 160 | 116 |
| Geothermal | 50 | 46 |
| Fusion Power | 392 | 304 |
| Fission Reactor (Breeder) | 740 | 634 |
| | <hr/> | <hr/> |
| TOTAL | 1,342 | 1,100 |

SOURCE: Based upon data extrapolated from ERDA, Budget Estimates -Fiscal Year 1977, Books I, II, and III, and subsequent correspondence with ERDA.

NOTE: These groupings are not mutually exclusive.

a. While the breeder is not, strictly speaking, an inexhaustible technology, its principal purpose is to extend many-fold the uranium resource base, and is included here because of this resource-conservation characteristic.

TABLE 12
 COMPARISON OF RELATIVE TECHNOLOGY FUNDING
 LEVELS IN THE FISCAL YEAR 1977 ENERGY RESEARCH BUDGET
 (by percentage)

| <u>Technology Measures</u> | <u>Budget Authority</u> | <u>Outlays</u> |
|---|-----------------------------|----------------|
| Total Nuclear Effort: Percent of Total | 60.9 | 59.4 |
| Direct Nuclear Technologies: Percent of Direct | 63.0 | 61.2 |
| Supply-Oriented Technologies: Percent of Total Percent of Direct | 74.2 88.2 | 72.4 86.9 |
| Demand-Limiting Technologies: Percent of Total Percent of Direct | 3.9 4.6 | 3.4 4.1 |
| Non-Renewable Resource Technologies: Percent of Total Percent of Direct | 30.0 35.6 | 30.8 37.0 |
| Essentially Inexhaustible Technologies: Percent of Total Percent of Direct | 43.6 51.8 | 41.0 49.2 |

TABLE 13
 RATIO COMPARISON OF REQUESTED TO APPROVED
 FUNDING FOR FISCAL YEAR 1977 ERDA PROGRAMS

| <u>Programs</u> | <u>Budget Authority</u> | | <u>Outlays</u> | |
|--------------------------|-------------------------|----------------|---------------------|----------------|
| | ERDA to Division | OMB to ERDA | ERDA to Division | OMB to ERDA |
| Fossil Energy | .884 | .662 | .928 | .775 |
| Solar Energy | .850 | .627 | .878 | .574 |
| Geothermal | .882 | .556 | .899 | .648 |
| Conservation | .922 | .511 | .897 | .548 |
| Fusion Power | .872 | .764 | .906 | .788 |
| Fission Reactor | .882 | .877 | .933 | .880 |
| Other Nuclear | .978 | .646 | .981 | .764 |
| Environmental | .877 | .690 | .932 | .775 |
| Basic Energy Sciences | .904 | .780 | .938 | .794 |

SOURCE: Derived from data presented in ERDA, FY 1977
Budget History Tables.

TABLE 14
 SUMMARY OF BIG-TICKET ITEMS IN THE PRESIDENT'S
 FISCAL YEAR 1977 BUDGET FOR ENERGY RESEARCH
 (millions of current dollars)

| Program and Line Item | Total Est. Cost of Fed. Share | Funded Through FY 1976 | Estimated Budget Authority | | Estimated Outlays | |
|---|-------------------------------------|------------------------------|-------------------------------|---------|----------------------|---------|
| | | | TQ | FY 1977 | TQ | FY 1977 |
| <u>FOSSIL ENERGY (Coal)</u> | | | | | | |
| 1. Ebulated Bed (H-Coal) Pilot <u>a/</u> | 60 | 32 | 7 | 21 | 5 | 17 |
| 2. Low BTU Combined Cycle Pilot <u>a/</u> | 50 | 13 | 4 | 17 | 3 | 18 |
| 3. Clean Boiler Fuel Demonstration <u>b/</u> | 91 | 33 | 8 | 30 | 4 | 26 |
| 4. High BTU Syngas Demonstration <u>b/</u> | 25 | 0 | 0 | 10 | 0 | 1 |
| 5. Low BTU Fuel Gas Demonstration <u>b/</u> | 19 | 0 | 0 | 7 | 0 | 1 |
| <u>SOLAR ENERGY</u> | | | | | | |
| 1. 10 MW Central Receiver Solar Pilot <u>a/</u> | 6 | 0 | 0 | 3 | 0 | 0 |
| <u>FUSION POWER</u> | | | | | | |
| 1. Tokamak Test Reactor | 228 | 15 | 6 | 80 | 2 | 34 |
| 2. High Energy Laser Facility | 55 | 2 | 0 | 10 | 1 | 11 |
| <u>FISSION REACTOR</u> | | | | | | |
| 1. Fast Flux Test Facility | 540 | 420 | 0 | 80 | 22 | 80 |
| 2. Clinch River Breeder Reactor | 1,486 ^{c/} | 281 | 24 | 238 | 15 | 171 |
| <u>URANIUM ENRICHMENT</u> | | | | | | |
| 1. Centrifuge Plant Demonstration Facility | 60 | 0 | 0 | 30 | 0 | 5 |

SOURCE: ERDA, Budget Estimates-Fiscal Year 1977, Books I, II, III, and V.

a. Estimates only since fossil energy pilot plants have been traditionally incorporated into program operating expenses as opposed to separate line-item listings in the capital budget.

b. Only architectural and engineering design work is included in fiscal year 1977 request; however, total project cost is expected to exceed \$50 million if authorized for continuation in the next funding phase.

c. As reported in the fiscal year 1977 ERDA budget. ERDA's recently revised figure of \$1,700 million is utilized as the total estimated cost of the federal share in Chapter IV.

CHAPTER III
A BUDGET PROJECTION MODEL FOR ENERGY RESEARCH

A broad energy research strategy is built up from many individual components. In the same manner, a valid budget projection model for energy R,D,&D should start at the project level where the basic unit is the individual test facility, pilot or demonstration plant. This chapter discusses relevant model design considerations, basic building blocks, appropriate spendout patterns for converting estimated project costs into annual budget authority and outlays, and four spending level concepts for utilization in budget forecasting for federal energy research.

Model Design Considerations

Essentially, the ideal budget projection model should be relevant, straightforward, and readily adaptable. It should also be capable of systematic aggregation of numerous basic building block elements. A high degree of flexibility is also necessary so that funding level outputs can be realistically combined in future policy analyses to form broad alternative research strategies based upon varying assessments of fiscal constraints, research opportunities, program maturity, and desired technology emphasis.

Basic Building Blocks

The basic building blocks for this analysis are energy research-related construction projects for which the federal share of the total estimated cost in 1977 dollars is projected to equal or exceed \$50 million. Such elements include those big-ticket items listed as separate line-item construction projects in the fiscal year 1977 budget request, large-scale projects traditionally listed under operating expenses in the ERDA budget, and potential projects highlighted in either ERDA-48, Vol 2,¹ or its updated sequel² entailing major construction efforts during the next decade.

-
1. A National Plan for Energy Research, Development and Demonstration: Creating Energy Choices for the Future, Vol. 2--Program Implementation, June 28, 1975.
 2. A National Plan for Energy Research, Development and Demonstration: Creating Energy Choices for the Future, (1976)--Program Implementation: available in draft form only when the data bank for this analysis was developed.

Budget Authority and Outlay Estimates

A crucial underpinning of the building block approach is the ability to assess realistically a probable spend-out pattern for converting total estimated costs into annual budget authority and outlays for each major project. In general, such large-scale construction projects are formally approved through phased funding on an annual basis. For the purposes of this analysis, three appropriation funding phases will be employed to derive budget authority projections for the general case--30 percent of the total estimated cost in the first year, 30 percent in the second, and the remaining 40 percent in the third. In addition, operating expenses estimated at 10 percent of the total estimated cost per year will be taken into account, normally running from the fourth through the seventh year of a project's lifespan. To convert to outlays, the first appropriation phase is assigned the following spendout rate: 17.5 percent in the first year, 35 percent in both the second and third, and 12.5 percent in the fourth. The second and third annual appropriations are spent as follows: 33.3 percent in the year of appropriation, 40 percent in the second, and 26.7 percent in the third. Outlays for project operating expenses are assumed to occur in the year for which they are appropriated and in general, begin by the fourth year and run through the seventh.

The spendout pattern developed in Table 15 for converting appropriations into outlays is typical for a recent ERDA pilot or demonstration plant costing \$100 million, and has been generally applied for costing out building block elements through fiscal year 1986 in this analysis.

Four Spending Level Concepts

To reflect the potential range of spending levels available over the next ten years, four levels reflecting different fiscal situations were systematically developed for each of the ten major energy research program areas.

The first spending level is derived from the OMB commitment projections contained in the fiscal year 1977 budget justification documents. This level will be referred to as the OMB program commitment projection, and essentially reflects a current services strategy with no new starts. In order to complete the data base for a full decade, these projections have been extended at fiscal year 1981 levels for an additional five years through fiscal year 1986.

The second level includes a real growth increment to obtain a base program projection. For mature research programs like fossil energy, fission reactor, other agency direct, environmental and basic energy sciences, a 3 percent annual growth rate--using the fiscal year 1977 program funding request as a base--was employed. Newer or less developed program areas required higher growth rates. The solar energy, geothermal, fusion power, and other nuclear programs were assessed a 6 percent annual rate throughout the coming decade. The real growth increment for the conservation program was derived by permitting the fiscal year 1977 program request to accelerate at 40 percent per year through fiscal year 1981 before stabilizing to a zero growth rate. This second budget level is referred to as the base program increment projection.

A third and higher spending level is derived by fully accounting for those large-scale demonstration projects which have already been initiated but for which only architectural and engineering design or outdated completion cost estimates are included in the OMB program commitment projections. These revised cost estimates are added to the base program increment projections to obtain base program completion projections for affected programs.

The fourth level incorporates the highest level of spending and is based on full program funding of all big-ticket items scheduled in the program implementation portion of ERDA's National Plan for Energy Research, Development and Demonstration. As previously noted, only those projects with an estimated total federal cost greater than or equal to \$50 million were included in this calculation. This upper spending level limit is referred to as the full funding projection.

These alternative spending level concepts for each major program area form the basis of a flexible analytical framework for budgetary forecasting. Although only four alternative budget paths will be developed in this analysis --based upon pure strategy aggregations of these program funding levels--it is possible to assess the potential budgetary impact of any number of alternative energy research policies or strategies with the primary data in this model. For example, the full funding level for one technology could be combined with the base program completion level for another technology to obtain a mixed strategy.

TABLE 15
 DEVELOPMENT OF THE GENERAL CASE SPENDOUT PATTERN FOR
 CONVERTING APPROPRIATIONS INTO OUTLAYS
 (fiscal years, millions of 1977 dollars)

Example for a project whose federal share of the total estimated cost is projected to be \$100 million with construction beginning in fiscal year 1977.

| <u>Appropriation Phases</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> |
|------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| \$30 million for Phase I in 1977 | 5.25 | 10.5 | 10.5 | 3.75 | -- | -- | -- |
| \$30 million for Phase II in 1978 | -- | 10.0 | 12.0 | 8.0 | -- | -- | -- |
| \$40 million for Phase III in 1979 | -- | -- | 13.3 | 16.0 | 10.7 | -- | -- |
| <hr/> | | | | | | | |
| Construction Outlays | 5.25 | 20.5 | 35.8 | 27.75 | 10.7 | -- | -- |
| Plus Operating Expenses | -- | -- | -- | 10.0 | 10.0 | 10.0 | 10.0 |
| <hr/> | | | | | | | |
| TOTAL PROJECT OUTLAYS | 5.25 | 20.5 | 35.8 | 37.75 | 20.7 | 10.0 | 10.0 |

CHAPTER IV BUDGET PROJECTIONS

The purpose of this chapter is, first, to present the primary data developed for each of the ten major program areas, and second, to illustrate the probable overall budgetary impact through fiscal year 1986 of the four spending levels described in Chapter III.

Program Data

The budget authority and outlay data developed for this analysis in each of the ten major energy research program areas is presented on the following pages in Data Tables 1 through 20. Initial estimated costs for big-ticket items were developed from a wide variety of contacts including ERDA program and project managers, ERDA budget analysts and examiners, environmental impact statements, and industry sources. In general, spendout streams conform to the estimation guidelines established in Chapter III. However, discretionary exceptions do exist in some cases where follow-on stages at increased scale overlap earlier research efforts.

Alternative Budget Paths

Ten-year projections for alternative budget paths based upon pure strategy spending levels among major program areas--for both budget authority and outlays--are summarized and illustrated in Charts 1 and 2. A more detailed accounting of aggregate funding requirements is presented in Appendix A including conversion to current dollar estimates based upon a 7.5 percent inflation rate.

