

DOE Science Leads the Pack in 2008 Budget

AAAS R&D Funding Update on R&D in the FY 2008 DOE Budget

(This analysis is a preview of the DOE chapter in the forthcoming *AAAS Report XXXII: Research and Development FY 2008*, a comprehensive look at the President's budget for R&D in FY 2008. This analysis contains revised AAAS estimates of DOE R&D, different from figures originally presented in the President's budget. More tables and continually updated supplemental materials on R&D in the FY 2008 budget can be found on the AAAS R&D Web site at <http://www.aaas.org/spp/rd>.)

Highlights

- **The Department of Energy's (DOE) Office of Science would be the clear winner in the 2008 budget among R&D agencies because of its key role in the President's American Competitiveness Initiative (ACI). R&D in DOE Science would climb 15.4 percent from the final 2007 budget to \$4.1 billion, the largest percentage increase among the R&D funding agencies (see Table II-11).** Science programs would all receive substantial increases for the second year in a row to hit historic highs.

- The total DOE R&D portfolio would climb 5.7 percent or \$502 million to \$9.2 billion because of the large Science increase, partially offset by declining energy R&D funding and a rebounding defense R&D investment.

- DOE's energy-related R&D would total \$1.4 billion, an 8.9 percent cut from the final 2007 budget because of a surprise last-minute infusion of hundreds of millions of dollars in 2007. DOE R&D investments in renewable energy technologies such as hydrogen, biomass, and solar energy would be up dramatically from the 2006 level in both 2007 and 2008. But DOE once again proposes to eliminate R&D on gas and oil technologies and some renewables, and proposes to cancel \$50 million in mandatory funding for deepwater oil and gas exploration R&D.

DOE R&D in the FY 2008 Budget

President Bush's American Competitiveness Initiative (ACI) and Advanced Energy Initiative (AEI), both set for their second years in 2008, have made the Department of Energy's (DOE) R&D programs a high priority within an increasingly tight domestic budget. The FY 2008 budget would enable the department to increase its R&D funding at a time when most other agencies face falling budgets. DOE's Office of Science is the largest federal sponsor of physical sciences research and is thus one of three federal agencies (the other two are the National Science Foundation and the National Institute of Standards and Technology laboratories) that would receive substantial increases to fulfill the ACI's goal of increasing federal investments in basic physical sciences research. DOE's energy R&D portfolio funds R&D on a variety of topics, including renewable energy R&D on the Administration priorities of hydrogen, solar power, and biomass, all of which received substantial increases in 2007. But those increases would be offset by cuts in other energy R&D programs in the 2008 budget in areas such as energy conservation, fossil energy R&D, and even some renewables.

The DOE R&D portfolio would climb \$502 million or 5.7 percent to \$9.2 billion in the 2008 budget (see Table II-11), because of a substantial 15 percent increase for the Science portfolio. The energy R&D portfolio would fall 8.9 percent to \$1.4 billion in 2008 after an enormous increase in 2007, while DOE's defense R&D portfolio would gain 2.6 percent to \$3.8 billion after a large cut in 2007.

R&D in the DOE Office of Science

DOE's Office of Science, in its various incarnations over the decades, has long been the dominant federal sponsor of physical sciences research, especially in physics and related fields. It is also an important supporter of computer sciences, mathematics, environmental sciences, materials research, nanotechnology, and engineering; the Bush Administration's push to boost physical sciences broadly defined through large increases in the Science budget would pay off for all research areas. Last year, DOE requested a 14 percent increase for Science funding, and ended up with 5 percent in the recently finalized 2007 budget. To catch up with the ACI's ten-year funding trajectory, the 2008 increase for the total Office of Science budget would be 16 percent to \$4.4 billion, a \$601 million increase consistent with a plan to double the budget between 2006 and 2016. More than 90 percent of the Science budget goes to R&D activities; Science R&D would gain 15.4 percent in the FY 2008 budget to \$4.1 billion, making DOE Science once again the big winner among the major R&D funding agencies (see Table II-11). The large proposed increase following 2007's increase would mark a departure from the flat or declining funding trends of earlier years (see Figure 1), and in real terms would bring Science funding to its highest level since 1993, before the Superconducting Super Collider was canceled.

