# Observations on the President's Fiscal Year 2001 Federal Science and Technology Budget

Committee on Science, Engineering, and Public Policy

NATIONAL ACADEMY OF SCIENCES
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INSTITUTE OF MEDICINE

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# Preface

In 1995, the National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council issued a report entitled *Allocating Federal Funds for Science and Technology*, which recommended tracking of federal investments in the creation of new knowledge and technologies—what the report referred to as the federal science and technology (FS&T) budget.

COSEPUP is issuing this third annual report in order to identify potential impacts of the President's proposed FS&T budget. The Committee does not make recommendations about specific spending levels, but rather identifies aspects of the proposed budget as they affect the health of the nation's research enterprise.

This report also appears in the AAAS's Intersociety Working Group, *AAAS Report XXV: Research and Development FY2001,* through a cooperative arrangement between our organizations.

The report has been reviewed by persons chosen for their diverse perspectives and technical expertise in accordance with procedures approved by the National Research Council's Report Review Committee. The purposes of the independent review are to provide candid and critical comments that will assist COSEPUP in making its report as sound as possible and to ensure that the report meets institutional standards of objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their participation in the review of this report: Bernard Burke (Massachusetts Institute of Technology), John Gibbons (National Academy of

Engineering), Christopher Hill (George Mason University), Daniel Kelves (California Institute of Technology), Stephen Kohashi (Department of Housing and Urban Development), Kei Koizumu (American Association for the Advancement of Science), Charles Larson (Industrial Research Institute), John Mayo (Lucent Technologies), and Peter Raven (Chair, Report Review Committee).

The production of this report was the result of hard work of the project committee chaired by James Duderstadt. The project was aided by the help of the committee's professional staff: Richard E. Bissell, Peter Henderson, and Vivian Nolan.

**Maxine F. Singer,** Chair
Committee on Science, Engineering,
and Public Policy

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## FINDINGS

- The Administration's FY2001 budget proposes a Federal Science & Technology (FS&T) increase of 1.3 percent in constant dollars. The stated goals of the budget are to ensure the health of the nation's research enterprise through steady and balanced growth, and to capture the public imagination by identifying exciting initiatives in research to improve the health and welfare of the American people.
- The 21st Century Research Fund is part of the Administration's strategy to emphasize basic research and knowledge-creating investments. The Fund would increase 5.0 percent in constant dollars. The Fund represents an important step toward identifying those investments aimed at knowledge-creation.
- The budget would sharply increase National Science Foundation (NSF) spending, and would alleviate the disparity in funding growth in the life sciences and other scientific fields. In the committee's opinion, large budget reductions proposed for Department of Defense (DOD) and some other mission agencies may threaten adverse consequences for certain fields of science and engineering. In particular, uncertain funding jeopardizes recruitment and training of the next generation of researchers.
- In the committee's judgment, sharp funding increases in biomedical fields may strain the capacity of existing infrastructure and facilities in some universities and other institutions expected to carry out the increased research in those fields. In the context of such increases, the problems of unreimbursed indirect costs need attention through a simplified formula

that would protect both the interests of research organizations and the government.

- Since 1987, industry R&D has increased 196 percent, and the federal share of total R&D in the U.S. has dropped from 46 percent to 27 percent.

## The FY 2001 FS&T budget

The FS&T budget encompasses the federal investment in the creation of new knowledge and technologies, as detailed in earlier reports from the National Academies.[1] The Administration has moved toward this concept by identifying, in addition to the usual R&D budget, a budget known as the 21st Century Research Fund, similar in spirit to the FS&T concept but stressing as well its research priorities. We have compared the R&D, FS&T, and Fund budgets in Figure 2 and in Tables 1, 2, and 3. As can be seen in Table 1, FS&T differs from the Fund by about $11 billion, of which $3 billion is the 6.3 budget of DOD, $4 billion is Human Space Flight and Mission Support in NASA, and $2.8 billion is DOE Defense Activities. Both the FS&T budget and the Fund provide visibility for the research budget and its change in the context of the overall R&D budget.