DATA TABLE 1
FOSSIL ENERGY DEVELOPMENT PROGRAM
Budget Authority
(fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|--|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| OMB Program Commitment Total | | 477 | 675 | 566 | 604 | 538 | 538 | 538 | 538 | 538 | 538 |
| <u>Plus</u> Real Growth Increment of 3% | | -- | 14 | 29 | 44 | 60 | 76 | 93 | 110 | 127 | 145 |
| <hr/> | | | | | | | | | | | |
| Base Program Increment Total | | 477 | 689 | 595 | 648 | 598 | 614 | 631 | 648 | 665 | 683 |
| <u>Plus</u> Increase in Cost Estimates: | | | | | | | | | | | |
| 1. High BTU Syngas Demo | 325 | -- | -- | 98 | 98 | 130 | 35 | 35 | 35 | 35 | -- |
| 2. Low BTU Fuel Gas Demo | 281 | -- | -- | 84 | 84 | 112 | 30 | 30 | 30 | 30 | -- |
| <hr/> | | | | | | | | | | | |
| Base Program Completion Total | | 477 | 689 | 777 | 830 | 840 | 679 | 696 | 713 | 730 | 683 |
| <hr/> | | | | | | | | | | | |
| <u>Plus</u> Fully Fund Projects | | | | | | | | | | | |
| Under Consideration: | | | | | | | | | | | |
| 1. Synthoil Pilot | 100 | -- | 30 | 30 | 40 | 10 | 10 | 10 | 10 | -- | -- |
| 2. Pressurized Fluid Bed Pilot | 100 | -- | 30 | 30 | 40 | 10 | 10 | 10 | 10 | -- | -- |
| 3. Closed Cycle Gas Turbine Pilot | 75 | -- | -- | 23 | 23 | 30 | 8 | 8 | 8 | 8 | -- |
| 4. Alkali Turbine System Pilot | 75 | -- | -- | 23 | 23 | 30 | 8 | 8 | 8 | 8 | -- |
| 5. MHD Engr'g. Test Facility | 125 | -- | -- | 38 | 38 | 50 | 13 | 13 | 13 | -- | -- |
| 6. MHD Advanced ETF | 300 | -- | -- | -- | -- | -- | 90 | 90 | 120 | 30 | 30 |
| 7. MHD Demo | 750 | -- | -- | -- | -- | -- | 225 | 225 | 300 | 75 | 75 |
| 8. Press. Fluid Bed/Comb. Cycle Demo | 450 | -- | -- | -- | -- | -- | 135 | 135 | 180 | 45 | 45 |
| 9. In Situ Oil Shale Demo | 100 | -- | -- | 30 | 30 | 40 | 10 | 10 | 10 | 10 | -- |
| 10. In Situ Large Gasif. Test Facil. | 50 | -- | -- | 15 | 15 | 20 | 5 | 5 | 5 | -- | -- |
| 11. In Situ Large Gasif. Demo | 150 | -- | -- | -- | -- | -- | 45 | 45 | 60 | 15 | 15 |
| <hr/> | | | | | | | | | | | |
| Full Funding Total | | 477 | 749 | 966 | 1039 | 1030 | 1238 | 1255 | 1437 | 911 | 848 |
| <hr/> | | | | | | | | | | | |
| Full Funding in Current Dollars at 7.5% Inflation | | 477 | 805 | 1116 | 1291 | 1375 | 1776 | 1937 | 2385 | 1623 | 1626 |

a. TEC is total estimated cost.

DATA TABLE 2
FOSSIL ENERGY DEVELOPMENT PROGRAM
Outlays
(fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|--|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| OMB Program Commitment Total | | 442 | 568 | 650 | 683 | 591 | 564 | 538 | 538 | 538 | 538 |
| <u>Plus Real Growth Increment of 3%</u> | | -- | 13 | 27 | 41 | 55 | 70 | 86 | 102 | 118 | 135 |
| Base Program Increment Total | | 442 | 581 | 677 | 724 | 646 | 634 | 624 | 640 | 656 | 673 |
| <u>Plus Increase in Cost Estimates:</u> | | | | | | | | | | | |
| 1. High BTU Syngas Demo | 325 | -- | -- | 17 | 66 | 116 | 122 | 67 | 32 | 32 | -- |
| 2. Low BTU Fuel Gas Demo | 281 | -- | -- | 14 | 57 | 100 | 106 | 58 | 28 | 28 | -- |
| Base Program Completion Total | | 442 | 581 | 708 | 847 | 862 | 862 | 749 | 700 | 716 | 673 |
| <u>Plus Fully Fund Projects Under Consideration:</u> | | | | | | | | | | | |
| 1. Synthoil Pilot | 100 | -- | 5 | 20 | 35 | 37 | 20 | 10 | 10 | -- | -- |
| 2. Pressurized Fluid Bed Pilot | 100 | -- | 5 | 20 | 35 | 37 | 20 | 10 | 10 | -- | -- |
| 3. Closed Cycle Gas Turbine Pilot | 75 | -- | -- | 3 | 15 | 26 | 28 | 15 | 7 | 7 | -- |
| 4. Alkali Turbine System Pilot | 75 | -- | -- | 3 | 15 | 26 | 28 | 15 | 7 | 7 | -- |
| 5. MHD Engr'g. Test Facility | 125 | -- | -- | 6 | 25 | 44 | 47 | 25 | 12 | -- | -- |
| 6. MHD Advanced ETF | 300 | -- | -- | -- | -- | -- | 15 | 61 | 107 | 113 | 62 |
| 7. MHD Demo | 750 | -- | -- | -- | -- | -- | 39 | 153 | 268 | 283 | 155 |
| 8. Press. Fluid Bed/Comb. Cycle Demo | 450 | -- | -- | -- | -- | -- | 23 | 92 | 161 | 169 | 93 |
| 9. In Situ Oil Shale Demo | 100 | -- | -- | 5 | 20 | 35 | 37 | 20 | 10 | 10 | -- |
| 10. In Situ Large Gasif. Test Facil. | 50 | -- | -- | 2 | 10 | 17 | 18 | 10 | 5 | -- | -- |
| 11. In Situ Large Gasif. Demo | 150 | -- | -- | -- | -- | -- | 7 | 30 | 53 | 56 | 31 |
| Full Funding Total | | 442 | 591 | 767 | 1002 | 1084 | 1144 | 1190 | 1350 | 1361 | 1014 |
| Full Funding in Current Dollars at 7.5% Inflation | | 442 | 635 | 886 | 1245 | 1448 | 1642 | 1837 | 2240 | 2427 | 1944 |

a. TEC is total estimated cost.

DATA TABLE 3
SOLAR ENERGY DEVELOPMENT PROGRAM
Budget Authority
(fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|--|------|------|------|------|------|------|------|------|------|------|
| OMB Program Commitment Total | | 160 | 161 | 161 | 118 | 118 | 118 | 118 | 118 | 118 | 118 |
| <u>Plus</u> Real Growth Increment of 6% | | -- | 10 | 20 | 31 | 42 | 54 | 67 | 81 | 95 | 110 |
| <hr/> | | | | | | | | | | | |
| Base Program Increment Total | | 160 | 171 | 181 | 149 | 160 | 172 | 185 | 199 | 213 | 228 |
| <u>Plus</u> Increase in Cost Estimates: | | | | | | | | | | | |
| 1. 10MW Central Receiver Solar Pilot | 150 | -- | -- | 43 | 43 | 58 | 14 | 14 | 14 | 14 | -- |
| <hr/> | | | | | | | | | | | |
| Base Program Completion Total | | 160 | 171 | 224 | 192 | 218 | 186 | 199 | 213 | 227 | 228 |
| <hr/> | | | | | | | | | | | |
| <u>Plus</u> Fully Fund Projects Under Consideration: | | | | | | | | | | | |
| 1. Multiunit Wind Pilot (10MW) | 100 | -- | -- | -- | 30 | 30 | 40 | 10 | 10 | 10 | 10 |
| 2. Multiunit Wind Demo (100MW) | 250 | -- | -- | -- | -- | 75 | 75 | 100 | 25 | 25 | 25 |
| 3. Wind Energy Factory Facilities | 50 | -- | -- | -- | -- | 15 | 15 | 20 | 5 | 5 | 5 |
| 4. OTEC Offshore Pilot (25MW) | 400 | -- | -- | -- | -- | 120 | 120 | 160 | 40 | 40 | 40 |
| 5. OTEC Demo (100MW) | 850 | -- | -- | -- | -- | -- | -- | -- | 255 | 255 | 340 |
| 6. Solar Energy Research Inst. | 50 | -- | 15 | 15 | 20 | 5 | 5 | 5 | 5 | 5 | 5 |
| 7. Low Cost Silicon Array Pilot | 100 | -- | -- | 30 | 30 | 40 | 10 | 10 | 10 | 10 | -- |
| 8. Low Cost Silicon Array Demo | 200 | -- | -- | -- | -- | -- | -- | 60 | 60 | 80 | 20 |
| 9. Large Area Silicon Sheet Pilot | 125 | -- | -- | -- | -- | -- | -- | 38 | 38 | 50 | 13 |
| 10. Automated Array Pilot | 150 | -- | -- | -- | -- | -- | 45 | 45 | 60 | 15 | 15 |
| 11. Automated Array Demo | 200 | -- | -- | -- | -- | -- | -- | -- | 60 | 60 | 80 |
| 12. Central Receiver Demo (100MW) | 400 | -- | -- | -- | -- | -- | -- | 120 | 120 | 160 | 40 |
| 13. Distributed Collector Pilot | 85 | -- | -- | -- | 26 | 26 | 34 | 9 | 9 | 9 | -- |
| 14. Distributed Collector Demo | 400 | -- | -- | -- | -- | -- | -- | 120 | 120 | 160 | 40 |
| 15. Hybrid Solar Thermal Pilot | 75 | -- | -- | -- | -- | 23 | 23 | 30 | 8 | 8 | 8 |
| 16. Wood Plantation Pilot | 100 | -- | -- | 30 | 30 | 40 | 10 | 10 | 10 | 10 | -- |
| 17. Wood Plantation Demo | 250 | -- | -- | -- | -- | -- | -- | -- | -- | 75 | 75 |
| 18. Marine Biomass Pilot | 100 | -- | -- | -- | -- | -- | 30 | 30 | 40 | 10 | 10 |
| 19. Marine Biomass Demo | 250 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 75 |
| <hr/> | | | | | | | | | | | |
| Full Funding Total | | 160 | 186 | 299 | 328 | 592 | 593 | 966 | 1088 | 1214 | 1029 |

Full Funding in Current Dollars
at 7.5% Inflation

160 200 346 407 791 851 1491 1805 2165 1973

a. TEC is total estimated cost.

DATA TABLE 4
SOLAR ENERGY DEVELOPMENT PROGRAM
Outlays
(fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | Fed. Share of TEC ^a | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|-----------------------------------|------|------|------|------|------|------|------|------|------|------|
| OMB Program Commitment Total | | 116 | 133 | 147 | 123 | 121 | 119 | 118 | 118 | 118 | 118 |
| <u>Plus Real Growth Increment of 6%</u> | | -- | 7 | 14 | 22 | 30 | 39 | 49 | 58 | 69 | 80 |
| Base Program Increment Total | | 116 | 140 | 161 | 145 | 151 | 158 | 167 | 176 | 187 | 198 |
| <u>Plus Increase in Cost Estimates:</u> | | | | | | | | | | | |
| 1. 10MW Central Receiver Solar Pilot | 150 | -- | -- | 7 | 30 | 53 | 56 | 31 | 15 | 15 | -- |
| Base Program Completion Total | | 116 | 140 | 168 | 175 | 204 | 214 | 198 | 191 | 202 | 198 |
| <u>Plus Fully Fund Projects</u> | | | | | | | | | | | |
| Under Consideration: | | | | | | | | | | | |
| 1. Multiunit Wind Pilot (10MW) | 100 | -- | -- | -- | 5 | 20 | 35 | 37 | 20 | 10 | 10 |
| 2. Multiunit Wind Demo (100MW) | 250 | -- | -- | -- | -- | 13 | 51 | 89 | 94 | 51 | 25 |
| 3. Wind Energy Factory Facilities | 50 | -- | -- | -- | -- | 2 | 10 | 17 | 18 | 10 | 5 |
| 4. OTEC Offshore Pilot (25MW) | 400 | -- | -- | -- | -- | 21 | 82 | 143 | 151 | 82 | 40 |
| 5. OTEC Demo (100MW) | 850 | -- | -- | -- | -- | -- | -- | -- | 44 | 174 | 304 |
| 6. Solar Energy Research Inst. | 50 | -- | 2 | 10 | 17 | 18 | 10 | 5 | 5 | 5 | 5 |
| 7. Low Cost Silicon Array Pilot | 100 | -- | -- | 5 | 20 | 35 | 37 | 20 | 10 | 10 | -- |
| 8. Low Cost Silicon Array Demo | 200 | -- | -- | -- | -- | -- | -- | 10 | 41 | 71 | 75 |
| 9. Large Area Silicon Sheet Pilot | 125 | -- | -- | -- | -- | -- | -- | 6 | 25 | 44 | 47 |
| 10. Automated Array Pilot | 150 | -- | -- | -- | -- | -- | 7 | 30 | 53 | 56 | 31 |
| 11. Automated Array Demo | 200 | -- | -- | -- | -- | -- | -- | -- | 10 | 41 | 71 |
| 12. Central Receiver Demo (100MW) | 400 | -- | -- | -- | -- | -- | -- | 21 | 82 | 143 | 151 |
| 13. Distributed Collector Pilot | 85 | -- | -- | -- | 4 | 17 | 30 | 32 | 17 | 8 | -- |
| 14. Distributed Collector Demo | 400 | -- | -- | -- | -- | -- | -- | 21 | 82 | 143 | 151 |
| 15. Hybrid Solar Thermal Pilot | 75 | -- | -- | -- | -- | 3 | 15 | 26 | 28 | 15 | 7 |
| 16. Wood Plantation Pilot | 100 | -- | -- | 5 | 20 | 35 | 37 | 20 | 10 | 10 | -- |
| 17. Wood Plantation Demo | 250 | -- | -- | -- | -- | -- | -- | -- | -- | 13 | 51 |
| 18. Marine Biomass Pilot | 100 | -- | -- | -- | -- | -- | 5 | 20 | 35 | 37 | 20 |
| 19. Marine Biomass Demo | 250 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 13 |
| Full Funding Total | | 116 | 142 | 188 | 241 | 368 | 528 | 675 | 916 | 1125 | 1053 |

Full Funding in Current Dollars
at 7.5% Inflation

| | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|------|------|------|------|
| 116 | 153 | 217 | 299 | 491 | 758 | 1042 | 1520 | 2006 | 2019 |
|-----|-----|-----|-----|-----|-----|------|------|------|------|

a. TEC is total estimated cost.