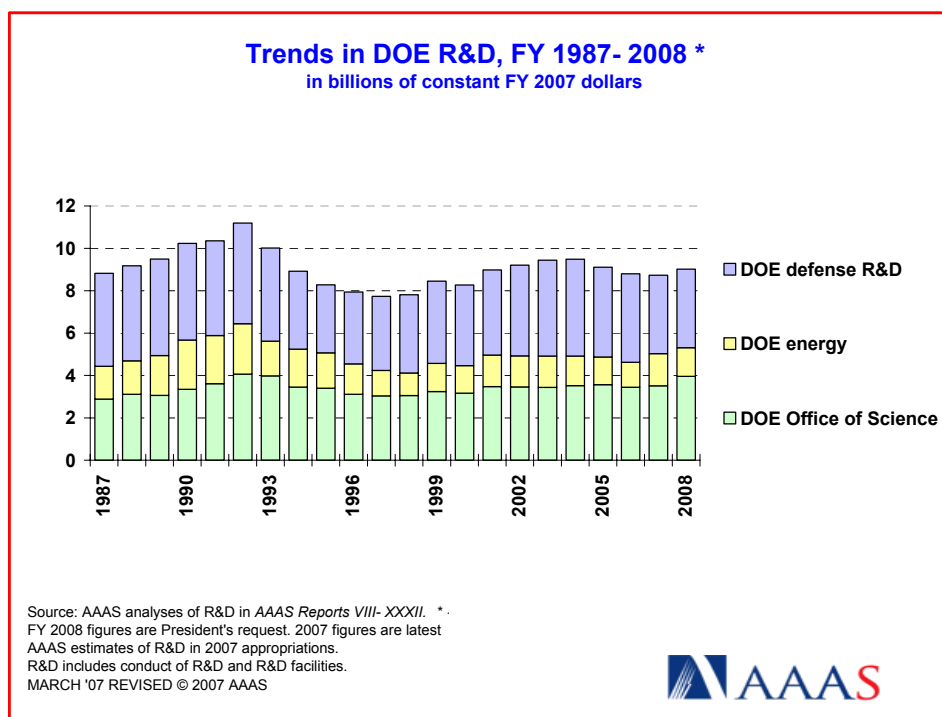


Figure 1. (click on the image for PDF)

Funding for every Science program would increase substantially for the second year in a row, including a 34 percent increase for fusion research, a 20 percent boost for basic energy sciences, and a 20 percent increase for computing research (see Figure 2). (All changes are based on a recently announced final distribution of 2007 funds among Science programs from the 2007 appropriation enacted last month.)

The Office of Science supports cutting-edge research through a mix of laboratory research at DOE's national laboratories, university-based research, and the construction and operation of large scientific user facilities that can be used by external researchers for their experiments. Roughly half of Science R&D funding goes to operate and construct facilities, while the other half supports research, mostly at DOE laboratories but a large portion at universities. The laboratory research and large facilities are housed primarily at ten Science laboratories that are federally owned and contractor operated, such as the Oak Ridge National Laboratory in Tennessee, Brookhaven National Laboratory in New York, and Argonne

National Laboratory in Illinois. After several years in which tight budgets have forced the cancellation of planned facilities, dramatic reductions in facility operating times, and reductions in external research support, the 2007 increase and the even larger 2008 requested increase would allow the Office to open new facilities and begin planning for newer ones, expand user times at existing facilities, and boost support of external research.