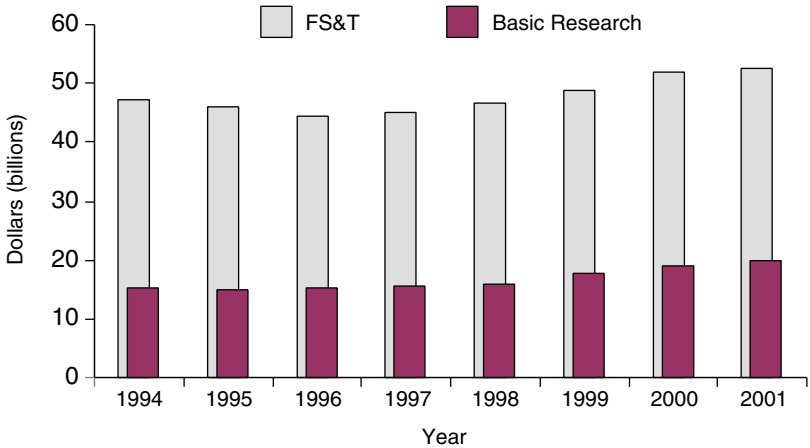


FIGURE 1 FS&T Budget and Basic Research, FY 1994-FY 2001 (budget authority in billions of constant FY 2000 dollars)

[1]*Allocating Federal Funds for Science and Technology,* Committee on Criteria for Federal Support of Research and Development, NAP 1995; and the annual "*Observations . . .*" reports from COSEPUP in 1998 and 1999.

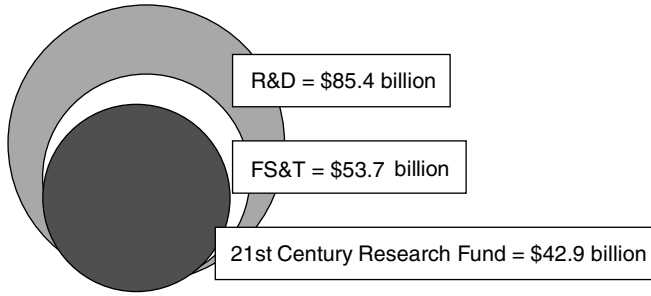


FIGURE 2 FY 2001 R&D, FS&T, and 21st Century Research Fund (in billions)

The FY2001 budget proposes a small increase in FS&T—$674 million, an increase of 1.3 percent from FY 2000 in constant dollars, to a total of $52.6 billion.[2] (See Figure 1) Last year, the administration requested an increase of only 0.4 percent in FS&T spending, but the Congress raised it 6.4 percent in appropriations. (see Table 3). Of particular note in FY2001 are the proposed increases at NSF (17.5 percent), HHS (3.9 percent), and certain programs in DOE (5.9% overall). NASA has a real increase (0.7 percent) for the first time in several years. DOD FS&T spending would be cut 13.9 percent. Aside from large proposed increases at NIH and NSF, proposed FS&T spending in the rest of the federal government would be down 1.4 percent.

The administration proposes to spend $42.9 billion on the 21st Century Research Fund, an increase of 5.0 percent in constant dollars over FY 2000. This is substantially higher than the 1.7 percent increase in constant dollars proposed by the administration for this fund in FY 2000, but smaller than the 6.5 percent growth actually appropriated by Congress last year. A set of inter-agency initiatives is highlighted this year, with focused efforts in nanotechnology ($485 million), information technology ($2.27 billion), clean energy ($283 million), climate change ($1.4 billion), and six others, as detailed in Table 4. The emergence of the 21st Century Research Fund is a welcome program descriptive device for some areas of research that are ripe for making dramatic progress, and other areas of current importance to society.

[2]The GDP deflator, about 2.2 percent a year for 1994-2000 and 2.0 percent for 2001, is used by both COSEPUP and AAAS in calculating constant-dollar figures.

## CONCERNS

### Overall U.S. Investment in Research and Development

The FS&T budget is one part of the broader measure of R&D in the federal government, as well as of the total public and private support of R&D. Total R&D spending has been rising as a share of GDP and is now nearing 3 percent—2.8 percent in 1999. While hard and precise targets for total R&D spending and for its composition are hard to establish, there is a wide consensus that U.S. economic growth and scientific preeminence depend on maintaining and possibly increasing the share of GDP devoted to R&D. The administration has suggested a target goal of total R&D as 3.0 percent of the U.S. gross domestic product (GDP).[3] Movement in recent decades toward that goal has been achieved through growing private rather than public investment. As seen in Figure 3, there has been a significant divergence of federal and non-federal investment patterns in R&D as shares of GDP since 1987.[4]

Basic research receives its principal support from publicly supported R&D, whereas privately sponsored R&D emphasizes applied research and development. The continued effectiveness of industry expenditures on applied research and development depends on the continued flow of basic research findings and the associated training of scientists and engineers.[5] Industry benefits from, and invests in, the development of products based on basic research conducted in prior decades. Thus, continued growth of basic research will help sustain continued high returns to private R&D outlays, and ensure a pipeline of new knowledge accessible to future generations.