DATA TABLE 5
 GEOTHERMAL ENERGY DEVELOPMENT PROGRAM
 Budget Authority
 (fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC</u> | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|------------------------------|------|------|------|------|------|------|------|------|------|------|
| OMB Program Commitment Total | | 50 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 |
| <u>Plus</u> Real Growth Increment of 6% | | -- | 3 | 6 | 10 | 13 | 17 | 21 | 25 | 30 | 34 |
| Base Program Increment Total | | 50 | 61 | 64 | 68 | 71 | 75 | 79 | 83 | 88 | 92 |
| <u>Plus</u> Increase in Cost Estimates: | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Base Program Completion Total | | 50 | 61 | 64 | 68 | 71 | 75 | 79 | 83 | 88 | 92 |
| <u>Plus</u> Fully Fund Projects under Consideration: | | | | | | | | | | | |
| 1. High Salinity Pilot | 50 | -- | 15 | 15 | 20 | 5 | 5 | 5 | 5 | -- | -- |
| 2. Moderate Temp. Resource Pilot | 50 | -- | 15 | 15 | 20 | 5 | 5 | 5 | 5 | -- | -- |
| 3. Magmatic Resource Test Facility | 100 | -- | -- | 30 | 30 | 40 | 10 | 10 | 10 | 10 | -- |
| 4. Geopressure Pilot | 150 | -- | -- | -- | -- | -- | 45 | 45 | 60 | 15 | 15 |
| 5. Hot Dry Rock Pilot | 200 | -- | -- | -- | -- | -- | -- | 60 | 60 | 80 | 20 |
| 6. Hot Dry Rock Demo | 400 | -- | -- | -- | -- | -- | -- | -- | -- | 120 | 120 |
| 7. Sedimentary Hydrothermal Demo | 200 | -- | 60 | 60 | 80 | 20 | 20 | 20 | 20 | -- | -- |
| 8. Volcanic Hydrothermal Demo | 375 | -- | -- | 113 | 113 | 150 | 38 | 38 | 38 | 38 | -- |
| Full Funding Total | | 50 | 151 | 297 | 331 | 291 | 198 | 262 | 381 | 351 | 247 |
| Full Funding in Current Dollars at 7.5% Inflation | | 50 | 162 | 343 | 411 | 389 | 284 | 404 | 632 | 626 | 473 |

DATA TABLE 6
 GEOTHERMAL ENERGY DEVELOPMENT PROGRAM
 Outlays
 (fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC</u> | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|--|------------------------------|------|------|------|------|------|------|------|------|------|------|
| OMB Program Commitment Total | | 46 | 53 | 56 | 58 | 59 | 58 | 58 | 58 | 58 | 58 |
| <u>Plus</u> Real Growth Increment of 6% | | -- | 3 | 6 | 9 | 12 | 16 | 19 | 23 | 27 | 32 |
| Base Program Increment Total | | 46 | 56 | 62 | 67 | 71 | 74 | 77 | 81 | 85 | 90 |
| <u>Plus</u> Increase in Cost Estimates: | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Base Program Completion Total | | 46 | 56 | 62 | 67 | 71 | 74 | 77 | 81 | 85 | 90 |
| <u>Plus Fully Fund Projects under Consideration:</u> | | | | | | | | | | | |
| 1. High Salinity Pilot | 50 | -- | 2 | 10 | 17 | 18 | 10 | 5 | 5 | -- | -- |
| 2. Moderate Temp. Resource Pilot | 50 | -- | 2 | 10 | 17 | 18 | 10 | 5 | 5 | -- | -- |
| 3. Magmatic Resource Test Facility | 100 | -- | -- | 5 | 20 | 35 | 37 | 20 | 10 | 10 | -- |
| 4. Geopressure Pilot | 150 | -- | -- | -- | -- | -- | 7 | 30 | 53 | 56 | 31 |
| 5. Hot Dry Rock Pilot | 200 | -- | -- | -- | -- | -- | -- | 10 | 41 | 71 | 75 |
| 6. Hot Dry Rock Demo | 400 | -- | -- | -- | -- | -- | -- | -- | -- | 21 | 82 |
| 7. Sedimentary Hydrothermal Demo | 200 | -- | 10 | 41 | 71 | 75 | 41 | 20 | 20 | -- | -- |
| 8. Volcanic Hydrothermal Demo | 375 | -- | -- | 19 | 76 | 134 | 141 | 77 | 37 | 37 | -- |
| Full Funding Total | | 46 | 70 | 147 | 268 | 351 | 320 | 244 | 252 | 280 | 278 |
| Full Funding in Current Dollars at 7.5% Inflation | | 46 | 75 | 170 | 310 | 469 | 459 | 377 | 418 | 499 | 533 |

DATA TABLE 7
 CONSERVATION RESEARCH AND DEVELOPMENT PROGRAM
 Budget Authority
 (fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC</u> | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|--|------------------------------|------|------|------|------|------|------|------|------|------|------|
| OMB Program Commitment Total | | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Plus Real Growth Increment of 40% through 1981 | | -- | 48 | 115 | 209 | 341 | 341 | 341 | 341 | 341 | 341 |
| Base Program Increment Total | | 120 | 168 | 235 | 329 | 461 | 461 | 461 | 461 | 461 | 461 |
| Plus Increase in Cost Estimates: | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Base Program Completion Total | | 120 | 168 | 235 | 329 | 461 | 461 | 461 | 461 | 461 | 461 |
| Plus Fully Fund Projects under Consideration: | | | | | | | | | | | |
| 1. Demo of Fuel Cells Power Plant | 50 | -- | -- | -- | 15 | 15 | 20 | 5 | 5 | 5 | 5 |
| 2. Large Scale Recovery Pilot | 50 | -- | 15 | 15 | 20 | 5 | 5 | 5 | 5 | -- | -- |
| 3. Large Scale Landfill Pilot | 60 | -- | 18 | 18 | 24 | 6 | 6 | 6 | 6 | -- | -- |
| 4. Large Scale Bioconversion Pilot | 60 | -- | 18 | 18 | 24 | 6 | 6 | 6 | 6 | -- | -- |
| 5. Large Scale Pyrolysis Pilot | 70 | -- | -- | 21 | 21 | 28 | 7 | 7 | 7 | 7 | -- |
| 6. Large Scale Combustion Pilot | 80 | -- | -- | -- | 24 | 24 | 32 | 8 | 8 | 8 | 8 |
| Full Funding Total | | 120 | 219 | 307 | 457 | 545 | 537 | 498 | 498 | 481 | 474 |
| Full Funding in Current Dollars at 7.5% Inflation | | 120 | 235 | 355 | 568 | 729 | 771 | 769 | 826 | 858 | 909 |

DATA TABLE 8
 CONSERVATION RESEARCH AND DEVELOPMENT PROGRAM
 Outlays
 (fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC</u> | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|--|------------------------------|------|------|------|------|------|------|------|------|------|------|
| OMB Program Commitment Total | | 91 | 110 | 120 | 120 | 125 | 122 | 120 | 120 | 120 | 120 |
| <u>Plus</u> Real Growth Increment of 40% through 1981 | | -- | 36 | 87 | 159 | 256 | 256 | 256 | 256 | 256 | 256 |
| Base Program Increment Total | | 91 | 146 | 207 | 279 | 381 | 378 | 376 | 376 | 376 | 376 |
| <u>Plus</u> Increase in Cost Estimates: | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Base Program Completion Total | | 91 | 146 | 207 | 279 | 381 | 378 | 376 | 376 | 376 | 376 |
| <u>Plus Fully Fund Projects under Consideration:</u> | | | | | | | | | | | |
| 1. Demo of Fuel Cells Power Plant | 50 | -- | -- | -- | 2 | 10 | 17 | 18 | 10 | 5 | 5 |
| 2. Large Scale Recovery Pilot | 50 | -- | 2 | 10 | 17 | 18 | 10 | 5 | 5 | -- | -- |
| 3. Large Scale Landfill Pilot | 60 | -- | 3 | 12 | 21 | 22 | 12 | 6 | 6 | -- | -- |
| 4. Large Scale Bioconversion Pilot | 60 | -- | 3 | 12 | 21 | 22 | 12 | 6 | 6 | -- | -- |
| 5. Large Scale Pyrolysis Pilot | 70 | -- | -- | 3 | 14 | 25 | 26 | 14 | 7 | 7 | -- |
| 6. Large scale combustion pilot | 80 | -- | -- | -- | 4 | 16 | 28 | 30 | 16 | 7 | 7 |
| Full Funding Total | | 91 | 154 | 244 | 358 | 494 | 483 | 455 | 426 | 395 | 388 |
| Full Funding in Current Dollars at 7.5% Inflation | | 91 | 166 | 282 | 445 | 660 | 693 | 702 | 707 | 704 | 744 |

DATA TABLE 9
 FUSION POWER RESEARCH AND DEVELOPMENT PROGRAM
 Budget Authority
 (fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| OMB Program Commitment Total | | 392 | 430 | 407 | 398 | 487 | 487 | 487 | 487 | 487 | 487 |
| <u>Plus Real Growth Increment of 6%</u> | | -- | 24 | 48 | 75 | 103 | 133 | 164 | 197 | 233 | 270 |
| Base Program Increment Total | | 392 | 454 | 455 | 473 | 590 | 620 | 651 | 684 | 720 | 757 |
| <u>Plus Increase in Cost Estimates:</u> | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Base Program Completion Total | | 392 | 454 | 455 | 473 | 590 | 620 | 651 | 684 | 720 | 757 |
| <u>Plus Fully Fund Projects</u> Under Consideration: | | | | | | | | | | | |
| 1. Experimental Power Reactor I | 700 | -- | -- | -- | -- | -- | 210 | 210 | 280 | 70 | 70 |
| 2. Advanced Fusion Facility | 50 | -- | -- | 15 | 15 | 20 | 5 | 5 | 5 | 5 | -- |
| 3. Fusion Eng. Research Facility | 100 | -- | -- | -- | 30 | 30 | 40 | 10 | 10 | 10 | 10 |
| 4. Oper. Test System Facility | 150 | -- | -- | -- | -- | -- | 45 | 45 | 60 | 15 | 15 |
| Full Funding Total | | 392 | 454 | 470 | 518 | 640 | 920 | 921 | 1039 | 820 | 852 |
| Full Funding in Current Dollars at 7.5% Inflation | | 392 | 488 | 543 | 644 | 855 | 1321 | 1421 | 1724 | 1462 | 1633 |

a. TEC is total estimated cost.

DATA TABLE 10
 FUSION POWER RESEARCH AND DEVELOPMENT PROGRAM
 Outlays
 (fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| OMB Program Commitment Total | | 304 | 419 | 422 | 395 | 428 | 428 | 428 | 428 | 428 | 428 |
| <u>Plus</u> Real Growth Increment of 6% | | -- | 18 | 38 | 58 | 80 | 103 | 127 | 153 | 181 | 210 |
| Base Program Increment Total | | 304 | 437 | 460 | 453 | 508 | 531 | 555 | 581 | 609 | 638 |
| <u>Plus</u> Increase in Cost Estimates: | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Base Program Completion Total | | 304 | 437 | 460 | 453 | 508 | 531 | 555 | 581 | 609 | 638 |
| <u>Plus</u> Fully Fund Projects Under Consideration: | | | | | | | | | | | |
| 1. Experimental Power Reactor I | 700 | -- | -- | -- | -- | -- | 36 | 143 | 250 | 264 | 144 |
| 2. Advanced Fusion Facility | 50 | -- | -- | 2 | 10 | 17 | 18 | 10 | 5 | 5 | -- |
| 3. Fusion Eng. Research Facility | 100 | -- | -- | -- | 5 | 20 | 35 | 37 | 20 | 10 | 10 |
| 4. Oper. Test System Facility | 150 | -- | -- | -- | -- | -- | 7 | 30 | 53 | 56 | 31 |
| Full Funding Total | | 304 | 437 | 462 | 468 | 545 | 627 | 775 | 909 | 944 | 823 |
| Full Funding in Current Dollars at 7.5% Inflation | | 304 | 470 | 534 | 581 | 728 | 900 | 1196 | 1508 | 1684 | 1578 |

a. TEC is total estimated cost.

DATA TABLE 11
FISSION POWER REACTOR DEVELOPMENT PROGRAM
Budget Authority
(fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| OMB Program Commitment Total | | 790 | 775 | 744 | 700 | 647 | 647 | 647 | 647 | 647 | 647 |
| <u>Plus</u> Real Growth Increment of 3% | | -- | 24 | 48 | 73 | 99 | 126 | 153 | 182 | 211 | 241 |
| <u>Base Program Increment Total</u> | | 790 | 799 | 792 | 773 | 746 | 773 | 800 | 829 | 858 | 888 |
| <u>Plus</u> Increase in Cost Estimates: | | | | | | | | | | | |
| 1. Clinch River Breeder Reactor | 214 | -- | 64 | 64 | 86 | 21 | 21 | 21 | 21 | 21 | 21 |
| <u>Base Program Completion Total</u> | | 790 | 863 | 856 | 859 | 767 | 794 | 821 | 850 | 879 | 909 |
| <u>Plus</u> Fully Fund Projects Under Consideration: | | | | | | | | | | | |
| 1. Prototype Large Breeder Reactor | 1600 | -- | -- | -- | -- | 480 | 480 | 640 | 160 | 160 | 160 |
| 2. High Performance Fuel Lab | 100 | -- | 30 | 30 | 40 | 10 | 10 | 10 | 10 | -- | -- |
| 3. Fuel and Mat'l Eval. Facility | 100 | -- | 30 | 30 | 40 | 10 | 10 | 10 | 10 | -- | -- |
| 4. Plant Component Test Facility | 290 | -- | 87 | 87 | 116 | 29 | 29 | 29 | 29 | -- | -- |
| 5. Safety Research and Eval. Facility | 500 | -- | 150 | 150 | 200 | 50 | 50 | 50 | 50 | -- | -- |
| 6. Gas Cooled Fast Reactor Demo | 900 | -- | -- | -- | 270 | 270 | 360 | 90 | 90 | 90 | 90 |
| 7. Gas Cooled Test Facilities | 100 | -- | 30 | 30 | 40 | 10 | 10 | 10 | 10 | -- | -- |
| 8. Direct Cycle Htgr Demo | 1500 | -- | -- | 450 | 450 | 600 | 150 | 150 | 150 | 150 | 150 |
| 9. VHTR Demo | 1400 | -- | -- | -- | -- | -- | -- | -- | 420 | 420 | 560 |
| <u>Full Funding Total</u> | | 790 | 1190 | 1633 | 2015 | 2226 | 1893 | 1810 | 1779 | 1699 | 1869 |
| Full Funding in Current Dollars at 7.5% Inflation | | 790 | 1279 | 1887 | 2503 | 2973 | 2718 | 2793 | 2951 | 3030 | 3583 |

a. TEC is total estimated cost.

