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Big Increase for DOE Office of Science Proposed

AAAS R&D Funding Update on R&D in the FY 2009 DOE Budget

(This analysis is a preview of the DOE chapter in the forthcoming *AAAS Report XXXIII: Research and Development FY 2009*, a comprehensive look at the President's budget for R&D in FY 2009. 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 2009 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 a clear winner in the 2009 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 21 percent from the final 2008 appropriation to $4.3 billion, the largest percentage increase among the R&D funding agencies, in an effort to keep the office on track to double its budget between 2006 and 2016 after appropriations setbacks the last two years (see Table II-11). Most Science programs would receive substantial increases to hit historic highs, but these gains depend crucially on the outcomes of 2009 appropriations.

- The total DOE R&D portfolio would soar 8.9 percent or $858 million to $10.5 billion because of the large Science increase, and smaller increases for DOE's energy and defense R&D portfolios.

- DOE's energy-related R&D would total $2.4 billion, a slight increase after enormous increases in 2007 and 2008. Investments in renewables such as biomass and nuclear energy would show strong gains. In fossil fuels, coal R&D would soar 26 percent to $624 million, including a 25 percent boost to $149 million for carbon sequestration research and a doubling of funding for the recently restructured FutureGen project to $156 million. But DOE once again proposes to eliminate funding for gas and oil technology R&D, and to cancel $50 million in mandatory funding for a deepwater oil and gas exploration R&D program.

DOE R&D in the FY 2009 Budget

President Bush's American Competitiveness Initiative (ACI) and Advanced Energy Initiative (AEI), both set for their third years in 2009, have made the Department of Energy's (DOE) R&D programs a high priority within an increasingly tight domestic budget. 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 is a key Administration and congressional priority that received enormous increases in 2007 and 2008.

The total DOE budget would increase by $1.1 billion or 4.7 percent to $25.5 billion (see Table II-11). The DOE R&D portfolio would climb $858 million or 8.9 percent to $10.5 billion in the 2009 budget (see Table II-11), because of a 21 percent increase for R&D in the Science portfolio. The energy R&D portfolio would gain slightly by 0.5 percent to $2.4 billion after enormous increases in 2007 and 2008, while DOE's defense R&D portfolio would gain 2.9 percent to $3.8 billion.

R&D in the DOE Office of Science

DOE's Office of Science 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. The ACI envisions the Science budget doubling between 2006 and 2016, but so far Science appropriations have fallen short of that trajectory. In 2007, DOE requested a 14 percent increase for Science funding, and ended up with 5 percent; in 2008, the request was for a 16 percent increase, but again the final increase was 5 percent. To catch up with the ACI's ten-year funding trajectory, the 2009 increase for the total Office of Science budget would be 19 percent to $4.7 billion, a $749 million boost. More than 90 percent of the Science budget goes to R&D activities; Science R&D would gain 21 percent in the FY 2009 budget to $4.3 billion, making DOE Science once again the big winner among the major R&D funding agencies (see Table II-11). The large proposed increase would mark a departure from the flat or declining funding trends of recent years (see Figure 1), and in real terms would bring Science funding to its highest level ever, surpassing the peak budgets of the early 1990s before the Superconducting Super Collider was canceled.