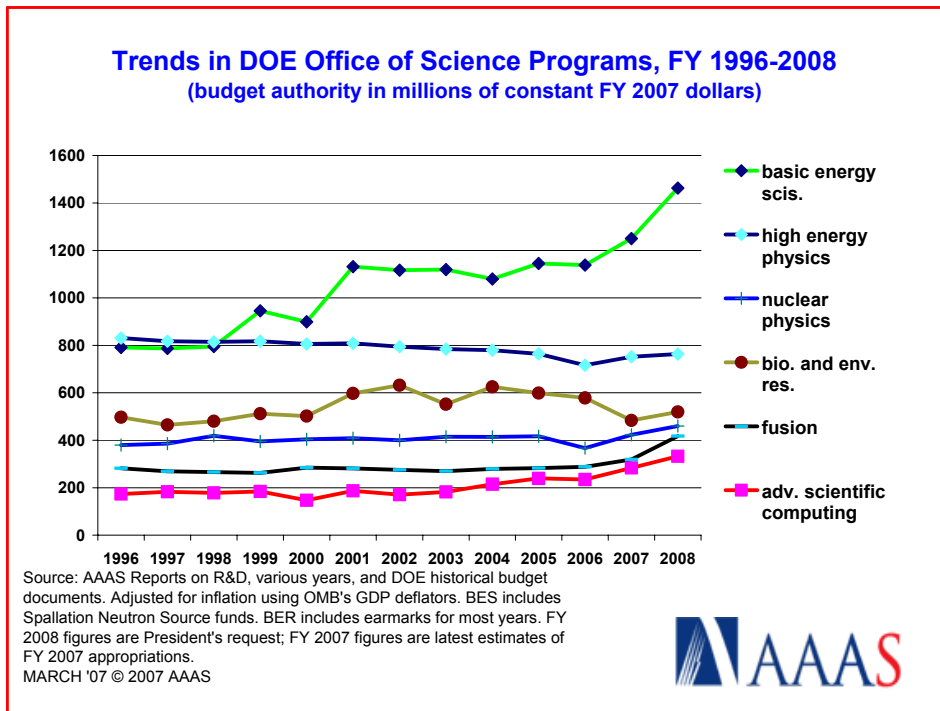


Figure 2. (click on the image for PDF)

Basic Energy Sciences (BES) has fared the best among Science program areas in recent years, and would continue to do well with a 19.9 percent increase to \$1.5 billion in 2008 (see Figure 2). Construction funding for the Linac Coherent Light Source, the Advanced Light Source, and planning for the National Synchrotron Light Source II would keep the program busy with a full plate of future facilities, even as the Spallation Neutron Source (SNS; due to open this year), four light sources, five nanoscale research centers would keep current operations at a high level. BES would also fund more basic research on hydrogen, solar, and biomass topics as a complement to the more applied energy research programs elsewhere in DOE.

High-performance computing research in the Advanced Scientific Computing Research (ASCR) program would be in for a 20 percent boost to \$340 million to expand the availability of high-performance computing capacity that researchers can use for their experiments, primarily at Oak Ridge and Argonne laboratories. By 2008, ASCR could be operating two centers with greater than 250 teraflop computing capability, working toward petaflop capability. Biological and Environmental Research (BER) could climb 10 percent to \$532 million to lead DOE's charge into bioenergy, genomics, and climate change modeling.

The multinational International Thermonuclear Experimental Reactor (ITER) would continue to expand with full U.S. participation through the Fusion Energy Sciences program, up 34 percent or \$109 million to \$428 million in 2008. The enormous increase would go a long way toward alleviating congressional concerns that U.S. participation in ITER, being built in France, could siphon off resources from domestic fusion research and facilities. ITER funding climbed from \$19 million last year to a possible \$60 million in 2007, and would soar to \$160 million next year. The large Fusion increase would enable ITER funding to climb and still leave enough for a slight increase for domestic fusion activities in New Jersey, California, and Massachusetts.

The High Energy Physics (HEP) program, which funds basic research on the nature of matter and energy, would get a 4.1 percent increase to \$782 million (see Table II-11). The program does most of its work at three facilities located at two DOE labs (Fermilab in Illinois and the Stanford Linear Accelerator Center in California) and also cooperates in the international Large Hadron Collider (LHC) in Switzerland, which transitions from fabrication toward operation later this year. Some funding pressure would be relieved by a planned shift in operating funds for the B-factory in California from HEP to the BES program. The increase along with the money freed up from the transfer should allow the program to sustain facility operating times, to boost research funding, and to sustain a \$60 million research investment in the International Linear Collider, the next big international high-energy physics project after the LHC. The Nuclear Physics (NP) program would get an 11.5 percent increase to \$471 million. NP seeks to understand the structure and interactions of subatomic particles, and supports four user facilities.

After more than a decade of cuts and stagnant budgets, the DOE Office of Science would have a second year of growth if the 2008 budget is enacted (see Figure 1). Although Science funding in real terms would still be below the early 1990s when the now-canceled SSC project consumed resources, the ACI increases would take funding well above the roughly \$3.4 billion in today's dollars that the Office has had for most of this decade. Most Science programs would reach new highs in the 2008 budget (see Figure 2).

DOE Energy R&D Programs

Last year, President Bush proposed dramatic funding boosts for selected alternative energy R&D programs as part of his Advanced Energy Initiative (ACI) as part of a push to reduce U.S. dependence on Middle East oil. A few weeks ago, Congress unexpectedly added even more money to energy R&D to bring DOE energy R&D to \$1.5 billion in 2007, a surprising 32 percent boost over the year before. The 2008 request retreats from the 2007 highs in most areas, and would decline overall by 8.9 percent from this year, but the \$1.4 billion total would still be a significant boost compared to 2006 or previous years.