DATA TABLE 12
 FISSION POWER REACTOR DEVELOPMENT PROGRAM
 Outlays
 (fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|--|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| OMB Program Commitment Total | | 684 | 745 | 771 | 734 | 688 | 667 | 647 | 647 | 647 | 647 |
| Plus Real Growth Increment of 3% | | -- | 21 | 42 | 63 | 86 | 109 | 133 | 157 | 182 | 208 |
| Base Program Increment Total | | 684 | 766 | 813 | 797 | 774 | 776 | 780 | 804 | 829 | 855 |
| Plus Increase in Cost Estimates: | | | | | | | | | | | |
| 1. Clinch River Reeder Reactor | 214 | -- | 11 | 43 | 76 | 80 | 44 | 21 | 21 | 21 | 21 |
| Base Program Completion Total | | 684 | 777 | 856 | 873 | 854 | 820 | 801 | 825 | 850 | 876 |
| Plus Fully Fund Projects Under Consideration: | | | | | | | | | | | |
| 1. Prototype Large Breeder Reactor | 1600 | -- | -- | -- | -- | 84 | 328 | 572 | 604 | 331 | 160 |
| 2. High Performance Fuel Lab | 100 | -- | 5 | 20 | 35 | 37 | 20 | 10 | 10 | -- | -- |
| 3. Fuel and Mat'l Eval. Facility | 100 | -- | 5 | 20 | 35 | 37 | 20 | 10 | 10 | -- | -- |
| 4. Plant Component Test Facility | 290 | -- | 15 | 59 | 103 | 109 | 60 | 29 | 29 | -- | -- |
| 5. Safety Research and Eval. Facility | 500 | -- | 26 | 102 | 179 | 188 | 103 | 50 | 50 | -- | -- |
| 6. Gas Cooled Fast Reactor Demo | 900 | -- | -- | -- | 47 | 184 | 322 | 339 | 186 | 90 | 90 |
| 7. Gas Cooled Test Facilities | 100 | -- | 5 | 20 | 35 | 37 | 20 | 10 | 10 | -- | -- |
| 8. Direct Cycle Htgr Demo | 1500 | -- | -- | 78 | 307 | 537 | 566 | 310 | 150 | 150 | 150 |
| 9. VHTR Demo | 1400 | -- | -- | -- | -- | -- | -- | -- | 73 | 287 | 501 |
| Full Funding Total | | 684 | 833 | 1155 | 1614 | 2067 | 2259 | 2131 | 1947 | 1708 | 1777 |
| Full Funding in Current Dollars at 7.5% Inflation | | 684 | 895 | 1335 | 2005 | 2760 | 3243 | 3289 | 3230 | 3046 | 3407 |

a. TEC is total estimated cost.

DATA TABLE 13
OTHER NUCLEAR PROGRAMS
Budget Authority
(fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|--|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 1. Nuclear Fuel Cycle | | 179 | 196 | 201 | 201 | 201 | 201 | 201 | 201 | 201 | 201 |
| 2. Nuclear Safeguards | | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |
| 3. Process Development | | 96 | 80 | 73 | 72 | 73 | 73 | 73 | 73 | 73 | 73 |
| 4. Advanced Isotope Separation | | 44 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| OMB Program Commitment Total | | 347 | 344 | 342 | 341 | 342 | 342 | 342 | 342 | 342 | 342 |
| <u>Plus Real Growth Increment of 6%</u> | | -- | 21 | 43 | 66 | 91 | 117 | 145 | 175 | 206 | 239 |
| Base Program Increment Total | | 347 | 365 | 385 | 407 | 433 | 459 | 487 | 517 | 548 | 581 |
| <u>Plus Increase in Cost Estimates:</u> | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Base Program Completion Total | | 347 | 365 | 385 | 407 | 433 | 459 | 487 | 517 | 548 | 581 |
| <u>Plus Fully Fund Projects Under Consideration:</u> | | | | | | | | | | | |
| 1. LWR Training & Tech. Center | 150 | -- | 45 | 45 | 60 | 15 | 15 | 15 | 15 | -- | -- |
| 2. LWR Commercial Assist. Program | 450 | -- | -- | 50 | 120 | 120 | 160 | 45 | 45 | 45 | 45 |
| 3. HTGR Recycle Demo Facility | 750 | -- | -- | 25 | 25 | 210 | 210 | 280 | 75 | 75 | 75 |
| 4. LMFBR Large Scale Comp. Testing | 200 | -- | 60 | 60 | 80 | 20 | 20 | 20 | 20 | -- | -- |
| 5. LMFBR Fuel Cycle Pilot | 450 | -- | -- | 135 | 135 | 180 | 45 | 45 | 45 | 45 | -- |
| 6. LMFBR Fuel Cycle Demo | 700 | -- | -- | -- | -- | -- | -- | -- | -- | 210 | 210 |
| 7. 1st Terminal Storage Plant | 100 | -- | -- | -- | -- | 30 | 30 | 40 | 10 | 10 | 10 |
| 8. 2nd Terminal Storage Plant | 100 | -- | -- | -- | -- | -- | -- | 30 | 30 | 40 | 10 |
| 9. 3rd Terminal Storage Plant | 100 | -- | -- | -- | -- | -- | -- | -- | -- | 30 | 30 |
| 10. LIS Uranium Enrich. Pilot | 100 | -- | -- | -- | -- | 30 | 30 | 40 | 10 | 10 | 10 |
| Full Funding Total | | 347 | 470 | 700 | 827 | 1038 | 969 | 1002 | 767 | 1013 | 971 |
| Full Funding in Current Dollars at 7.5% Inflation | | 347 | 505 | 809 | 1027 | 1386 | 1391 | 1546 | 1272 | 1807 | 1862 |

a. TEC is total estimated cost.

DATA TABLE 14
OTHER NUCLEAR PROGRAMS
Outlays
(fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC</u> | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|--|------------------------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 1. Nuclear Fuel Cycle | | 147 | 169 | 179 | 189 | 199 | 199 | 199 | 199 | 199 | 199 |
| 2. Nuclear Safeguards | | 27 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 |
| 3. Process Development | | 69 | 69 | 61 | 54 | 54 | 54 | 54 | 54 | 54 | 54 |
| 4. Advanced Isotope Separation | | 39 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| OMB Program Commitment Total | | 282 | 304 | 306 | 309 | 319 | 319 | 319 | 319 | 319 | 319 |
| <u>Plus Real Growth Increment of 6%</u> | | -- | 17 | 35 | 54 | 74 | 95 | 118 | 142 | 167 | 194 |
| Base Program Increment Total | | 282 | 321 | 341 | 363 | 393 | 414 | 437 | 461 | 486 | 513 |
| <u>Plus Increase in Cost Estimates:</u> | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Base Program Completion Total | | 282 | 321 | 341 | 363 | 393 | 414 | 437 | 461 | 486 | 513 |
| <u>Plus Fully Fund Projects under Consideration:</u> | | | | | | | | | | | |
| 1. LWR Training and Tech. Center | 150 | -- | 7 | 30 | 53 | 56 | 31 | 15 | 15 | -- | -- |
| 2. LWR Commercial Assist. Program | 450 | -- | -- | 2 | 31 | 99 | 161 | 161 | 87 | 45 | 40 |
| 3. HTGR Recycle Demo Facility | 750 | -- | -- | 1 | 6 | 49 | 160 | 264 | 271 | 148 | 72 |
| 4. IMFBR Large Scale Comp. Testing | 200 | -- | 10 | 41 | 71 | 75 | 41 | 20 | 20 | -- | -- |
| 5. IMFBR Fuel Cycle Pilot | 450 | -- | -- | 23 | 92 | 161 | 169 | 93 | 45 | 45 | -- |
| 6. IMFBR Fuel Cycle Demo | 700 | -- | -- | -- | -- | -- | -- | -- | -- | 36 | 143 |
| 7. 1st Terminal Storage Plant | 100 | -- | -- | -- | -- | 5 | 20 | 35 | 37 | 20 | 10 |
| 8. 2nd Terminal Storage Plant | 100 | -- | -- | -- | -- | -- | -- | 5 | 20 | 35 | 37 |
| 9. 3rd Terminal Storage Plant | 100 | -- | -- | -- | -- | -- | -- | -- | -- | 5 | 20 |
| 10. LIS Uranium Enrich. Pilot | 100 | -- | -- | -- | -- | 5 | 20 | 35 | 37 | 20 | 10 |
| Full Funding Total | | 282 | 338 | 438 | 616 | 843 | 1016 | 1065 | 993 | 840 | 845 |
| Full Funding in Current Dollars at 7.5% Inflation | | 282 | 363 | 506 | 765 | 1126 | 1459 | 1644 | 1647 | 1498 | 1620 |

DATA TABLE 15
OTHER AGENCY DIRECT ENERGY PROGRAMS
Budget Authority
(fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|--|--|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 1. Nuclear Regulatory Commission | | 104 | 104 | 104 | 104 | 104 | 104 | 104 | 104 | 104 | 104 |
| 2. Department of Interior | | 98 | 98 | 98 | 98 | 98 | 98 | 98 | 98 | 98 | 98 |
| 3. Environmental Protection Agency | | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 |
| 4. National Aeronautics & Space Admin. | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| <u>OMB Program Commitment Total</u> | | <u>257</u> |
| <u>Plus Real Growth Increment of 3%</u> | | -- | 8 | 16 | 24 | 32 | 41 | 50 | 59 | 69 | 78 |
| <u>Base Program Increment Total</u> | | <u>257</u> | <u>265</u> | <u>273</u> | <u>281</u> | <u>289</u> | <u>298</u> | <u>307</u> | <u>316</u> | <u>326</u> | <u>335</u> |
| <u>Plus Increase in Cost Estimates:</u> | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| <u>Base Program Completion Total</u> | | <u>257</u> | <u>265</u> | <u>273</u> | <u>281</u> | <u>289</u> | <u>298</u> | <u>307</u> | <u>316</u> | <u>326</u> | <u>335</u> |
| <u>Plus Fully Fund Projects Under Consideration:</u> | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| <u>Full Funding Total</u> | | <u>257</u> | <u>265</u> | <u>273</u> | <u>281</u> | <u>289</u> | <u>298</u> | <u>307</u> | <u>316</u> | <u>326</u> | <u>335</u> |
| Full Funding in Current Dollars at 7.5% Inflation | | 257 | 285 | 315 | 349 | 386 | 428 | 474 | 524 | 581 | 642 |

a. TEC is total estimated cost.

DATA TABLE 16
 OTHER AGENCY DIRECT ENERGY PROGRAMS
 Outlays
 (fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC</u> | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|--|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 1. Nuclear Regulatory Commission | | 98 | 98 | 98 | 98 | 98 | 98 | 98 | 98 | 98 | 98 |
| 2. Department of the Interior | | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 |
| 3. Environmental Protection Agency | | 77 | 65 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 |
| 4. National Aeronautics and Space Admin. | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMB Program Commitment Total | | 272 | 259 | 249 |
| <u>Plus Real Growth Increment of 3%</u> | | -- | 8 | 17 | 25 | 34 | 43 | 53 | 63 | 73 | 82 |
| Base Program Increment Total | | 272 | 267 | 266 | 274 | 283 | 292 | 302 | 312 | 322 | 332 |
| <u>Plus Increase in Cost Estimates:</u> | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Base Program Completion Total | | 272 | 267 | 266 | 274 | 283 | 292 | 302 | 312 | 322 | 332 |
| <u>Plus Fully Fund Projects under Consideration:</u> | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Full Funding Total | | 272 | 267 | 266 | 274 | 283 | 292 | 302 | 312 | 322 | 332 |
| Full Funding in Current Dollars at 7.5% Inflation | | 272 | 287 | 307 | 340 | 378 | 419 | 466 | 518 | 574 | 637 |

DATA TABLE 17
 ENVIRONMENTAL RESEARCH AND SAFETY PROGRAM
 Budget Authority
 (fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|--|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 1. Biomed. and Environ. Research | | 202 | 203 | 207 | 207 | 207 | 207 | 207 | 207 | 207 | 207 |
| 2. Operational Safety | | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| 3. Environmental Control Tech. | | 16 | 16 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| 4. Reactor Safety Facilities | | 33 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| <hr/> <u>OMB Program Commitment Total</u> | | <u>260</u> | <u>233</u> |
| | <u>Plus Real Growth Increment of 3%</u> | -- | 8 | 16 | 24 | 33 | 41 | 50 | 60 | 69 | 79 |
| <hr/> <u>Base Program Increment Total</u> | | <u>260</u> | <u>241</u> | <u>249</u> | <u>257</u> | <u>266</u> | <u>274</u> | <u>283</u> | <u>293</u> | <u>302</u> | <u>312</u> |
| | <u>Plus Increase in Cost Estimates:</u> | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| <hr/> <u>Base Program Completion Total</u> | | <u>260</u> | <u>241</u> | <u>249</u> | <u>257</u> | <u>266</u> | <u>274</u> | <u>283</u> | <u>293</u> | <u>302</u> | <u>312</u> |
| | <u>Plus Fully Fund Projects Under Consideration:</u> | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| <hr/> <u>Full Funding Total</u> | | <u>260</u> | <u>241</u> | <u>249</u> | <u>257</u> | <u>266</u> | <u>274</u> | <u>283</u> | <u>293</u> | <u>302</u> | <u>312</u> |
| <hr/> Full Funding in Current Dollars at 7.5% Inflation | | 260 | 259 | 288 | 319 | 355 | 318 | 437 | 486 | 539 | 598 |

a. TEC is total estimated cost.