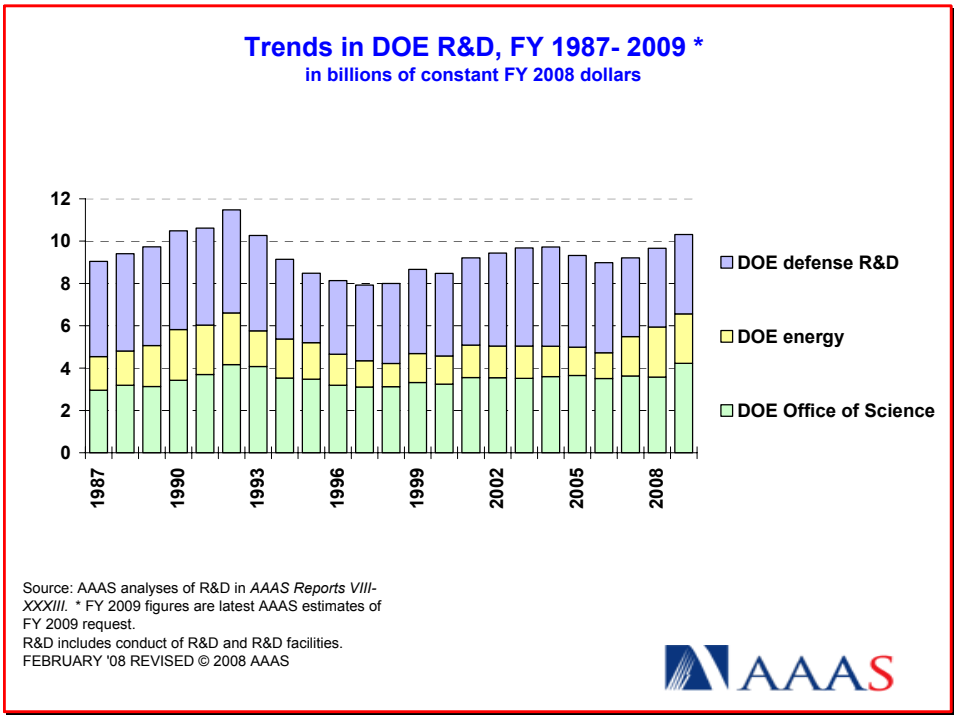

Figure 1. (click on the image for PDF)

Funding for every Science program would increase substantially, with the largest boosts for programs that faced the most disappointing outcomes in 2008 appropriations, including a 72 percent increase for fusion research, a 24 percent boost for basic energy sciences, and a 17 percent increase for high-energy physics (see Figure 2).

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.

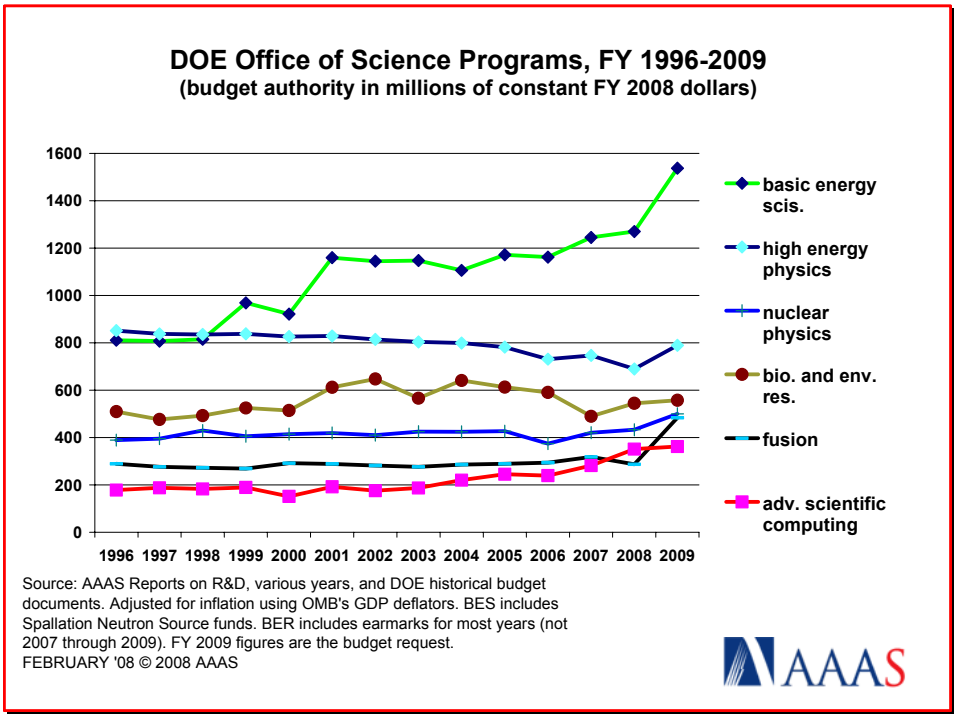

Figure 2. (click on the image for PDF)