The growth of industry spending on R&D should, therefore, not lull observers into thinking that the federal research budget can consequently be reduced. This growth does not reduce the need for a strong federal research budget.

### Balancing the FS&T Portfolio

The differences in the growth rates of FS&T investments across fields are a concern.[6] In essence, the life sciences budget has surged ahead while the FS&T

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[3]*Science in the National Interest*, The White House, 1994.

[4]Federal R&D as a percentage of total R&D in the United States reached a high point in 1964 at 66.8 percent, equaled 46.4 percent in 1987, and in 1999 was 26.7 percent. See NSF, *National Patterns of Research and Development Resources 1999 Data Update* (NSF 00-306).

[5]*Capitalizing on Investments in Science and Technology*, COSEPUP, National Academy Press, 1999.

[6]For an NRC review of this problem using data through FY1997, see *Securing America's Industrial Strength*, Board on Science, Technology, and Economic Policy, Appendix A.

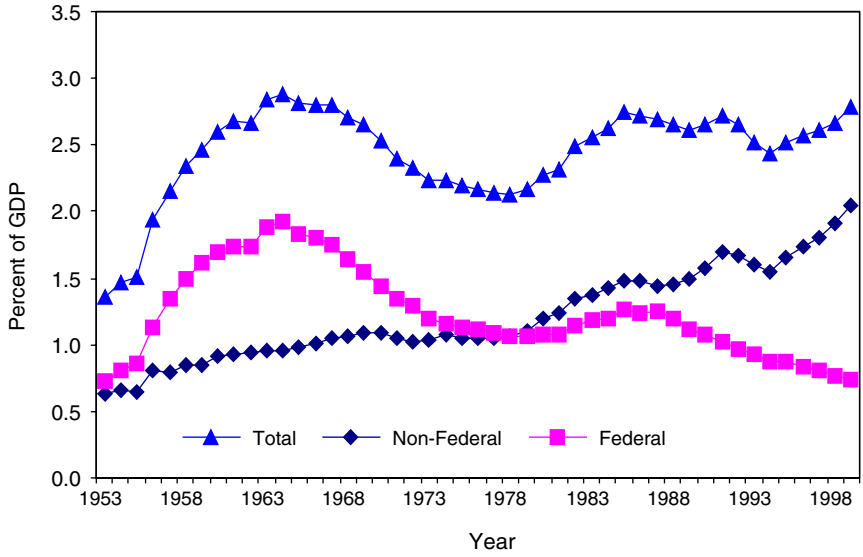


FIGURE 3. Federal, Non-Federal, and Total Support for R&D as a Percent of GDP, 1953-1999

Source: National Science Foundation, *National Patterns of Research and Development Resources: 1999 Data Update* (NSF 00-306).

budgets for other fields have increased only slightly or have decreased with the cuts in the DOD budget. FS&T at NIH provided an increase to life sciences research between FY1998 and FY2000 that is greater than all of FS&T proposed for NSF for FY2001.

Research in the life sciences is motivated by a need to improve health. Yet many of the improvements seen in the past decades are due to advancement of knowledge that comes from other fields. Examples would include magnetic resonance imaging, positron emission, and miniaturization in athroscopic surgery. As Harold Varmus, former Director of NIH, has often explained, discoveries in biology and medicine depend on progress in physics, chemistry, engineering, and many allied fields. The FY2001 budget recognizes the need for balanced expansion of research with substantial increases proposed for the National Science Foundation in particular.

While reallocation of funds within a limited budget is inescapable, abrupt decreases can raise difficult problems. Among major programs, for instance, a cut of 14 percent is proposed for DOD FS&T. DOD has been and remains a major sponsor of academic research in the physical sciences and engineering. Much greater attention needs to be given to the impact of such reductions on fields, as available retrospectively in NSF data, where multi-year trends may sig-

nal the erosion of U.S. capability. Analysis could assess whether those trends affect U.S. global leadership in science and engineering.