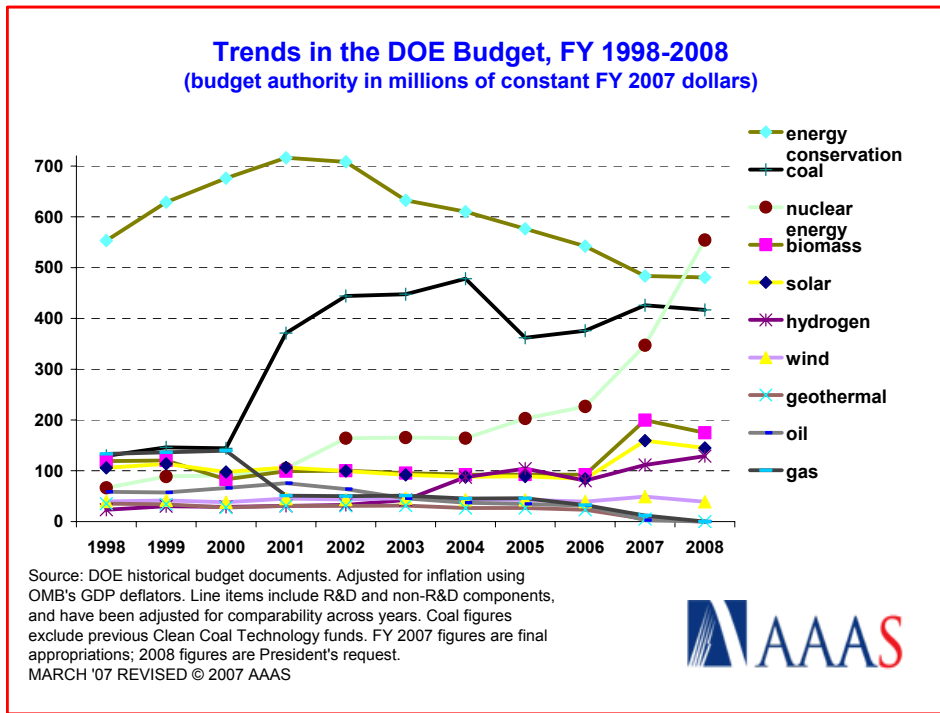


Figure 3. (click on the image for PDF)

But the Administration's energy R&D increases in some areas would be offset by steep cuts in other energy areas, and would follow the clear priorities outlined in last year's budget favoring hydrogen,

biomass, and solar R&D while downgrading geothermal, hydropower, and energy conservation R&D. Within the fossil fuels portfolio, coal would be a clear priority, while R&D on oil and gas technologies would be eliminated. Hydrogen technology R&D would total \$213 million in 2008, up 10 percent and up dramatically from \$153 million last year (see Figure 3). Biomass R&D would edge down to \$179 million, down \$20 million from 2007 but nearly double last year's funding, while solar energy R&D spending would be \$148 million, nearly double the \$82 million in 2006 (see Figure 3). These increases over 2006 would be magnified because the 2006 totals include numerous congressionally earmarked projects; the lack of earmarks in 2007 and the 2008 request mean that non-earmarked R&D programs in these areas could see their funding more than double, even quadruple in the case of biomass, between 2006 and 2008. DOE has been busy in recent weeks announcing several multimillion dollar awards in solar and biomass R&D; the 2008 request would allow these multi-year projects to continue and be joined by many other projects.

Also proposed for a big increase is nuclear energy R&D, a renewable energy technology funded in a separate account, up 13.6 percent to \$125 million in 2008. The nuclear energy R&D is part of large increases for the broader nuclear energy portfolio combining R&D, facilities, demonstration projects, and the Global Nuclear Energy Partnership (GNEP) to promote spent nuclear fuel recycling. The total nuclear energy effort (R&D and non-R&D) has increased dramatically this decade (see Figure 3).

But there would be steep cuts to other renewable energy R&D programs. As with last year's request, DOE would eliminate the \$23 million geothermal program and the dwindling \$1 million hydropower R&D program; Congress saved these two programs from elimination in the final 2007 appropriation. Wind energy R&D, after climbing \$10 million to \$49 million in 2007, would fall back to nearly the 2006 level with a 2008 request of \$40 million.

There would also be cuts in energy conservation and fossil energy R&D programs, in a repeat of the 2007 request. Congress fought off many of the proposed cuts in 2007. Fossil energy R&D would fall 27 percent down to \$359 million, the net of increases in the Administration's longstanding priority area of coal R&D and steep cuts or proposed eliminations in other fossil fuel programs. Coal R&D would stay at \$427 million after a big increase in 2007, driven in large part by a doubling of funding for the FutureGen program (\$108 million) to develop a near-emission-free, coal-fired electricity and hydrogen production plant. Funding for the Clean Coal Power Initiative program to develop cleaner coal-based power plants would also increase from \$60 million to \$73 million. But as DOE requested and Congress rejected for the past two years, the budget would eliminate the oil R&D and gas R&D programs, and in 2007 DOE has already ended the cooperative fossil energy R&D program. The request would try again to block \$50 million in mandatory funding for an ultra-deepwater and unconventional natural gas and other petroleum research fund that was created in the Energy Policy Act of 2005 for a 2007 start. Congress declined to block 2007 funding, so DOE and the consortium selected to manage the effort recently finalized a 10-year contract for this research effort, paid for out of oil and gas royalty fees. DOE would block 2008 funding in order to shift money to other programs.