After a significant hit in 2008 that deleted the U.S. contribution to the International Thermonuclear Experimental Reactor (ITER) project, fusion research would total $493 million, up $207 million or 72 percent. The entire increase would go to a $215 million ITER contribution in 2009 on the project now underway in France, after appropriators zeroed out U.S. participation in ITER in 2008 to preserve funding for domestic fusion programs. The 2008 request would have provided $160 million, and DOE ended up scrounging for $11 million to keep U.S. participation alive. Domestic fusion projects in New Jersey, California, and Massachusetts would mostly stay even in 2009 after an increase in 2008.

The High-Energy Physics (HEP) program also took a significant hit in 2008 appropriations, but would rebound in the 2009 budget with a $805 million request, up $116 million or 16.8 percent. The program does most of its work at three facilities located at two DOE labs (Fermilab in Illionois and the Stanford Linear Accelerator Center (SLAC) in California) and also cooperates in the international Large Hadron Collider (LHC) in Switzerland, which transitions from fabrication toward operation this year. In wrapping up 2008 appropriations, Congress slashed funding for early work on the International Linear Collider (ILC), the next big international high-energy physics project after the LHC, which resulted in layoffs and furloughs at the Fermilab in Illinois. From a $60 million request, ILC work was slashed to $15 million; the 2009 request proposes $67 million. The 2009 request would get these and other HEP efforts back on track, though the lost jobs may never be recovered. The Nuclear Physics program would also receive a strong 18 percent boost to $510 million in the 2009 request, allowing for a full schedule of operations at the Relativistic Heavy Ion Collider (RHIC) in New York.

Basic Energy Sciences (BES) has fared the best among Science program areas in recent years, although the 2008 appropriation resulted in the cancellation of several grants competitions. The program would continue to do well in 2009 with a 23.5 percent increase to $1.6 billion in 2009 (see Figure 2). BES would initiate new Energy Frontier Research Centers, a $100 million competitively awarded research program on basic research for energy technologies. Construction funding for the National Synchrotron Light Source II, follow-on construction for the Advanced Light Source, and the final phases of the Linac Coherent Light

Source would keep the program busy with a full plate of future facilities, even as the Spallation Neutron Source (SNS) and two other neutron sources, four light sources and five nanoscale research centers would keep current operations at a high level.

High-performance computing research in the Advanced Scientific Computing Research (ASCR) program would be in for a 5 percent boost to $369 million to expand the availability of high-performance computing capacity that researchers can use for their experiments, primarily at Oak Ridge and Argonne laboratories. Biological and Environmental Research (BER) could increase 4 percent in 2009 to $569 million after a large increase in 2008 to lead DOE's charge into bioenergy, genomics, and climate change modeling, including funding for three bioenergy research centers in Tennessee, Wisconsin, and California to work on cellulosic ethanol and other biofuels.

After more than a decade of cuts and stagnant budgets, the DOE Office of Science would climb above Cold War-era funding levels to an all-time high if the 2009 budget is enacted (see Figure 1). Most Science programs would reach new highs in the 2009 budget (see Figure 2), but similar increases proposed in 2007 and 2008 did not make it through the congressional appropriations process and some program areas suffered steep cuts.

DOE Energy R&D Programs

In the last few years, DOE's applied investments in energy R&D have expanded dramatically from roughly $1.5 billion a year to well over $2 billion (see Figure 1). In 2009, DOE would sustain enormous 2007 and 2008 increases in energy R&D with a $2.4 billion request, up $11 million or 0.5 percent.