Swings in FS&T levels pose difficulties for those planning careers in science and engineering. Federal research funding directly and indirectly supports the training of the next generation of scientists and engineers. Only rarely do budget decisions take into account those effects of the various agencies funding research. A recent National Research Council review of major fields with substantial declines in federal research support (chemical engineering, mechanical engineering, and electrical engineering) in the 1990s shows a strong correlation with reduced graduate enrollments in those fields. [7]

Mission agencies contribute substantially to fields not readily identifiable in the stated missions. The cuts in programs at NASA, DOE, and DOD are especially notable. These declines, accumulated over a period of years, can be damaging to a research infrastructure that takes years to build and to maintain at state-of-the-art condition.

The adequacy of physical infrastructure also requires close attention.[8] The rapid, recent increases in FS&T funding for the life sciences challenge the capacity of research institutions to respond to the demands for expanded programs. Construction lead time for buildings and laboratories can be long. Without such physical capital, ambitious research programs may be needlessly costly or simply unattainable. Recent FS&T proposals have inadequately reflected the long-term costs to research institutions of raising the funds and building the human and physical infrastructure to maintain an adequate research capacity.[9]

Rising levels of federal support for research programs increase tension between the government and universities over indirect cost recovery. Universities are presently contributing substantially toward making this investment effective with their own resources as a result of incomplete cost recovery and other forms of cost-sharing.[10] Unless universities can find additional revenue, this cost burden will cause tradeoffs with other university functions. The successful completion of efforts to reform rules governing reimbursement for indirect costs deserves high priority.

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[7] *Securing America's Industrial Strength*, Board on Science, Technology, and Economic Policy, National Academy Press, 1999, pp. 89-93.

[8] An example of the analysis needed has been done for information technology: National Research Council, *Funding A Revolution: Government Support for Computing Research Infrastructure*, CPSMA, National Academy Press, 1999.

[9] The federal government directly paid for 9 percent of construction, renovation, and repair of academic research facilities in 1998, with the rest of the funds coming from state/local governments (about 30%) and internal university funds (about 60%). National Science Foundation, *Scientific and Engineering Research Facilities at Colleges and Universities: 1998: An Overview* (NSF 99-413), Arlington, VA: NSF, 1999, pp. xii-xiii.

[10] See National Science and Technology Council, *Presidential Review Directive 4,* Chapter 5, April 27, 1999.

## CONCLUSIONS

The Administration has made progress in FY2001 in the strategy and presentation of the federal science and technology budget. Some areas of FS&T have increased with generally positive impacts, and other programs have been cut. The strong increase proposed for NSF (17.5 percent) represents an important investment in basic research and a step toward better balance in federal support among the various research fields. Overall, the proposed increase in constant dollars is only 1.3 percent. The initiatives highlighted in the President's budget and the 21st Century Research Fund are useful, and may fuel the kind of research that fosters public support for research as well as improvements in the quality of life.

The budget causes concerns about the effects of proposed cuts in Defense and other mission agencies. A continuing need exists to analyze possible imbalances among the fields of science and engineering—at a time when many fields are increasingly interdependent for achieving optimal results in the productivity of the economy and the pursuit of knowledge.

# FS&T TABLES

TABLE 1 Alternative Perspectives on the President's FY 2001 Science and Technology Budget (millions of current dollars)