Although the Energy Conservation portfolio is now part of the Energy Supply and Conservation program, funding for its component Vehicle Technologies, Building Technologies and Industrial Technologies would all fall. As shown in Figure 3, energy conservation has declined every year since 2001 in real terms.

DOE Defense R&D

DOE and its predecessors have long had responsibility for managing the nation's nuclear weapons stockpile, supplying nuclear reactors to the Navy, and dealing with the environmental consequences of nuclear weapons work. DOE's defense R&D to address these responsibilities would gain 2.6 percent or \$96 million to \$3.8 billion in 2008 after a cut in 2007 (see Table II-11). The core Weapons Activities program, which funds science-based alternatives to nuclear testing in order to maintain the U.S. nuclear weapons stockpile, would receive \$6.5 billion in 2008. A little less than half of this spending goes to R&D activities, for a total of \$2.7 billion (up 2.8 percent). To keep pace with an increasing reliance on complex high-end computing simulations of nuclear explosions, the Advanced Simulation and Computing program

would receive \$586 million (down 5.2 percent). The program, the defense counterpart to the nondefense ASCR program, mostly takes place in DOE's three weapons laboratories (Los Alamos and Sandia in New Mexico, Lawrence Livermore in California). The Inertial Confinement Fusion program, aimed at simulating nuclear weapons fusion under controlled laboratory conditions, would receive \$412 million.

The DOE proposal to initiate research on a new generation of nuclear weapons has been opposed by Congress so far, but DOE would move forward on the Reliable Replacement Warhead (RRW) project to explore new warhead designs for use with existing nuclear weapons. DOE recently selected Lawrence Livermore to design the RRW, but the project still faces continuing skepticism in Congress over whether the U.S. needs new warheads, even for existing weapons. Development of the RRW would receive \$89 million in Weapons Activities in 2008, up from just \$28 million this year.

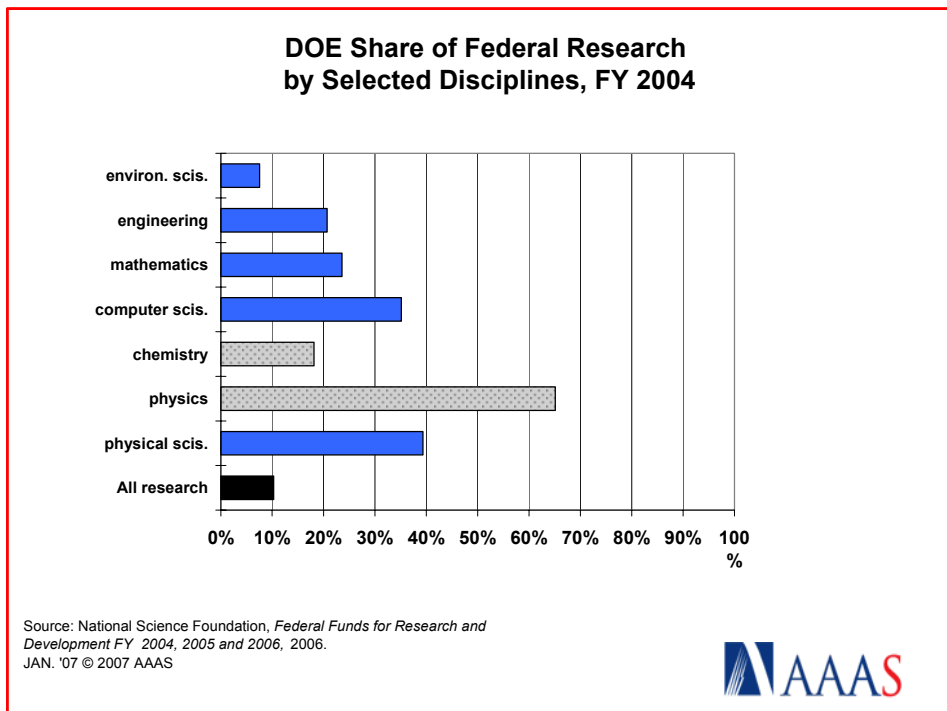


Figure 4. (click on the image for PDF)

Impacts of DOE R&D

DOE is the dominant sponsor of the physical sciences, funding more than a third of all federal support (see Figure 4). DOE is by far the largest federal sponsor of physics research, responsible for nearly two-thirds of all federal physics research. DOE's impact on the physical sciences is magnified if one also considers facilities; DOE scientific user facilities are heavily used by the physical sciences and other research communities for experiments, even for research funded by other agencies. DOE is also a leading sponsor of computer sciences, mathematics, and engineering research, computer sciences in particular.