There would be some reshuffling of renewable energy R&D priorities, but funding for most areas would remain high compared to earlier years. Hydrogen technology R&D would total $146 million in 2009, down sharply from $211 million in 2008. Biomass R&D would continue its spectacular recent growth with a 14 percent boost to $225 million, up from $90 million as recently as 2006, while solar energy R&D spending would be $156 million, down from 2008 but almost double the $82 million as recently as 2006. In a change of priorities, the geothermal R&D program DOE had proposed for elimination in past years would instead get a boost in 2009 to $30 million, up 51 percent. But hydropower funding would fall from $10 million to $3 million, another installment in the annual tug-of-war between DOE and Congress over its relative importance with Congress reversing previous attempts to eliminate the program.

Also proposed for a big increase is nuclear energy R&D, a renewable energy technology funded in a separate account, up a stunning 43 percent to $630 million in 2009, partially from the transfer in of programs from other DOE accounts and partially from a dramatic proposed increase in advanced fuel cycle R&D because of its key role in the Administration's signature Global Nuclear Energy Partnership (GNEP) to promote spent nuclear fuel recycling. Much of the additional funding for nuclear R&D would focus on technology development for advanced, proliferation-resistant nuclear fuel, in addition to the longstanding portfolio of new nuclear reactor designs, fuel fabrication technologies, and general nuclear energy R&D support.

Funding for other energy programs would increase more moderately, though at funding levels boosted over the past two years. Wind energy R&D would receive $53 million, up $3 million, while the former energy conservation accounts, now split into three, would gain $16 million to $348 million.

Fossil energy R&D would climb in 2009 to $625 million, up 8.5 percent, but DOE would put all its fossil energy eggs into the coal basket. Congress fought off similar proposed consolidations in 2007 and 2008. Coal R&D would gain a whopping 26 percent to $624 million. The FutureGen program would see its budget more than double to $156 million, but this project to develop a near-emission-free, coal-fired electricity and hydrogen production plant was recently restructured by DOE from a single R&D facility to multiple commercial-scale demonstrations, a move that was poorly received in Illinois which had already been selected as the single site. Funding for the Clean Coal Power Initiative program to develop cleaner

coal-based power plants would also increase from $69 million to $85 million. And carbon sequestration research, funded in the coal program because the primary goal is to sequester carbon from coal-fired power plants in geologic formations, would climb 25 percent to $149 million after similar increases the past two years. But as DOE requested and Congress rejected for the past three years, the budget would eliminate the oil R&D and gas R&D programs. 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. DOE would block 2009 funding in order to shift money to other programs.

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 2.9 percent or $107 million to $3.8 billion in 2009 (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 $6.6 billion in 2009. A little less than half of this spending goes to R&D activities, for a total of $2.8 billion (up 1.6 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 $562 million (down 2.2 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 $421 million, down 10 percent primarily because construction costs would wind down on the National Ignition Facility in California, the program's new flagship science facility.

The DOE proposal to initiate research on a new generation of nuclear weapons has been opposed by Congress so far, but DOE would still press on with 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. Congress zeroed out RRW development funding in 2008, but DOE would request $10 million in 2009, and would spread out funding in other programs as well.

Impacts of DOE R&D

DOE is the dominant sponsor of the physical sciences, funding nearly half of all federal support (see Figure 3). DOE is by far the largest federal sponsor of physics research, responsible for 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; 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. 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 but only if the 2009 increases make it through the appropriations process.