DATA TABLE 18
 ENVIRONMENTAL RESEARCH AND SAFETY PROGRAM
 Outlays
 (fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|--|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 1. Biomed. and Environ. Research | | 198 | 199 | 204 | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| 2. Operational Safety | | 6 | 6 | 7 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| 3. Environmental Control Tech. | | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| 4. Reactor Safety Facilities | | 25 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| <hr/> <u>OMB Program Commitment Total</u> | | <hr/> 244 | <hr/> 227 | <hr/> 226 | <hr/> 221 |
| <u>Plus Real Growth Increment of 3%</u> | | -- | 7 | 15 | 23 | 31 | 39 | 47 | 56 | 65 | 74 |
| <hr/> <u>Base Program Increment Total</u> | | <hr/> 244 | <hr/> 234 | <hr/> 241 | <hr/> 244 | <hr/> 252 | <hr/> 260 | <hr/> 268 | <hr/> 277 | <hr/> 286 | <hr/> 295 |
| <u>Plus Increase in Cost Estimates:</u> | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| <hr/> <u>Base Program Completion Total</u> | | <hr/> 244 | <hr/> 234 | <hr/> 241 | <hr/> 244 | <hr/> 252 | <hr/> 260 | <hr/> 268 | <hr/> 277 | <hr/> 286 | <hr/> 295 |
| <u>Plus Fully Fund Projects Under Consideration:</u> | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| <hr/> <u>Full Funding Total</u> | | <hr/> 244 | <hr/> 234 | <hr/> 241 | <hr/> 244 | <hr/> 252 | <hr/> 260 | <hr/> 268 | <hr/> 277 | <hr/> 286 | <hr/> 295 |
| <u>Full Funding in Current Dollars at 7.5% Inflation</u> | | 244 | 252 | 279 | 303 | 337 | 373 | 414 | 460 | 510 | 566 |

a. TEC is total estimated cost.

DATA TABLE 19
 BASIC ENERGY SCIENCES PROGRAM
 Budget Authority
 (fiscal years, millions of 1977 dollars)

| <u>Spending Level</u> | <u>Fed. Share of TEC^a</u> | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|--|------|------|------|------|------|------|------|------|------|------|
| OMB Program Commitment Total | | 227 | 233 | 233 | 233 | 233 | 233 | 233 | 233 | 233 | 233 |
| <u>Plus</u> Real Growth Increment of 3% | | -- | 7 | 14 | 21 | 28 | 36 | 44 | 52 | 61 | 69 |
| Base Program Increment Total | | 227 | 240 | 247 | 254 | 261 | 269 | 277 | 285 | 294 | 302 |
| <u>Plus</u> Increase in Cost Estimates: | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Base Program Completion Total | | 227 | 240 | 247 | 254 | 261 | 269 | 277 | 285 | 294 | 302 |
| <u>Plus</u> Fully Fund Projects Under Consideration: | | | | | | | | | | | |
| 1. Intense Pulsed Neutron Source | 50 | -- | 15 | 15 | 20 | 5 | 5 | 5 | 5 | -- | -- |
| 2. Adv. Sync. Radiation Source | 50 | -- | 15 | 15 | 20 | 5 | 5 | 5 | 5 | -- | -- |
| 3. Very High Flux Neutron Source | 50 | -- | -- | -- | 15 | 15 | 20 | 5 | 5 | 5 | 5 |
| Full Funding Total | | 227 | 270 | 277 | 309 | 286 | 299 | 292 | 300 | 299 | 307 |
| Full Funding in Current Dollars at 7.5% Inflation | | 277 | 290 | 320 | 384 | 382 | 429 | 451 | 498 | 533 | 589 |

a. TEC is total estimated cost.

DATA TABLE 20
 BASIC ENERGY SCIENCES PROGRAM
 Outlays
 (fiscal years, millions of 1977 dollars)

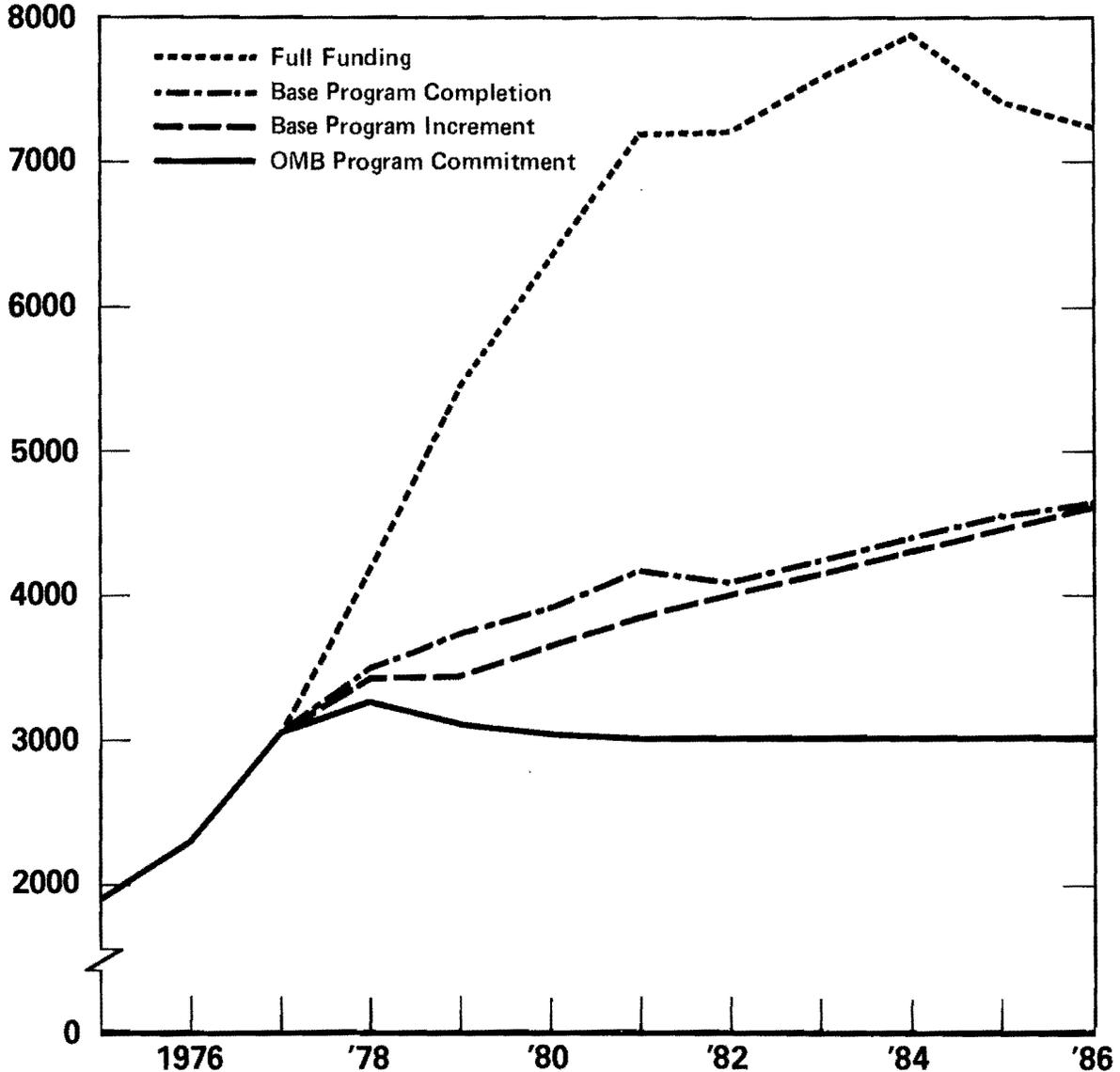
| <u>Spending Level</u> | <u>Fed. Share of TEC</u> | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|--|------------------------------|------|------|------|------|------|------|------|------|------|------|
| OMB Program Commitment Total | | 204 | 222 | 229 | 222 | 222 | 222 | 222 | 222 | 222 | 222 |
| <u>Plus Real Growth Increment of 3%</u> | | -- | 6 | 12 | 19 | 26 | 32 | 40 | 47 | 54 | 62 |
| Base Program Increment Total | | 204 | 228 | 241 | 241 | 248 | 254 | 262 | 269 | 276 | 284 |
| <u>Plus Increase in Cost Estimates:</u> | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Base Program Completion Total | | 204 | 228 | 241 | 241 | 248 | 254 | 262 | 269 | 276 | 284 |
| <u>Plus Fully Fund Projects under Consideration:</u> | | | | | | | | | | | |
| 1. Intense Pulsed Neutron Source | 50 | -- | 2 | 10 | 17 | 18 | 10 | 5 | 5 | -- | -- |
| 2. Adv. Sync. Radiation Source | 50 | -- | 2 | 10 | 17 | 18 | 10 | 5 | 5 | -- | -- |
| 3. Very High Flux Neutron Source | 50 | -- | -- | -- | 2 | 10 | 17 | 18 | 10 | 5 | 5 |
| Full Funding Total | | 204 | 232 | 261 | 277 | 294 | 291 | 290 | 289 | 281 | 289 |
| Full Funding in Current Dollars at 7.5% Inflation | | 204 | 249 | 302 | 344 | 393 | 418 | 448 | 479 | 501 | 554 |

Chart 1.

Alternative Energy Research Budget Paths, 1977-1986

BUDGET AUTHORITY

(Fiscal Years, Millions of 1977 Dollars)



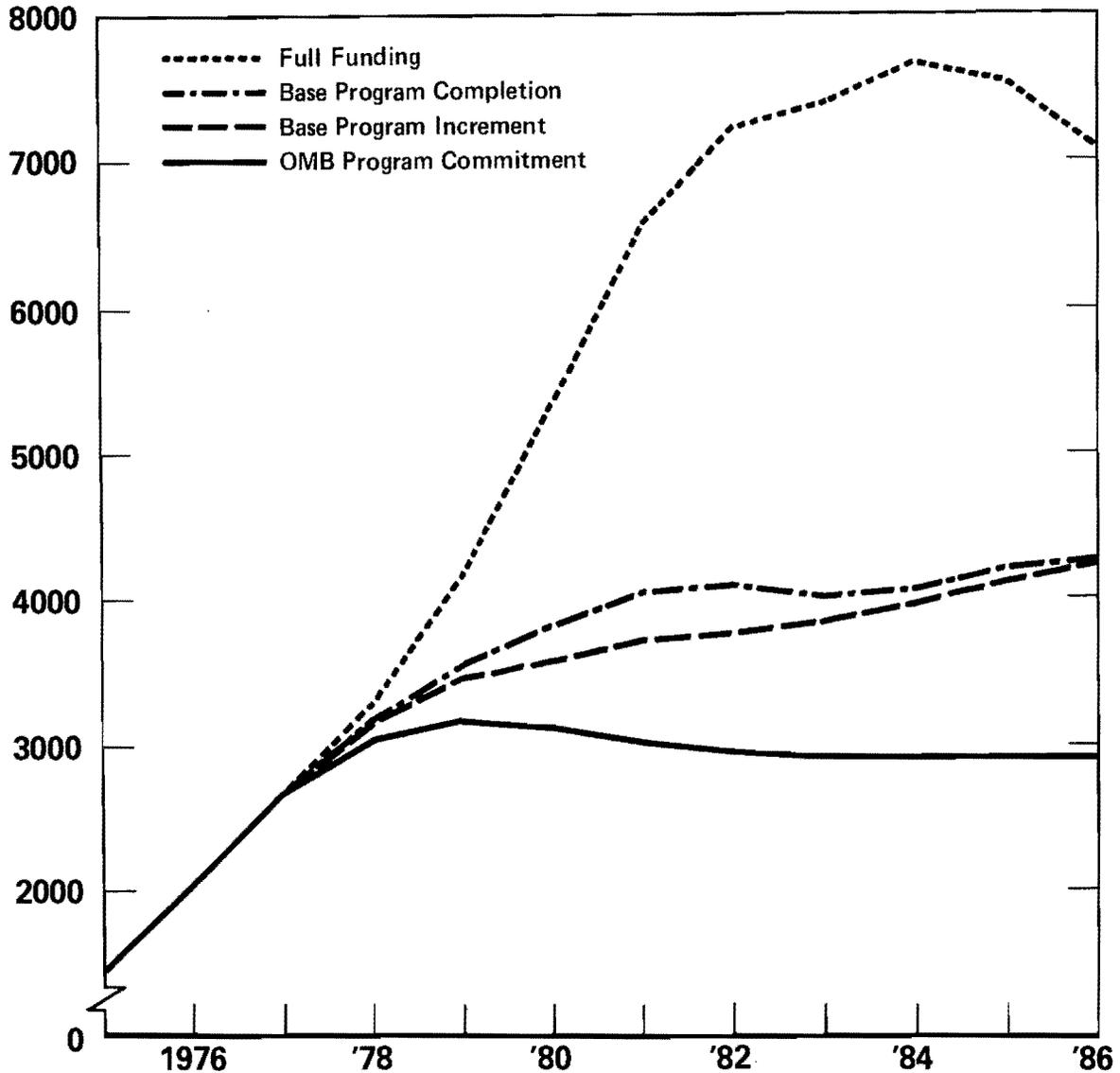
| BUDGET PATH | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|-------------------------|------|------|------|------|------|------|------|------|------|------|
| OMB Program Commitment | 3080 | 3286 | 3121 | 3062 | 3033 | 3033 | 3033 | 3033 | 3033 | 3033 |
| Base Program Increment | 3080 | 3453 | 3476 | 3639 | 3875 | 4015 | 4161 | 4315 | 4475 | 4639 |
| Base Program Completion | 3080 | 3517 | 3765 | 3950 | 4196 | 4115 | 4261 | 4415 | 4575 | 4660 |
| Full Funding | 3080 | 4195 | 5471 | 6362 | 7203 | 7219 | 7596 | 7898 | 7416 | 7244 |

Chart 2.