But DOE support for most disciplines has stagnated in recent years because of flat or declining Office of Science budgets and the lingering impact of post-Cold War cutbacks both on the defense and nondefense sides of DOE. Physical sciences support peaked at the end of the Cold War in the early 1990s but has mostly declined since then (see Figure 5); this decline along with similar trends in other physical sciences funding agencies is an important backdrop to the ACI and other initiatives to boost future federal support of the physical sciences. DOE support of other key disciplines has stagnated in recent years as well: after a long climb in the 1990s as DOE transitioned to computer simulations as an alternative to nuclear testing, DOE computer sciences support has stagnated this decade; DOE's key role in the Human Genome Project led to a sustained boost in life sciences funding for most of the 1990s but has been declining in recent

years; and waning environmental cleanup needs as well as flat Science budgets have led to a steady decline in environmental sciences support. Only engineering research has done well over the past decade, both from reclassifications of development to research but also increasing engineering work done as part of the energy and defense portfolios. The ACI's broad-based increases for Science research should benefit all of these disciplines, and promise a turnaround in their fortunes when the 2007 and 2008 are spent.

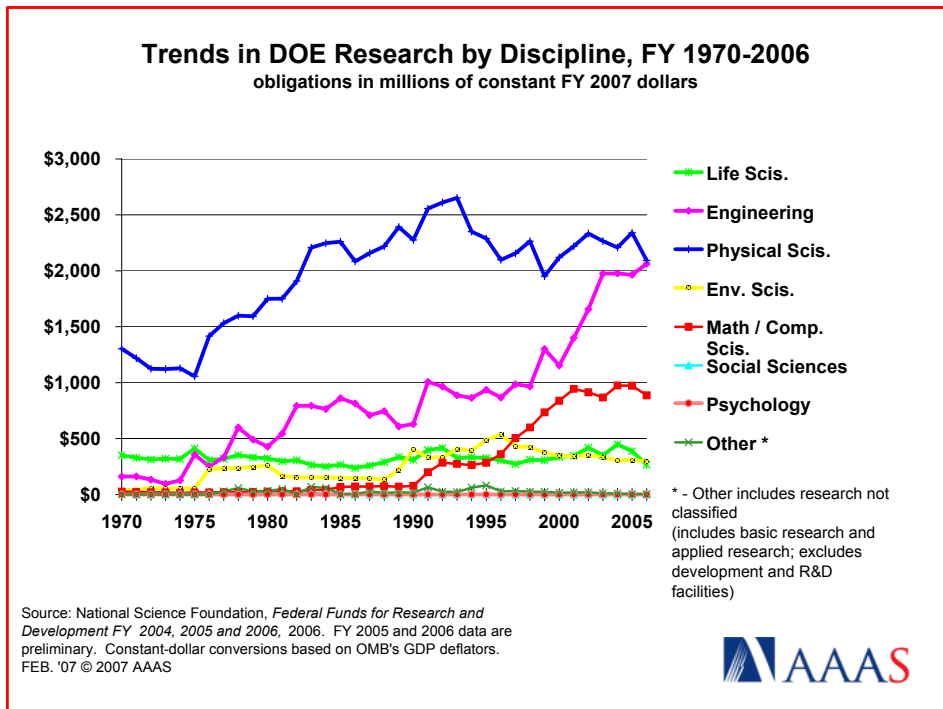


Figure 5. (click on the image for PDF)

Outlook for the DOE Budget

Because the ACI and energy R&D are high priorities both for the Bush Administration and the new Democratic majority in Congress, DOE R&D programs are well placed to receive large increases in the 2008 appropriations process, just as they did in the just-completed 2007 process. As always, even in previous Congresses, congressional appropriators will tinker with the DOE request and will rearrange the mix of priorities, especially in the energy area where DOE proposals to eliminate several programs are likely to run into resistance. But a large increase for DOE Science, if not 15 percent then a smaller but still substantial one, and more money for DOE Energy than requested are highly likely to emerge in the final 2008 DOE appropriation.