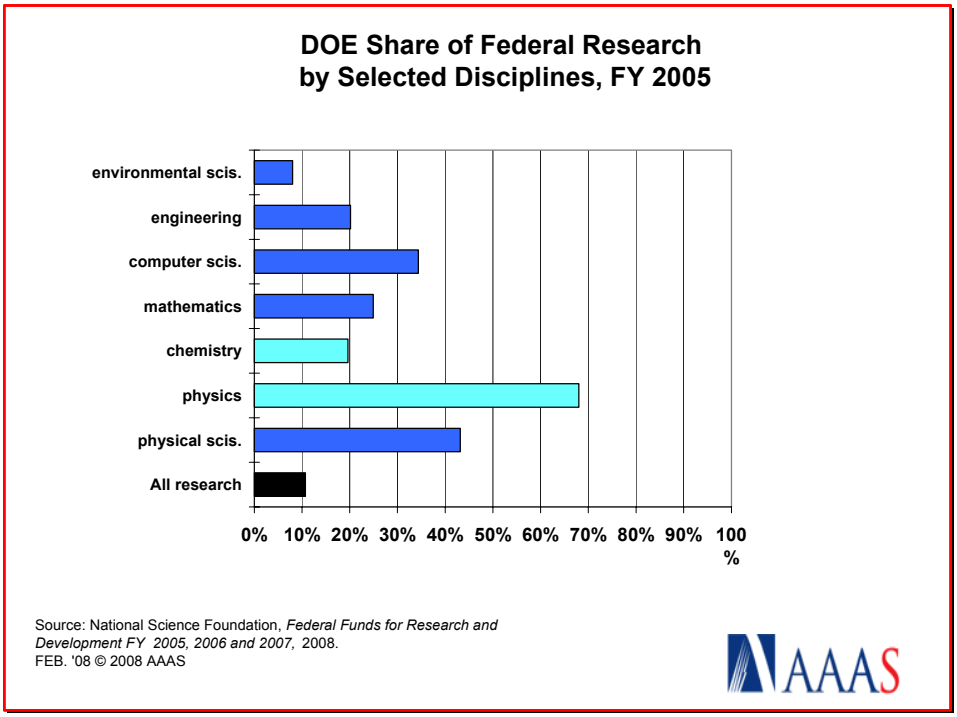

Figure 3. (click on the image for PDF)

Outlook for the DOE Budget

Because the ACI and energy R&D are high priorities both for the Bush Administration and the Democratic Congress, DOE R&D programs are well placed to receive large increases in the 2009 appropriations process, but the ACI increases could be vulnerable because they represent a large potential source of funds if Congress goes looking for dollars to shift to other domestic programs. As always, 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 the overall outcome will hinge on whether Congress will be any more successful than in the past two years in securing more money overall for domestic appropriations. If not, then as in past years, Congress will most likely raid the large Science increase to shore up funding for domestic programs proposed for steep cuts or elimination.

(More materials on R&D in the FY 2009 budget, historical data and charts, and more information on *AAAS Report XXXIII: Research and Development FY 2009*, can be found on the AAAS R&D Web site at http://www.aaas.org/spp/rd.)