Alternative Energy Research Budget Paths, 1977-1986

OUTLAYS

(Fiscal Years, Millions of 1977 Dollars)



| BUDGET PATH | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|-------------------------|------|------|------|------|------|------|------|------|------|------|
| OMB Program Commitment | 2685 | 3040 | 3176 | 3114 | 3023 | 2969 | 2920 | 2920 | 2920 | 2920 |
| Base Program Increment | 2685 | 3176 | 3469 | 3587 | 3707 | 3771 | 3848 | 3977 | 4112 | 4254 |
| Base Program Completion | 2685 | 3187 | 3550 | 3816 | 4056 | 4099 | 4025 | 4073 | 4208 | 4275 |
| Full Funding | 2685 | 3298 | 4169 | 5362 | 6581 | 7220 | 7395 | 7671 | 7542 | 7094 |

CHAPTER V
IMPLICATIONS FOR THE FUTURE

Although it is not possible to predict with certainty the budgetary impact of alternative spending levels, it is possible to determine a realistic budget floor and ceiling between which currently foreseeable longer-run outcomes are likely to lie. This chapter compares the alternative budget path projections derived from funding all major program areas at each of the four funding levels developed in this analysis, and presents likely out-year shifts in program emphasis for selected paths. It also highlights the rapidly expanding role of large-scale pilots and demonstration plants, and discusses the potential magnitude of new construction decisions confronting the Congress over the next decade.

Comparison of Alternative Budget Paths

Total cumulative budget authority over the next ten years for the OMB program commitment levels--as measured in 1977 dollars--will amount to about \$30.7 billion. Annual requests for budget authority are expected to peak in fiscal year 1978. Similarly, outlays will total approximately \$29.7 billion, peaking in fiscal year 1979. Translated into total current dollars--utilizing a 7.5 percent inflation rate--this amounts to \$43.4 billion in budget authority and \$41.9 billion in outlays.

Aggregate budget authority for the base program increment projection will amount to about \$39.1 billion in 1977 dollars over the next ten years. Annual requests for new budget authority will continue to rise throughout the forecast period. In the same fashion, annual outlays are expected to continue increasing with the total cumulative amount through fiscal year 1986 approaching \$36.6 billion. In current dollars using a 7.5 percent rate of inflation, this amounts to \$56.7 billion in budget authority and \$53.0 billion in outlays.

The cumulative total for new budget authority in the base program completion projection in 1977 dollars is \$40.5 billion, progressing generally upward over the forecast period with a minor dip in fiscal year 1982. Likewise, annual outlays turn slightly downward in fiscal year 1983 before regaining their upward momentum. Outlays over the next decade are expected to total about \$38 billion. In current dollars based upon a 7.5 percent inflation rate,

cumulative budget authority should approach \$58.6 billion with outlays trailing at around \$54.9 billion.

Finally, aggregate budget authority in 1977 dollars required to support the full funding projection--based upon minimal fiscal constraints which would permit all projects contemplated in the National Plan to go forward on schedule--should total approximately \$63.7 billion for the ten-year period. Annual budget authority requests are expected to peak in fiscal year 1984. Similarly, outlays for the forecast period should total about \$59 billion with annual spending also peaking in fiscal year 1984. Cumulative ten-year budget authority in current dollars using a 7.5 percent inflation rate amounts to about \$93.7 billion with outlays following at \$88.1 billion.

A summary comparison of the salient characteristics exhibited by these alternative fiscal budget path projections is contained in Table 16.

Probable Shifts in Program Emphasis

Since they do not provide full funding for completion of all projects already approved in principle by the Congress, the OMB program commitment and base program increment projections in effect represent cutbacks in federal energy research at a time when Congress is supporting an expanding federal role. As a consequence, only two budget paths will be examined here for possible out-year shifts in relative program funding. These are: the base program completion path which allows for modest increases in real growth of programs and completion of all projects in the budget, and the full funding path. The criterion for comparing out-year program funding levels will be individual program totals as a percent of total energy research for that particular budget path. Only budget authority will be considered. Tables 17 and 18 develop and present these changes for the base program completion case. Likewise, Tables 19 and 20 portray probable shifts in relative program funding for the full funding case.

If a base program completion path is pursued throughout the decade, the fission reactor program would in all likelihood remain the largest energy research program. The fossil energy program would continue to maintain its second-place ranking throughout most of the next ten years. However, in fiscal year 1981, it would momentarily become the single largest energy research program, and in fiscal year 1986, drop to third place in overall program size. With

respect to emerging technologies, the fusion power program would rise from third to second position by the end of the forecast period. In addition, the conservation program would be expected to climb rapidly from ninth to fifth place. However, both the solar energy and geothermal programs would continue to receive minor attention as a percent of the total energy research effort. Such results reflect the maturity of the fission and fossil programs--for which a number of large, expensive projects can now be foreseen--and the relative newness of the solar and geothermal programs, as well as the differences in scale of meaningful investigation in these programs.

If a full funding path is pursued for the next ten years, the fission reactor program would continue to receive a lion's share of the total energy research budget. To support this commitment, the other nuclear programs area would also continue to be a major consumer of research dollars throughout most of the coming decade. Of the non-nuclear technology areas, the most noticeable shift in relative program funding would occur in the solar energy program. Between fiscal years 1978 and 1985, this program would rise dramatically from ninth to second place among energy research programs. The conservation program would expand from ninth to sixth place in relative program size during the full ten-year period. However, the geothermal program would remain the smallest program throughout the forecast period. Finally, the fossil energy program would decline from second to fifth largest by fiscal year 1986.

The Expanding Role of Large-Scale Projects

If a full funding path is pursued--as outlined in the program implementation section of the National Plan--an increasing share of the total energy research budget would be devoted to the construction of large-scale test facilities, pilots, and near-commercial demonstrations. In fact, this commitment would be expected to almost triple between now and fiscal year 1981, when it could consume nearly half of the entire budget for energy R,D,&D. Table 21 summarizes these trends over the next decade for both budget authority and outlays. (Appendix B provides a detailed breakdown of probable spendout patterns for the unappropriated balances associated with big-ticket items included in the OMB commitment projections. Totals derived from this appendix have been incorporated into Part A of this table.)

As this apparent commitment to large-scale demonstration grows over time, less and less flexibility will remain in the overall energy research effort for fully exploring evolving or as yet untested energy technologies and processes.

Magnitude of Future Construction Decisions

In the event that a full funding budget strategy is pursued, Congress would be asked to appropriate a total of approximately \$27.5 billion in budget authority and \$25.9 billion in outlays (which is the federal share in 1977 dollars) solely for construction of large-scale projects over the next decade. Annual funding requests for such big-ticket items are expected to peak in fiscal year 1984 when new budget authority will approach \$3.8 billion and outlays will total almost \$3.9 billion. This would constitute a seven-fold increase over the fiscal year 1977 request for construction-related budget authority, and a ten-fold increase over the comparable request for outlays.

TABLE 16
A COMPARISON OF ALTERNATIVE
ENERGY RESEARCH BUDGET PATHS, 1977-1986
(fiscal years, millions of 1977 dollars)

| <u>Budget Path</u> | <u>Budget Authority</u> | | | <u>Outlays</u> | | |
|-------------------------------|---------------------------|----------------------|------------------------|---------------------------|----------------------|------------------------|
| | <u>Ten-Year Total</u> | <u>Peak Year</u> | <u>Peak Amount</u> | <u>Ten-Year Total</u> | <u>Peak Year</u> | <u>Peak Amount</u> |
| 1. OMB Program Commitment | 30,747 | 1978 | 3,286 | 29,687 | 1979 | 3,176 |
| 2. Base Program Increment | 39,128 | 1986 | 4,639 | 36,586 | 1986 | 4,254 |
| 3. Base Program Completion | 40,534 | 1986 | 4,660 | 37,974 | 1986 | 4,275 |
| 4. Full Funding | 63,684 | 1984 | 7,898 | 59,017 | 1984 | 7,671 |

TABLE 17
LONGER TERM PROGRAM EMPHASIS AT BASE PROGRAM COMPLETION LEVELS
Budget Authority
(fiscal years, percent of total funding)

| <u>Major Program Area</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Fossil Energy | 15.5 | 19.6 | 20.6 | 21.0 | 20.0 | 16.5 | 16.3 | 16.1 | 16.0 | 14.7 |
| Solar Energy | 5.2 | 4.0 | 5.9 | 4.9 | 5.2 | 4.5 | 4.7 | 4.8 | 5.0 | 4.9 |
| Geothermal | 1.6 | 1.7 | 1.7 | 1.7 | 1.7 | 1.8 | 1.9 | 1.9 | 1.9 | 2.0 |
| Conservation | 3.9 | 4.8 | 6.2 | 8.3 | 11.0 | 11.2 | 10.8 | 10.4 | 10.0 | 9.9 |
| Fusion Power | 12.7 | 12.9 | 12.1 | 12.0 | 14.1 | 15.1 | 15.2 | 15.5 | 15.7 | 16.2 |
| Fission Reactor | 25.6 | 24.5 | 22.7 | 21.7 | 18.3 | 19.3 | 19.3 | 19.3 | 19.2 | 19.5 |
| Other Nuclear | 11.3 | 10.4 | 10.2 | 10.3 | 10.3 | 11.2 | 11.4 | 11.7 | 12.0 | 12.5 |
| Other Agency Direct | 8.3 | 7.5 | 7.3 | 7.1 | 6.9 | 7.2 | 7.2 | 7.2 | 7.1 | 7.2 |
| Environmental | 8.4 | 6.9 | 6.6 | 6.5 | 6.3 | 6.6 | 6.6 | 6.6 | 6.6 | 6.7 |
| Basic Energy Sciences | 7.4 | 6.8 | 6.6 | 6.4 | 6.2 | 6.5 | 6.5 | 6.5 | 6.4 | 6.5 |

NOTE: Totals may not add to 100 percent due to rounding.

TABLE 18
PROGRAM RANKINGS THROUGH FISCAL YEAR 1986
AT BASE PROGRAM COMPLETION LEVELS
Budget Authority

| <u>Major Program Area</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Fossil Energy | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 3 |
| Solar Energy | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Geothermal | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Conservation | 9 | 9 | 8 | 5 | 4 | 4 | 5 | 5 | 5 | 5 |
| Fusion Power | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| Fission Reactor | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
| Other Nuclear | 4 | 4 | 4 | 4 | 5 | 5 | 4 | 4 | 4 | 4 |
| Other Agency Direct | 6 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Environmental | 5 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Basic Energy Sciences | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |

TABLE 19
 LONGER TERM PROGRAM EMPHASIS AT FULL FUNDING LEVELS
 Budget Authority
 (fiscal years, percent of total funding)

| <u>Major Program Area</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Fossil Energy | 15.5 | 17.9 | 17.7 | 16.3 | 14.3 | 17.1 | 16.5 | 18.2 | 12.3 | 11.7 |
| Solar Energy | 5.2 | 4.4 | 5.5 | 5.1 | 8.2 | 8.2 | 12.7 | 13.8 | 16.4 | 14.2 |
| Geothermal | 1.6 | 3.6 | 5.4 | 5.2 | 4.0 | 2.7 | 3.4 | 4.8 | 4.7 | 3.4 |
| Conservation | 3.9 | 5.2 | 5.6 | 7.2 | 7.6 | 7.4 | 6.6 | 6.3 | 6.5 | 6.5 |
| Fusion Power | 12.7 | 10.8 | 8.6 | 8.1 | 8.9 | 12.7 | 12.1 | 13.2 | 11.1 | 11.8 |
| Fission Reactor | 25.6 | 28.4 | 29.8 | 31.7 | 30.9 | 26.2 | 23.8 | 22.5 | 22.9 | 25.8 |
| Other Nuclear | 11.3 | 11.2 | 12.8 | 13.0 | 14.4 | 13.4 | 13.2 | 9.7 | 13.7 | 13.4 |
| Other Agency Direct | 8.3 | 6.3 | 5.0 | 4.4 | 4.0 | 4.1 | 4.0 | 4.0 | 4.4 | 4.6 |
| Environmental | 8.4 | 5.7 | 4.6 | 4.0 | 3.7 | 3.8 | 3.7 | 3.7 | 4.1 | 4.3 |
| Basic Energy Sciences | 7.4 | 6.4 | 5.1 | 4.9 | 4.0 | 4.1 | 3.8 | 3.8 | 4.0 | 4.2 |

NOTE: Totals may not add to 100 percent due to rounding.