(More materials on R&D in the FY 2008 budget, historical data and charts, and more information on AAAS Report XXXII: *Research and Development FY 2008*, can be found on the AAAS R&D Web site at <http://www.aaas.org/spp/rd>.)

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Table II-11. Department of Energy R&D

Table II-11. R&D in the Department of Energy
(budget authority in millions of dollars)

	FY 2006	FY 2007	FY 2008	Change FY 07-08	
	Actual	Estimate *	Budget	Amount	Percent
Summary of DOE R&D (see notes at end of table):					
1. Energy Supply&Conservation 1.	682	969	974	5	0.5%
2. Science	3,356	3,511	4,052	541	15.4%
3. Fossil Energy 2/	433	493	359	-134	-27.2%
4. Atomic Energy Defense	4,072	3,699	3,796	97	2.6%
5. Radioactive Waste Mngmt.	41	60	53	-7	-11.7%
Total DOE R&D	8,584	8,732	9,234	502	5.7%
Detail of DOE R&D:					
1. Energy Supply and Conservation 1/ (does not include non-R&D components)					
Efficiency and Renewables 1/	459	760	761	1	0.1%
- Hydrogen Technology	153	194	213	19	10.0%
- Biomass and Biorefinery Sys.	90	200	179	-20	-10.2%
- Solar Energy	82	159	148	-11	-6.9%
- Wind Energy	38	49	40	-9	-18.8%
- Geothermal Tech.	23	5	0	-5	-100.0%
- Hydropower	0	0	0	0	--
- Vehicle Tech.	178	188	176	-12	-6.3%
- Building Tech.	68	104	86	-18	-17.1%
- Industrial Tech.	56	57	46	-11	-18.7%
- minus demos & other non-R&D	-230	-196	-128	68	-34.5%
Electricity Delivery & Reliability	130	99	88	-11	-11.1%
Nuclear Energy	93	110	125	15	13.6%
Total Supply & Conservation R&C	682	969	974	5	0.5%
2. Science (does not include non-R&D components)					
High-Energy Physics (HEP)					
Proton Accelerator-Based	362	375	390	15	4.0%
Electron Accelerator-Based	112	104	80	-24	-23.4%
Non-Accelerator Physics	54	60	72	13	21.0%
Theoretical Physics	48	56	57	1	0.9%
Advanced Tech. R&D	122	157	183	27	17.1%
Construction	0	0	0	0	--
Total HEP	698	752	782	30	4.1%
Nuclear Physics					
Medium-Energy Nuclear Phys.	103	114	123	10	8.4%
Heavy Ion Nuclear Phys.	157	183	203	21	11.3%
Low Energy Nuclear Phys.	67	81	91	10	12.0%
Nuclear Theory	28	33	36	3	8.8%
Construction	2	12	18	6	46.0%
Total Nuclear Physics	358	423	471	49	11.5%

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	FY 2006 Actual	FY 2007 Estimate *	FY 2008 Budget	Change FY 07-08	
				Amount	Percent
Fusion Energy Sciences					
Science	149	154	160	5	3.4%
Facility Operations	104	122	237	115	95.0%
Enabling R&D	28	43	31	-12	-27.5%
Total Fusion	281	319	428	109	34.1%
Basic Energy Sciences (BES)					
Materials Sciences	727	898	1,093	195	21.7%
Chem. Scis., Geoscis., Energy	207	227	284	57	25.2%
Construction	176	125	121	-4	-3.0%
Total BES	1,110	1,250	1,498	248	19.9%
Advanced Scientific Computing Research (ASCR)					
Math., Info. and Compu. Sci.	228	283	340	57	20.0%
Laboratory Technology Res.	0	0	0	0	--
Total ASCR	228	283	340	57	20.0%
Biological and Environmental Research (BER)					
Life Sciences	198	237	282	45	18.9%
Climate Change Research	137	135	138	3	2.4%
Environmental Remediation	91	97	97	0	0.2%
Medical Apps./ Measure.	139	14	14	0	0.0%
Construction	0	0	0	0	--
Total BER	564	483	532	48	10.0%
Small Bus. Innov. Research	117	0	0	0	--
Total Science R&D	3,356	3,511	4,052	541	15.4%
<i>Science Non-R&D Items</i>	276	287	346	59	20.7%
<i>Total Science Budget (incl nonR&D)</i>	3,632	3,797	4,398	601	15.8%
3. Fossil Energy R&D 2/ (does not include non-R&D components)					
Coal Research	367	426	427	1	0.2%
- <i>Clean Coal Power Init.</i>	48	60	73	13	20.8%
- <i>FutureGen</i>	17	54	108	54	100.0%
- <i>Fuels and Power Sys.</i>	301	311	246	-66	-21.1%
Oil Technology	31	3	0	-3	-100.0%
Natural Gas Technology	32	12	0	-12	-100.0%
Cooperative R&D	6	0	0	0	--