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

	FY 2007 Actual	FY 2008 Estimate	**FY 2009 Budget**	Change FY 08-09 Amount	Change FY 08-09 Percent
Summary of DOE R&D (see notes at end of table):					
1. Energy Efficiency & Renewables	938	1,238	**1,025**	-213	-17.2%
2. Electricity Delivery & Reliability	97	111	**100**	-11	-9.9%
3. Nuclear Energy	300	441	**630**	189	42.9%
4. Fossil Energy	481	576	**625**	49	8.5%
5. Science	3,560	3,574	**4,314**	740	20.7%
6. Atomic Energy Defense	3,649	3,718	**3,825**	107	2.9%
7. Nuclear Waste Disposal	10	3	**0**	-3	-100.0%
Total DOE R&D	9,035	9,661	**10,519**	858	8.9%
Detail of DOE R&D:					
1. Energy Efficiency & Renewable Energy 1/ (does not include non-R&D components)					
Hydrogen Technology	190	211	**146**	-65	-30.7%
Biomass and Biorefinery Sys.	196	198	**225**	27	13.5%
Solar Energy	157	168	**156**	-12	-7.3%
Wind Energy	49	50	**53**	3	6.0%
Geothermal Tech.	5	20	**30**	10	51.4%
Hydropower	0	10	**3**	-7	-69.7%
Vehicle Tech.	184	213	**221**	8	3.8%
Building Tech.	103	109	**124**	15	13.5%
Industrial Tech.	56	64	**62**	-2	-3.6%
Congressional projects	0	187	**0**	-187	-100.0%
- minus demos & other non-R&D	-1	8	**5**	-3	-34.4%
Total Efficiency & Renewables R&D	938	1,238	**1,025**	-213	-17.2%
2. Electricity Delivery & Reliability	97	111	**100**	-11	-9.9%
3. Nuclear Energy	300	441	**630**	189	42.9%
4. Fossil Energy 2/ (does not include non-R&D components)					
Coal Research	414	493	**624**	130	26.4%
- Clean Coal Power Init.	*59*	*69*	***85***	*16*	*22.5%*
- FutureGen	*53*	*74*	***156***	*82*	*109.9%*
- Carbon sequestration	*97*	*119*	***149***	*30*	*25.4%*
- Other Fuels and Power Sys.	*206*	*231*	***234***	*3*	*1.2%*
Oil Technology	3	5	**0**	-5	-100.0%
Natural Gas Technology	12	20	**0**	-20	-100.0%
Cooperative R&D	0	5	**0**	-5	-100.0%
Clean Coal Tech 2/	0	-58	**0**	58	-100.0%
Ultra Deepwater R&D 3/	50	50	**0**	-50	-100.0%
Congressional Projects	0	48	**0**	-48	-100.0%
Plant & Cap. Equip. and adjs.	2	13	**1**	-12	-90.1%
Total Fossil Energy R&D	481	576	**625**	49	8.5%

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

	FY 2007 Actual	FY 2008 Estimate	**FY 2009 Budget**	Change FY 08-09 Amount	Change FY 08-09 Percent
5. Science (does not include non-R&D components)					
High-Energy Physics (HEP)					
Proton Accelerator-Based	344	369	**420**	51	13.8%
Electron Accelerator-Based	101	66	**49**	-17	-25.6%
Non-Accelerator Physics	61	74	**86**	12	16.6%
Theoretical Physics	60	60	**63**	3	4.7%
Advanced Tech. R&D	167	120	**187**	67	55.3%
Total HEP	732	689	**805**	116	16.8%
Nuclear Physics					
Medium-Energy Nuclear Phys.	109	112	**121**	9	7.7%
Heavy Ion Nuclear Phys.	180	185	**202**	16	8.8%
Low Energy Nuclear Phys.	78	84	**97**	13	15.5%
Nuclear Theory	33	34	**40**	6	17.4%
Isotope Production	0	0	**20**	20	- -
Construction	12	18	**31**	14	77.1%
Total Nuclear Physics	412	433	**510**	77	17.9%
Fusion Energy Sciences					
Science	145	164	**168**	5	2.8%
Facility Operations	146	101	**302**	201	199.3%
Enabling R&D	21	22	**23**	1	4.2%
Total Fusion	312	287	**493**	207	72.1%
Basic Energy Sciences (BES)					
Materials Sciences	879	954	**1,126**	172	18.0%
Chem. Scis., Geoscis., Energy	217	223	**297**	75	33.5%
Construction	125	93	**145**	52	56.0%
Total BES	1,221	1,270	**1,568**	298	23.5%
Advanced Scientific Computing Research (ASCR)					
Math., Computation. & Compu. Sci.	107	134	**151**	18	13.2%
High Perf. Computing Network Facil	169	218	**218**	0	0.0%
Total ASCR	276	351	**369**	18	5.0%
Biological and Environmental Research (BER)					
Biological Research	350	408	**414**	6	1.5%
Climate Change Research	130	137	**155**	18	13.2%
Total BER	480	544	**569**	24	4.4%
Small Bus. Innov. Research	126	0	**0**	0	- -
Total Science R&D	3,560	3,574	**4,314**	740	20.7%

(continued)