TABLE 20
PROGRAM RANKINGS THROUGH FISCAL YEAR 1986
AT FULL FUNDING LEVELS
Budget Authority

| <u>Major Program Area</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Fossil Energy | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 4 | 5 |
| Solar Energy | 8 | 9 | 6 | 7 | 5 | 5 | 4 | 3 | 2 | 2 |
| Geothermal | 10 | 10 | 7 | 6 | 7 | 10 | 10 | 7 | 7 | 10 |
| Conservation | 9 | 8 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Fusion Power | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 5 | 4 |
| Fission Reactor | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Other Nuclear | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 5 | 3 | 3 |
| Other Agency Direct | 6 | 6 | 9 | 9 | 8 | 8 | 7 | 8 | 8 | 7 |
| Environmental | 5 | 7 | 10 | 10 | 10 | 9 | 9 | 10 | 9 | 8 |
| Basic Energy Sciences | 7 | 5 | 8 | 8 | 9 | 7 | 8 | 9 | 10 | 9 |

TABLE 21
 FEDERAL SHARE OF LARGE-SCALE CONSTRUCTION
 PROJECTS AS A PERCENT OF FULL FUNDING
 (fiscal years, millions of 1977 dollars)

| Big-Ticket Components | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| I. Budget Authority -- | | | | | | | | | | |
| A. OMB Commitment Projects | 526 | 518 | 385 | 435 | 207 | 202 | 187 | 174 | 174 | 174 |
| B. Revised Cost Estimates | 0 | 64 | 289 | 289 | 321 | 100 | 100 | 100 | 100 | 21 |
| C. Projects Under Consideration: | 0 | 663 | 1676 | 2412 | 3007 | 3104 | 3335 | 3483 | 2851 | 2584 |
| Total Big-Ticket: | 526 | 1245 | 2350 | 3136 | 3525 | 3406 | 3622 | 3757 | 3125 | 2779 |
| Full Funding Level: | 3080 | 4259 | 5526 | 6417 | 7256 | 7268 | 7630 | 7915 | 7416 | 7230 |
| Big-Ticket as Percent of Full Funding Level: | 17.1% | 29.2% | 42.5% | 48.9% | 48.6% | 46.9% | 47.5% | 47.5% | 42.1% | 48.4% |
| II. Outlays -- | | | | | | | | | | |
| A. OMB Commitment Projects | 364 | 444 | 703 | 614 | 396 | 206 | 201 | 174 | 174 | 174 |
| B. Revised Cost Estimates | 0 | 11 | 81 | 229 | 349 | 328 | 177 | 96 | 96 | 21 |
| C. Projects Under Consideration: | 0 | 109 | 619 | 1546 | 2525 | 3121 | 3370 | 3598 | 3334 | 2819 |
| Total Big-Ticket: | 364 | 564 | 1403 | 2389 | 3270 | 3655 | 3748 | 3868 | 3604 | 3014 |
| Full Funding Level: | 2685 | 3331 | 4218 | 5416 | 6634 | 7327 | 7547 | 7809 | 7665 | 7201 |
| Big-Ticket as Percent of Full Funding Level: | 13.6% | 16.9% | 33.3% | 44.1% | 49.3% | 49.9% | 49.7% | 49.5% | 47.0% | 41.9% |

APPENDIX A
DEVELOPMENT OF AGGREGATE FUNDING REQUIREMENTS

This appendix provides a tabular accounting of total budget authority and outlay requirements (in Tables A-1 through A-8) for each of the four alternative budget paths developed in this analysis. Projected totals are in 1977 dollars, and have been derived from the programmatic data developed and presented in Chapter IV. Direct as well as supporting technologies have been aggregated to arrive at annual projections for total federal energy research, development, and demonstration over the next decade. Moreover, these projected totals have been converted to current dollars utilizing an average inflation rate over the next ten years of 7.5 percent annually.

TABLE A-1
OMB PROGRAM COMMITMENT TOTALS

Budget Authority

(fiscal years, millions of 1977 dollars)

| <u>Programs</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| I. Direct Energy Technologies: | | | | | | | | | | |
| A. Fossil Energy | 477 | 675 | 566 | 604 | 538 | 538 | 538 | 538 | 538 | 538 |
| B. Solar Energy | 160 | 161 | 161 | 118 | 118 | 118 | 118 | 118 | 118 | 118 |
| C. Geothermal | 50 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 |
| D. Conservation | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Subtotal | (807) | (1014) | (905) | (900) | (834) | (834) | (834) | (834) | (834) | (834) |
| E. Fusion Power | 392 | 430 | 407 | 398 | 487 | 487 | 487 | 487 | 487 | 487 |
| F. Fission Reactor | 790 | 775 | 744 | 700 | 647 | 647 | 647 | 647 | 647 | 647 |
| G. Other Nuclear | 347 | 344 | 342 | 341 | 342 | 342 | 342 | 342 | 342 | 342 |
| Subtotal | (1529) | (1549) | (1493) | (1493) | (1439) | (1476) | (1476) | (1476) | (1476) | (1476) |
| H. Other Agencies | 257 | 257 | 257 | 257 | 257 | 257 | 257 | 257 | 257 | 257 |
| TOTAL DIRECT | 2593 | 2820 | 2655 | 2596 | 2567 | 2567 | 2567 | 2567 | 2567 | 2567 |
| II. Supporting Technologies: | | | | | | | | | | |
| A. Environmental | 260 | 233 | 233 | 233 | 233 | 233 | 233 | 233 | 233 | 233 |
| B. Basic Energy Sciences | 227 | 233 | 233 | 233 | 233 | 233 | 233 | 233 | 233 | 233 |
| TOTAL SUPPORT | 487 | 466 | 466 | 466 | 466 | 466 | 466 | 466 | 466 | 466 |
| III. Grand Total, Energy RD&D: | | | | | | | | | | |
| A. Constant 1977 Dollars | 3080 | 3286 | 3121 | 3062 | 3033 | 3033 | 3033 | 3033 | 3033 | 3033 |
| B. Current Dollars At 7.5% Inflation | 3080 | 3532 | 3607 | 3804 | 4050 | 4354 | 4681 | 5032 | 5409 | 5815 |

TABLE A-2
OMB PROGRAM COMMITMENT TOTALS

Outlays

(fiscal years, millions of 1977 dollars)

| <u>Programs</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| I. Direct Energy Technologies: | | | | | | | | | | |
| A. Fossil Energy | 442 | 568 | 650 | 683 | 591 | 564 | 538 | 538 | 538 | 538 |
| B. Solar Energy | 116 | 133 | 147 | 123 | 121 | 119 | 118 | 118 | 118 | 118 |
| C. Geothermal | 46 | 53 | 56 | 58 | 59 | 58 | 58 | 58 | 58 | 58 |
| D. Conservation | 91 | 110 | 120 | 120 | 125 | 122 | 120 | 120 | 120 | 120 |
| Subtotal | (695) | (864) | (973) | (984) | (896) | (863) | (834) | (834) | (834) | (834) |
| E. Fusion Power | 304 | 419 | 422 | 395 | 428 | 428 | 428 | 428 | 428 | 428 |
| F. Fission Reactor | 684 | 745 | 771 | 734 | 688 | 667 | 647 | 647 | 647 | 647 |
| G. Other Nuclear | 282 | 304 | 306 | 309 | 319 | 319 | 319 | 319 | 319 | 319 |
| Subtotal | (1270) | (1468) | (1499) | (1438) | (1435) | (1414) | (1394) | (1394) | (1394) | (1394) |
| H. Other Agencies | 272 | 259 | 249 | 249 | 249 | 249 | 249 | 249 | 249 | 249 |
| TOTAL DIRECT | 2237 | 2591 | 2721 | 2671 | 2580 | 2526 | 2477 | 2477 | 2477 | 2477 |
| II. Supporting Technologies: | | | | | | | | | | |
| A. Environmental | 244 | 227 | 226 | 221 | 221 | 221 | 221 | 221 | 221 | 221 |
| B. Basic Energy Sciences | 204 | 222 | 229 | 222 | 222 | 222 | 222 | 222 | 222 | 222 |
| TOTAL SUPPORT | 448 | 449 | 455 | 443 | 443 | 443 | 443 | 443 | 443 | 443 |
| III. Grand Totals: | | | | | | | | | | |
| A. Constant 1977 Dollars | 2685 | 3040 | 3176 | 3114 | 3023 | 2969 | 2920 | 2920 | 2920 | 2920 |
| B. Current Dollars At 7.5% Inflation | 2685 | 3268 | 3670 | 3869 | 4037 | 4262 | 4506 | 4844 | 5208 | 5598 |

TABLE A-3
BASE PROGRAM INCREMENT TOTALS

Budget Authority

(fiscal years, millions of 1977 dollars)

| <u>Programs</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| I. Direct Energy Technologies: | | | | | | | | | | |
| A. Fossil Energy | 477 | 689 | 595 | 648 | 598 | 614 | 631 | 648 | 665 | 683 |
| B. Solar Energy | 160 | 171 | 181 | 149 | 160 | 172 | 185 | 199 | 213 | 228 |
| C. Geothermal | 50 | 61 | 64 | 68 | 71 | 75 | 79 | 83 | 88 | 92 |
| D. Conservation | 120 | 168 | 235 | 329 | 461 | 461 | 461 | 461 | 461 | 461 |
| Subtotal | (807) | (1089) | (1075) | (1194) | (1290) | (1322) | (1356) | (1391) | (1427) | (1464) |
| E. Fusion Power | 392 | 454 | 455 | 473 | 590 | 620 | 651 | 684 | 720 | 757 |
| F. Fission Reactor | 790 | 799 | 792 | 773 | 746 | 773 | 800 | 829 | 858 | 888 |
| G. Other Nuclear | 347 | 365 | 385 | 407 | 433 | 459 | 487 | 517 | 548 | 581 |
| Subtotal | (1529) | (1618) | (1632) | (1653) | (1769) | (1852) | (1938) | (2030) | (2126) | (2226) |
| H. Other Agencies | 257 | 265 | 273 | 281 | 289 | 298 | 307 | 316 | 326 | 335 |
| TOTAL DIRECT | 2593 | 2972 | 2980 | 3128 | 3348 | 3472 | 3601 | 3737 | 3879 | 4025 |
| II. Supporting Technologies: | | | | | | | | | | |
| A. Environmental | 260 | 241 | 249 | 257 | 266 | 274 | 283 | 293 | 302 | 312 |
| B. Basic Energy Sciences | 227 | 240 | 247 | 254 | 261 | 269 | 277 | 285 | 294 | 302 |
| TOTAL SUPPORT | 487 | 481 | 496 | 511 | 527 | 543 | 560 | 578 | 596 | 614 |
| III. Grand Totals: | | | | | | | | | | |
| A. Constant 1977 Dollars | 3080 | 3453 | 3476 | 3639 | 3875 | 4015 | 4161 | 4315 | 4475 | 4639 |
| B. Current Dollars At 7.5% Inflation | 3080 | 3712 | 4017 | 4521 | 5175 | 5764 | 6422 | 7159 | 7981 | 8894 |

TABLE A-4
BASE PROGRAM INCREMENT TOTALS

Outlays

(fiscal years, millions of 1977 dollars)

| <u>Programs</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| I. Direct Energy Technologies: | | | | | | | | | | |
| A. Fossil Energy | 442 | 581 | 677 | 724 | 646 | 634 | 624 | 640 | 656 | 673 |
| B. Solar Energy | 116 | 140 | 161 | 145 | 151 | 158 | 167 | 176 | 187 | 198 |
| C. Geothermal | 46 | 56 | 62 | 67 | 71 | 74 | 77 | 81 | 85 | 90 |
| D. Conservation | 91 | 146 | 207 | 279 | 381 | 378 | 376 | 376 | 376 | 376 |
| Subtotal | (695) | (923) | (1107) | (1215) | (1249) | (1244) | (1244) | (1273) | (1304) | (1337) |
| E. Fusion Power | 304 | 437 | 460 | 453 | 508 | 531 | 555 | 581 | 609 | 638 |
| F. Fission Reactor | 684 | 766 | 813 | 797 | 774 | 776 | 780 | 804 | 829 | 855 |
| G. Other Nuclear | 282 | 321 | 341 | 363 | 393 | 414 | 437 | 461 | 486 | 513 |
| Subtotal | (1270) | (1524) | (1614) | (1613) | (1675) | (1721) | (1772) | (1846) | (1924) | (2006) |
| H. Other Agencies | 272 | 267 | 266 | 274 | 283 | 292 | 302 | 312 | 322 | 332 |
| TOTAL DIRECT | 2237 | 2714 | 2987 | 3102 | 3207 | 3257 | 3318 | 3431 | 3550 | 3675 |
| II. Supporting Technologies: | | | | | | | | | | |
| A. Environmental | 244 | 234 | 241 | 244 | 252 | 260 | 268 | 277 | 286 | 295 |
| B. Basic Energy Sciences | 204 | 228 | 241 | 241 | 248 | 254 | 262 | 269 | 276 | 284 |
| TOTAL SUPPORT | 448 | 462 | 482 | 485 | 500 | 514 | 530 | 546 | 562 | 579 |
| III. Grand Totals: | | | | | | | | | | |
| A. Constant 1977 Dollars | 2685 | 3176 | 3469 | 3587 | 3707 | 3771 | 3848 | 3977 | 4112 | 4254 |
| B. Current Dollars At 7.5% Inflation | 2685 | 3414 | 4009 | 4456 | 4951 | 5414 | 5939 | 6598 | 7334 | 8156 |