| Agency | 21st Century Fund | FS&T | R&D |
|---|---|---|---|
| **Dept. of Defense** | **4,361** | **7,609** | **38,576** |
| Basic research (6.1) | 1,217 | 1,217 | 1,217 |
| Applied research (6.2) | 3,144 | 3,144 | 3,144 |
| Advanced technology development (6.3) | — | 3,182 | 3,182 |
| Medical research | — | 66 | 66 |
| Test and evaluation | — | — | 30,967 |
| **NASA** | **5,165** | **10,040** | **10,040** |
| Space, Earth, and Life & Microgravity Sci. | 4,107 | 4,107 | 4,107 |
| Aerospace Technology | 1,058 | 1,193 | 1,193 |
| Other Science, Aeronautics, and Technology | — | 629 | 629 |
| Human Space Flight and Mission Support | — | 4,111 | 4,111 |
| **Dept. of Energy** | **4,221** | **6,882** | **7,639** |
| Solar and Renewable Energy R&D | 410 | 376 | 376 |
| Nuclear Energy R&D | — | 92 | 92 |
| Fossil Energy R&D | — | 293 | 293 |
| Energy Conservation | 660 | 465 | 465 |
| Science Programs | 3,151 | 2,969 | 2,969 |
| Atomic Energy Defense Activities | — | 2,647 | 3,405 |
| Radioactive Waste Management | — | 40 | 40 |
| **Dept. of Health & Human Services** | **18,813** | **19,168** | **19,168** |
| National Institutes of Health | 18,813 | 18,094 | 18,094 |
| Other HHS programs | — | 1,074 | 1,074 |
| **National Science Foundation** | **4,572** | **3,432** | **3,432** |
| Research and Related Activities | 3,541 | 3,183 | 3,183 |
| Major Research Equipment | 139 | 139 | 139 |
| Education and Human Resources | 729 | 110 | 110 |
| Salaries, Expenses, and Inspector General | 164 | — | — |
| **Dept. of Agriculture** | **1,649** | **1,824** | **1,824** |
| **Dept. of the Interior** | **895** | **590** | **590** |
| **Dept. of Transportation** | **899** | **778** | **778** |
| **Environmental Protection Agency** | **758** | **673** | **673** |
| **Dept. of Commerce** | **862** | **1,148** | **1,148** |
| **Dept. of Veterans' Affairs** | **321** | **655** | **655** |
| **Dept. of Education** | **379** | **271** | **271** |
| **Other Agencies** | **—** | **632** | **632** |
| **TOTAL** | **42,895** | **53,702** | **85,427** |

Source: OMB, *Budget of the U.S. Government FY 2001* and AAAS, Tables II-1, II-2, II-7, II-8, II-11, and II-12.

TABLE 2 Federal Science and Technology (FS&T) Budget, by Agency, FY 1999-FY2001 (millions of constant FY 2000 dollars)

| | | | | | Percent Change | |
|---|---|---|---|---|---|---|
| | 1994 Actual | 1999 Actual | 2000 Est. | 2001 Budgt. | FY 1999-FY 2000 | FY 2000-FY 2001 |
| **Dept.of Defense** | **9,129** | **7,726** | **8,667** | **7,460** | **12.2** | **–13.9%** |
| Basic Research (6.1) | 1,299 | 1,080 | 1,161 | 1,193 | 7.5% | 2.8% |
| Applied Research (6.2) | 3,560 | 3,103 | 3,410 | 3,082 | 9.9% | –9.6% |
| Adv. Tech. Dev. (6.3) | 4,270 | 3,505 | 3,826 | 3,120 | 9.2% | –18.5% |
| Medical Research (other) | — | 39 | 270 | 65 | 600.1 | –76.0 |
| **NASA** | **10,367** | **9,862** | **9,776** | **9,843** | **–0.9%** | **0.7%** |
| Hum. Space Flight R&D | n.a. | 2,357 | 2,333 | 2,093 | –1.0% | –10.3% |
| Sci., Aero., and Tech. | n.a. | 5,738 | 5,581 | 5,813 | –2.7% | 4.2% |
| Mission Support R&D | n.a. | 1,767 | 1,862 | 1,937 | 5.4% | 4.0% |
| **Dept. of Energy** | **6,530** | **6,315** | **6,372** | **6,747** | **0.9%** | **5.9%** |
| Energy Supply | n.a. | 364 | 364 | 459 | –0.1% | 26.1% |
| Fossil Energy R&D | n.a. | 299 | 328 | 287 | 9.6% | –12.4% |
| Energy Conservation | n.a. | 387 | 431 | 456 | 11.5% | 5.8% |
| Science | n.a. | 2,712 | 2,638 | 2,911 | –2.7% | 10.3% |
| Atomic Energy Defense | n.a. | 2,490 | 2,556 | 2,575 | 2.7% | 1.5% |
| Radioactive Waste Mgt. | n.a. | 63 | 55 | 39 | –12.6% | –28.7% |
| **Dept. of HHS** | **12,481** | **16,061** | **18,082** | **18,792** | **12.6%** | **3.9%** |
| NIH | 11,544 | 15,219 | 17,102 | 17,739 | 12.4% | 3.7% |
| Other | 937 | 842 | 980 | 1,053 | 16.3% | 7.4% |
| **NSF** | **2,472** | **2,710** | **2,864** | **3,365** | **5.7%** | **17.5%** |
| Res. and Rel. Act. R&D | n.a. | 2,526 | 2,649 | 3,121 | 4.9% | 17.8% |
| Maj. Res. Equipment | n.a. | 91 | 94 | 136 | 2.9% | 45.0% |
| Educ. & Hum. Res. R&D | n.a. | 92 | 121 | 108 | 31.0% | –10.9% |
| **Dept. of Agriculture** | **1,684** | **1,670** | **1,763** | **1,788** | **5.6%** | **1.4%** |
| **Dept. of the Interior** | **780** | **506** | **573** | **578** | **13.1%** | **0.9%** |
| **Dept. of Transportation** | **706** | **616** | **606** | **763** | **–1.6%** | **25.9%** |
| **EPA** | **648** | **679** | **647** | **660** | **–4.7%** | **2.0%** |
| **Dept. of Commerce** | **1,126** | **1,100** | **1,073** | **1,125** | **–2.5%** | **4.9%** |
| **Veterans Affairs** | * | **654** | **655** | **642** | **0.2%** | **–2.0%** |
| **Dept. of Education** | * | **208** | **233** | **266** | **12.0%** | **14.0%** |
| **Other Agencies** | **1,471** | **763** | **664** | **620** | **–13.0** | **–6.7%** |
| **FS&T TOTAL** | **47,396** | **48,865** | **51,975** | **52,649** | **6.4%** | **1.3%** |