(continued)

Table II-11. Department of Energy R&D

Table II-11. R&D in the Department of Energy
(budget authority in millions of dollars)

	FY 2006 Actual	FY 2007 Estimate *	FY 2008 Budget	Change FY 07-08 Amount Percent	
Clean Coal Tech 3/	-20	0	-58	-58	--
Ultra Deepwater R&D 2/	0	50	0	-50	-100.0%
Plant & Cap. Equip. and adjs.	18	3	-10	-12	-476.1%
Total Fossil Energy R&D 2/	433	493	359	-134	-27.2%
4. Atomic Energy Defense Activities (does not include non-R&D components)					
National Nuclear Security Administration (NNSA)					
Weapons Activities					
Science Campaigns	277	270	273	3	1.0%
Adv. Simulation & Computing	600	612	586	-26	-4.3%
Inertial Confinement Fusion	544	490	412	-77	-15.8%
All Other Weapons R&D	1,548	1,283	1,459	176	13.7%
Total Weapons Acts. R&D	2,968	2,655	2,730	75	2.8%
Nonproliferation & Verification	314	270	266	-4	-1.6%
Naval Reactors	752	750	776	26	3.5%
Total NNSA R&D	4,034	3,675	3,772	97	2.6%
Environmental Management	34	21	21	0	0.0%
Other AEDA R&D	4	3	3	0	0.0%
Total Atomic Defense R&D	4,072	3,699	3,796	97	2.6%
5. Radioactive Waste Mngmt.	41	60	53	-7	-11.7%
Total DOE R&D	8,584	8,732	9,234	502	5.7%
DOE R&D by Function:					
Defense	4,072	3,699	3,796	97	2.6%
General Science	3,356	3,511	4,052	541	15.4%
Energy	1,156	1,522	1,386	-136	-8.9%

Source: DOE budget justification, OMB data for R&D, and agency supporting documents.

Some data adjusted by AAAS based on DOE agency budget documents.

1/ Combined from the former Energy Supply and Energy Conservation accounts.

2/ There is \$50 million in mandatory funding for ultra-deepwater and unconventional natural gas R&D in FY 2007 and 2008, but the FY 2008 request proposes to cancel FY 2008 funds.

3/ Rescissions and deferrals of previously appropriated funds.

* - FY 2007 figures are estimates of final 2007 appropriations (P.L. 110-5) based on DOE's 2007 operating plan.

Please see Chapter 9 for a discussion of DOE R&D.

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Table II-11. Department of Energy R&D

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	FY 2006 Actual	FY 2007 Estimate *	FY 2008 Budget	Change FY 07-08	
				Amount	Percent
Department of Energy Budget (discretionary budget authority in millions of dollars)					
DOE Defense Programs:					
National Nuclear Security Administration (NNSA):					
Weapons Activities	6,355	6,276	6,511	236	3.8%
Defense Nuclear Nonprolif.	1,619	1,683	1,673	-11	-0.6%
Naval Reactors	782	782	808	26	3.4%
Other NNSA	354	340	395	54	16.0%
Total NNSA	9,110	9,081	9,387	306	3.4%
Defense Env. Cleanup	6,130	5,732	5,364	-368	-6.4%
Other Def. Environ. Activities	983	983	1,056	73	7.5%
Total DOE Defense	16,223	15,796	15,807	11	0.1%
Science	3,632	3,797	4,398	601	15.8%
Energy Supply and Conservation	1,812	2,155	2,188	33	1.6%
Fossil Energy	830	783	863	80	10.2%
Nondef. Environ. Cleanup	350	350	181	-169	-48.3%
Nuclear Waste Disposal	149	99	202	103	104.1%
Power Marketing Administrations	270	248	217	-30	-12.2%
Departmental Administration & IG	162	196	196	1	0.3%
All Other	145	176	207	31	17.4%
Total DOE Budget	23,573	23,599	24,259	660	2.8%

Source: Department of Energy budget justification.

DOE appropriations only (discretionary), excluding offsets.

Includes R&D and non-R&D components.

All figures are rounded to the nearest million. Changes calculated from unrounded figures.

* - FY 2007 figures are estimates of final 2007 appropriations (P.L. 110-5) based on DOE's 2007 operating plan.

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