TABLE A-5
BASE PROGRAM COMPLETION TOTALS

Budget Authority

(fiscal years, millions of 1977 dollars)

| <u>Programs</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| I. Direct Energy Technologies: | | | | | | | | | | |
| A. Fossil Energy | 477 | 689 | 777 | 830 | 840 | 679 | 696 | 713 | 730 | 683 |
| B. Solar Energy | 160 | 171 | 224 | 192 | 218 | 186 | 199 | 213 | 227 | 228 |
| C. Geothermal | 50 | 61 | 64 | 68 | 71 | 75 | 79 | 83 | 88 | 92 |
| D. Conservation | 120 | 168 | 235 | 329 | 461 | 461 | 461 | 461 | 461 | 461 |
| Subtotal | (807) | (1089) | (1300) | (1419) | (1590) | (1401) | (1435) | (1470) | (1506) | (1464) |
| E. Fusion Power | 392 | 454 | 455 | 473 | 590 | 620 | 651 | 684 | 720 | 757 |
| F. Fission Reactor | 790 | 863 | 856 | 859 | 767 | 794 | 821 | 850 | 879 | 909 |
| G. Other Nuclear | 347 | 365 | 385 | 407 | 433 | 459 | 487 | 517 | 548 | 581 |
| Subtotal | (1529) | (1682) | (1696) | (1739) | (1790) | (1873) | (1959) | (2051) | (2147) | (2247) |
| H. Other Agencies | 257 | 265 | 273 | 281 | 289 | 298 | 307 | 316 | 326 | 335 |
| TOTAL DIRECT | 2593 | 3036 | 3269 | 3439 | 3669 | 3572 | 3701 | 3837 | 3979 | 4046 |
| II. Supporting Technologies: | | | | | | | | | | |
| A. Environmental | 260 | 241 | 249 | 257 | 266 | 274 | 283 | 293 | 302 | 312 |
| B. Basic Energy Sciences | 227 | 240 | 247 | 254 | 261 | 269 | 277 | 285 | 294 | 302 |
| TOTAL SUPPORT | 487 | 481 | 496 | 511 | 527 | 543 | 560 | 578 | 596 | 614 |
| III. Grand Totals: | | | | | | | | | | |
| A. Constant 1977 Dollars | 3080 | 3517 | 3765 | 3950 | 4196 | 4115 | 4261 | 4415 | 4575 | 4660 |
| B. Current Dollars At 7.5% Inflation | 3080 | 3781 | 4351 | 4907 | 5604 | 5908 | 6576 | 7325 | 8159 | 8934 |

TABLE A-6
BASE PROGRAM COMPLETION TOTALS

Outlays

(fiscal years, millions of 1977 dollars)

| <u>Programs</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| I. Direct Energy Technologies: | | | | | | | | | | |
| A. Fossil Energy | 442 | 581 | 708 | 847 | 862 | 862 | 749 | 700 | 716 | 673 |
| B. Solar Energy | 116 | 140 | 168 | 175 | 204 | 214 | 198 | 191 | 202 | 198 |
| C. Geothermal | 46 | 56 | 62 | 67 | 71 | 74 | 77 | 81 | 85 | 90 |
| D. Conservation | 91 | 146 | 207 | 279 | 381 | 378 | 376 | 376 | 376 | 376 |
| Subtotal | (695) | (923) | (1145) | (1368) | (1518) | (1528) | (1400) | (1348) | (1379) | (1337) |
| E. Fusion Power | 304 | 437 | 460 | 453 | 508 | 531 | 555 | 581 | 609 | 638 |
| F. Fission Reactor | 684 | 777 | 856 | 873 | 854 | 820 | 801 | 925 | 850 | 876 |
| G. Other Nuclear | 282 | 321 | 341 | 363 | 393 | 414 | 437 | 461 | 486 | 513 |
| Subtotal | (1270) | (1535) | (1657) | (1689) | (1755) | (1765) | (1793) | (1867) | (1945) | (2027) |
| H. Other Agencies | 272 | 267 | 266 | 274 | 283 | 292 | 302 | 312 | 322 | 332 |
| TOTAL DIRECT | 2237 | 2725 | 3068 | 3331 | 3556 | 3585 | 3495 | 3527 | 3646 | 3696 |
| II. Supporting Technologies: | | | | | | | | | | |
| A. Environmental | 244 | 234 | 241 | 244 | 252 | 260 | 268 | 277 | 286 | 295 |
| B. Basic Energy Sciences | 204 | 228 | 241 | 241 | 248 | 254 | 262 | 269 | 276 | 284 |
| Total Support | 448 | 462 | 482 | 485 | 500 | 514 | 530 | 546 | 562 | 579 |
| III. Grand Totals: | | | | | | | | | | |
| A. Constant 1977 Dollars | 2685 | 3187 | 3550 | 3816 | 4056 | 4099 | 4025 | 4073 | 4208 | 4275 |
| B. Current Dollars At 7.5% Inflation | 2685 | 3426 | 4102 | 4741 | 5417 | 5885 | 6212 | 6757 | 7505 | 8196 |

TABLE A-7
FULL FUNDING TOTALS

Budget Authority

(fiscal years, millions of 1977 dollars)

| <u>Programs</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| I. Direct Energy Technologies: | | | | | | | | | | |
| A. Fossil Energy | 477 | 749 | 966 | 1039 | 1030 | 1238 | 1255 | 1437 | 911 | 848 |
| B. Solar Energy | 160 | 186 | 299 | 328 | 592 | 593 | 966 | 1088 | 1214 | 1029 |
| C. Geothermal | 50 | 151 | 297 | 331 | 291 | 198 | 262 | 381 | 351 | 247 |
| D. Conservation | 120 | 219 | 307 | 457 | 545 | 537 | 498 | 498 | 481 | 474 |
| Subtotal | (807) | (1305) | (1869) | (2155) | (2458) | (2566) | (2981) | (3404) | (2957) | (2598) |
| E. Fusion Power | 392 | 454 | 470 | 518 | 640 | 920 | 921 | 1039 | 820 | 853 |
| F. Fission Reactor | 790 | 1190 | 1633 | 2015 | 2226 | 1893 | 1810 | 1779 | 1699 | 1869 |
| G. Other Nuclear | 347 | 470 | 700 | 827 | 1038 | 969 | 1002 | 767 | 1013 | 971 |
| Subtotal | (1529) | (2114) | (2803) | (3360) | (3904) | (3782) | (3733) | (3585) | (3532) | (3692) |
| H. Other Agencies | 257 | 265 | 273 | 281 | 289 | 298 | 307 | 316 | 326 | 335 |
| TOTAL DIRECT | 2593 | 3684 | 4945 | 5796 | 6651 | 6646 | 7021 | 7305 | 6815 | 6625 |
| II. Supporting Technologies: | | | | | | | | | | |
| A. Environmental | 260 | 241 | 249 | 257 | 266 | 274 | 283 | 293 | 302 | 312 |
| B. Basic Energy Sciences | 227 | 270 | 277 | 309 | 286 | 299 | 292 | 300 | 299 | 307 |
| TOTAL SUPPORT | 487 | 511 | 526 | 566 | 552 | 573 | 575 | 593 | 601 | 619 |
| III. Grand Totals: | | | | | | | | | | |
| A. Constant 1977 Dollars | 3080 | 4195 | 5471 | 6362 | 7203 | 7219 | 7596 | 7898 | 7416 | 7244 |
| B. Current Dollars At 7.5% Inflation | 3080 | 4510 | 6322 | 7903 | 9619 | 10364 | 11723 | 13103 | 13226 | 13888 |

TABLE A-8
FULL FUNDING TOTALS

Outlays

(fiscal years, millions of 1977 dollars)

| <u>Programs</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| I. Direct Energy Technologies: | | | | | | | | | | |
| A. Fossil Energy | 442 | 591 | 767 | 1002 | 1084 | 1144 | 1190 | 1350 | 1361 | 1014 |
| B. Solar Energy | 116 | 142 | 188 | 241 | 368 | 528 | 675 | 916 | 1125 | 1053 |
| C. Geothermal | 46 | 70 | 147 | 268 | 351 | 320 | 244 | 252 | 280 | 278 |
| D. Conservation | 91 | 154 | 244 | 358 | 494 | 483 | 455 | 426 | 395 | 388 |
| Subtotal | (695) | (957) | (1346) | (1869) | (2297) | (2475) | (2564) | (2944) | (3161) | (2733) |
| E. Fusion Power | 304 | 437 | 462 | 468 | 545 | 627 | 775 | 909 | 944 | 823 |
| F. Fission Reactor | 684 | 833 | 1155 | 1614 | 2067 | 2259 | 2131 | 1947 | 1708 | 1777 |
| G. Other Nuclear | 282 | 338 | 438 | 616 | 843 | 1016 | 1065 | 993 | 840 | 845 |
| Subtotal | (1270) | (1608) | (2055) | (2698) | (3455) | (3902) | (3971) | (3849) | (3492) | (3445) |
| H. Other Agencies | 272 | 267 | 266 | 274 | 283 | 292 | 302 | 312 | 322 | 332 |
| TOTAL DIRECT | 2237 | 2832 | 3667 | 4841 | 6035 | 6669 | 6837 | 7105 | 6975 | 6510 |
| II. Supporting Technologies: | | | | | | | | | | |
| A. Environmental | 244 | 234 | 241 | 244 | 252 | 260 | 268 | 277 | 286 | 295 |
| B. Basic Energy Sciences | 204 | 232 | 261 | 277 | 294 | 291 | 290 | 289 | 281 | 289 |
| TOTAL SUPPORT | 448 | 466 | 502 | 521 | 546 | 551 | 558 | 566 | 567 | 584 |
| III. Grand Totals: | | | | | | | | | | |
| A. Constant 1977 Dollars | 2685 | 3298 | 4169 | 5362 | 6581 | 7220 | 7395 | 7671 | 7542 | 7094 |
| B. Current Dollars At 7.5% Inflation | 2685 | 3545 | 4818 | 6661 | 8789 | 10365 | 11413 | 12727 | 13451 | 13601 |

APPENDIX B
SPENDOUT PATTERNS FOR BIG-TICKET ITEMS
IN THE OMB COMMITMENT PROJECTION

The spendout patterns utilized in this appendix to convert the unappropriated balances for big-ticket items included in the OMB commitment projection are identical to those discussed in Chapter III. In some cases, however, it was necessary to estimate the balance remaining to be funded in subsequent years. Projections for budget authority are presented in Table B-1 while outlays are included in Table B-2.

TABLE B-1
 BIG TICKET ITEMS IN THE OMB COMMITMENT PROJECTION
 Budget Authority
 (fiscal years, millions of 1977 dollars)

| <u>Big-Ticket Items</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Ebulated Bed (H-Coal) Pilot ^{a/} | 21 | 5 | 5 | 5 | 5 | -- | -- | -- | -- | -- |
| Low BTU Combined Cycle Pilot ^{a/} | 17 | 15 | 5 | 5 | 5 | 5 | -- | -- | -- | -- |
| Clean Boiler Fuel Demo | 30 | 15 | 5 | 5 | 5 | 5 | 5 | -- | -- | -- |
| High BTU Syngas Demo (A&E only) ^{b/} | 10 | 8 | 7 | -- | -- | -- | -- | -- | -- | -- |
| Low BTU Fuel Gas Demo (A&E only) ^{b/} | 7 | 6 | 6 | -- | -- | -- | -- | -- | -- | -- |
| 10MW Central RCVR Pilot (A&E only) ^{b/} | 3 | 2 | 1 | -- | -- | -- | -- | -- | -- | -- |
| Tokamak Test Reactor | 80 | 94 | 33 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| High Energy Laser Facility | 10 | 20 | 25 | 4 | 4 | 4 | 4 | -- | -- | -- |
| Fast Fux Test Facility | 80 | 40 | 10 | 10 | 10 | 10 | -- | -- | -- | -- |
| Clinch River Breeder Reactor | 238 | 283 | 283 | 377 | 149 | 149 | 149 | 149 | 149 | 149 |
| Centrifuge Plant Demo Facility | 30 | 30 | 5 | 4 | 4 | 4 | 4 | -- | -- | -- |
| | | | | | | | | | | |
| OMB Commitment Total: | 526 | 518 | 385 | 435 | 207 | 202 | 187 | 174 | 174 | 174 |

a. Estimates Only

b. Architectural and Engineering

TABLE B-2
BIG-TICKET ITEMS IN THE OMB COMMITMENT PROJECTION
Outlays
(fiscal years, millions of 1977 dollars)

| <u>Big-Ticket Items</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1982</u> | <u>1983</u> | <u>1984</u> | <u>1985</u> | <u>1986</u> |
|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Ebulated Bed (H-Coal) Pilot <u>a/</u> | 17 | 11 | 5 | 5 | 5 | -- | -- | -- | -- | -- |
| Low BTU Combined Cycle Pilot <u>a/</u> | 18 | 14 | 7 | 5 | 5 | 5 | -- | -- | -- | -- |
| Clean Boiler Fuel Demo | 26 | 22 | 18 | 21 | 9 | 9 | 9 | -- | -- | -- |
| High BTU Syngas Demo (A&E only) <u>b/</u> | 1 | 5 | 9 | 7 | 3 | -- | -- | -- | -- | -- |
| Low BTU Fuel Gas Demo (A&E only) <u>b/</u> | 1 | 4 | 7 | 5 | 2 | -- | -- | -- | -- | -- |
| 10MW Central RCVR Pilot (A&E only) <u>b/</u> | 0 | 1 | 2 | 2 | 1 | -- | -- | -- | -- | -- |
| Tokamak Test Reactor | 34 | 75 | 69 | 61 | 35 | 25 | 25 | 25 | 25 | 25 |
| High Energy Laser Facility | 11 | 20 | 15 | 15 | 4 | 4 | 4 | -- | -- | -- |
| Fast Flux Test Facility | 80 | 51 | 15 | 10 | 10 | 10 | 10 | -- | -- | -- |
| Clinch River Breeder Reactor | 171 | 223 | 531 | 412 | 308 | 149 | 149 | 149 | 149 | 149 |
| Centrifuge Plant Demo Facility | 5 | 18 | 25 | 71 | 14 | 4 | 4 | -- | -- | -- |
| OMB Commitment Total: | 364 | 444 | 703 | 614 | 396 | 206 | 201 | 174 | 174 | 174 |

a. Estimates Only

b. Architectural and Engineering