n.a. = not available

*Dept. of Veterans Affairs and Dept. of Education included in "Other Agencies" in FY 1994.

Source: AAAS Tables II-1, II-2, II-7, II-8, II-11, and II-12.

TABLE 3 Trends in FS&T and R&D, FY 1994-FY 2001 (millions of constant FY 2000 dollars)

| | FS&T | | R&D | |
|---|---|---|---|---|
| Fiscal Year | Current | Constant | Current | Constant |
| 1994 | 43,002 | 47,396 | 71,074 | 78,338 |
| 1995 | 42,688 | 46,079 | 70,948 | 76,581 |
| 1996 | 42,162 | 44,649 | 71,206 | 75,407 |
| 1997 | 43,340 | 45,132 | 73,934 | 76,987 |
| 1998 | 45,191 | 46,464 | 75,942 | 78,080 |
| 1999* | 48,151 | 48,869 | 80,172 | 81,370 |
| 2000* | 51,975 | 51,975 | 83,334 | 83,334 |
| 2001* | 53,702 | 52,649 | 85,427 | 83,751 |
| Chg., FY 1994-FY 2001 | 24.9% | 11.1% | 20.2% | 6.9% |
| Chg., FY 1999-FY 2000 | 7.9% | 6.4% | 3.9% | 2.4% |
| Chg., FY 2000-FY 2001 | 3.3% | 1.3% | 2.5% | 0.5% |

* Note: Changes in DOE accounting for Atomic Energy Defense Activities have resulted in a modification in the calculation of FS&T beginning with FY 1999.
Source: AAAS Tables I-16 and II-1; FS&T figures for 1994-1998 carried forward from *Observations on the President's FY 2000 Federal Science and Technology Budget.*

TABLE 4 Cross-Cutting National Science and Technology Council Initiatives, President's FY 2001 Budget (millions of constant FY 2000 dollars)

| | | | | Percent Change | |
|---|---|---|---|---|---|
| | 1999 Actual | 2000 Est. | 2001 Budgt. | FY 1999-FY 2000 | FY 2000-FY 2001 |
| Nanotechnology Initiative | 251 | 270 | 485 | 7.7% | 79.7% |
| Information Technology R&D | 1,320 | 1,721 | 2,270 | 30.3% | 31.9% |
| Clean Energy | 198 | 196 | 283 | –1.0% | 44.6% |
| Climate Change Technology Initiative | 1,036 | 1,099 | 1,404 | 6.1% | 27.7% |
| Partnership for a New Generation of Vehicles | 239 | 226 | 250 | -5.2% | 10.6% |
| Integrated Science for Ecosystem Challenges | 639 | 657 | 732 | 2.8% | 11.5% |
| U.S. Global Change Res. Program | 1,682 | 1,701 | 1,706 | 1.1% | 0.3% |
| Interagency Education Research Initiative | 30 | 38 | 49 | 24.8% | 29.0% |
| Critical Infrastructure Prot. R&D | 457 | 461 | 594 | 0.9% | 28.9% |
| Weapons of Mass Destruction Preparedness R&D | 325 | 473 | 491 | 45.6% | 3.8% |

Source: U.S. Office of Management and Budget, *Budget of the United States Government, Fiscal Year 2001.*