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

	FY 2007 Actual	FY 2008 Estimate	**FY 2009 Budget**	Change FY 08-09 Amount	Change FY 08-09 Percent
Science Non-R&D Items 4/	*237*	*399*	***408***	*9*	*2.4%*
Total Science Budget (incl nonR&D)	*3,797*	*3,973*	***4,722***	*749*	*18.9%*
6. Atomic Energy Defense Activities (does not include non-R&D components)					
National Nuclear Security Administration (NNSA)					
Weapons Activities					
Science Campaigns	268	288	**323**	35	12.3%
Adv. Simulation & Computing	611	575	**562**	-13	-2.2%
Inertial Confinement Fusion	490	470	**421**	-49	-10.4%
All Other Weapons R&D	1,295	1,410	**1,481**	71	5.1%
Total Weapons Acts. R&D	2,664	2,742	**2,787**	45	1.6%
Nonproliferation & Verification	209	208	**208**	0	0.0%
Naval Reactors	752	743	**794**	51	6.9%
Total NNSA R&D	3,625	3,693	**3,789**	96	2.6%
Environmental Management	21	22	**33**	11	50.0%
Other AEDA R&D	3	3	**3**	0	0.0%
Total Atomic Defense R&D	3,649	3,718	**3,825**	107	2.9%
7. Nuclear Waste Disposal	10	3	**0**	-3	-100.0%
Total DOE R&D	9,035	9,661	**10,519**	858	8.9%
DOE R&D by Function:					
Defense	3,649	3,718	**3,825**	107	2.9%
General Science	3,560	3,574	**4,314**	740	20.7%
Energy	1,826	2,369	**2,380**	11	0.5%

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/ Rescissions and deferrals of previously appropriated funds.
3/ There is $50 million in mandatory funding for ultra-deepwater and unconventional natural gas R&D for all three years, but the FY 2009 request proposes to cancel FY 2009 funds.
4/ Includes 2008 congressional projects.

Please see Chapter 9 for a discussion of DOE R&D.
February 29, 2008 - revised

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

	FY 2007 Actual	FY 2008 Estimate	**FY 2009 Budget**	Change FY 08-09 Amount	Change FY 08-09 Percent
Department of Energy Budget (discretionary budget authority in millions of dollars)					
DOE Defense Programs:					
National Nuclear Security Administration (NNSA):					
Weapons Activities	6,259	6,297	**6,618**	321	5.1%
Defense Nuclear Nonprolif.	1,824	1,336	**1,247**	-89	-6.7%
Naval Reactors	782	775	**828**	53	6.9%
Other NNSA	358	402	**404**	2	0.5%
Total NNSA	9,223	8,810	**9,097**	287	3.3%
Defense Env. Cleanup	5,731	5,349	**5,297**	-52	-1.0%
Other Def. Environ. Activities	983	954	**1,561**	607	63.7%
Total DOE Defense	15,937	15,113	**15,955**	842	5.6%
Science	3,837	3,973	**4,722**	749	18.8%
Energy Supply and Conservation 1/	2,145	2,857	**2,243**	-613	-21.5%
Fossil Energy Research & Develop.	581	743	**754**	11	1.5%
Other Fossil Energy 2/	194	161	**373**	212	131.1%
Nondef. Environ. Cleanup	350	182	**213**	31	17.1%
Nuclear Waste Disposal	99	187	**247**	60	32.1%
Power Marketing Administrations	271	245	**209**	-36	-14.6%
Departmental Administration & IG	190	194	**207**	12	6.3%
All Other	647	722	**591**	-131	-18.2%
Total DOE Budget	24,250	24,378	**25,515**	1,137	4.7%

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.
1/ Former Energy Supply and Energy Conservation accounts. Includes nuclear energy, and electricity delivery and energy reliability.
2/ Includes clean coal, naval petroleum, and strategic petroleum reserve.

Please see Chapter 8 for a discussion of DOE R&D.
February 29, 2008 - revised