

Obama proposes big increases for energy, climate change, and basic research

The president's first budget, and a supplement from the American Recovery and Reinvestment Act, would put federal support for basic physical sciences research back on schedule for a 10-year doubling by 2016.

With a new administration taking charge at the White House, the increased funding for federal science and technology that began with the economic stimulus bill could be just a down payment on much bigger investments to come. Calling science "more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been," President Obama in April announced his goal of growing US S&T expenditures to a level of 3% of gross domestic product. Saying that his target represented "the largest commitment to scientific research and innovation in American history," Obama noted it would exceed the high watermark set in 1964, at the height of the space race. In 2007 total US R&D expenditures equaled 2.66% of GDP, according to NSF statistics. At its 1964 peak, the ratio was 2.88%.

In the years ahead, Obama's spending goals will collide head-on with his insistence that the massive federal budget deficit be brought under control. But for now, at least, the federal funding spigots have been opened for S&T through the American Recovery and Reinvestment Act, which Obama signed into law in February. The \$787 billion stimulus, meant to revive the flagging US economy, appropriated massive increases for S&T programs at the Department of Energy (DOE), NSF,

the National Institutes of Health (NIH), and other S&T funding agencies. (See PHYSICS TODAY, April 2009, page 22.) Compared with ARRA, the S&T increases in Obama's fiscal year 2010 request are puny. Still, the budget proposal, unveiled three months late on 14 May, presents the first detailed blueprint of the administration's priorities for S&T. The plan places far greater emphasis on developing alternative energy sources and slowing climate change than did the budgets proposed by President George W. Bush.

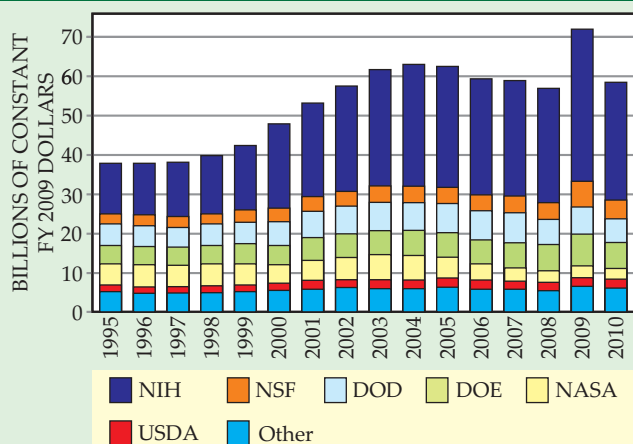
On the other hand, Obama adopts the objectives of Bush's American Competitiveness Initiative, which sought to double over 10 years the basic research budgets of NSF, DOE's Office of Science, and NIST's core laboratory programs—the programs that supply most of the federal investment for basic research in the physical sciences. Congress, which embraced that same goal with passage of the America COMPETES Act in 2007, jeopardized the 10-year timetable by failing to follow through with the required appropriations in both FY 2007 and 2008. This year, the \$5.2 billion supplied by ARRA to the three agencies, combined with increases provided in the FY 2009 omnibus appropriations act, has made up the shortfall and put the doubling back on schedule for now. Obama's 2010 budget seeks \$12.6 billion for the pro-

grams, an increase of \$731 million, or 6.1%, above the 2009 base (not including ARRA funds). In addition, his 2010 proposal spells out projections for completing the doubling effort in 2016; the three agencies would get \$19.5 billion, twice the \$9.7 billion they received in FY 2006.

The new administration says its budget request will place a "special emphasis" on basic and applied research that it believes will fundamentally improve understanding of nature, revolutionize key fields of science, and foster radically new technologies. After a four-year period, ending in 2008, where funding failed to keep pace with inflation, the FY 2009 enacted level and the 2010 request represent a "real-dollar turnaround in federal research investments across the spectrum of the sciences and engineering," according to a budget summary issued by the White House Office of Science and Technology Policy. But the \$59 billion research portfolio it proposes for basic and applied research is up just 0.6%, or \$376 million, compared with the current year level (excluding ARRA funding). And more than half of those funds—\$30.8 billion—will go to one agency, NIH.

The 2010 budget provides \$1.6 billion for the multiagency National Nanotechnology Initiative, a slight cut of \$17 million, or 1%, from the 2009 enacted level. That reduction is due to the

Trends in research by agency, FY 1995–2010



Federal support for basic and applied research will fall from a record high of \$71.9 billion this year to \$59 billion in fiscal 2010, under the budget proposed by President Obama. Excluding the \$13.3 billion that was appropriated earlier this year in the American Recovery and Reinvestment Act, some of which will be spent in FY 2010, year-to-year spending would rise 0.4%. The Obama request would add considerably to R&D programs that promote clean forms of energy and mitigate climate change. Department of Defense R&D would be pared nearly \$2 billion, or 2%, with nonmilitary R&D seeing an increase of \$2.2 billion, or 3.6%. The Obama administration has pledged to continue an effort begun by President George W. Bush in FY 2007 to double the budgets of key basic physical sciences research programs by 2016. Obama has promised further growth for R&D in the years ahead as he aims for the US to achieve a spending level equal to 3% of gross domestic product. The federal government today pays for about one-third of total US R&D.

proposed elimination in FY 2010 of earmarks—congressionally mandated projects—that were included in the FY 2009 Department of Defense budget. Like his predecessor, Obama is counting on the elimination of earmarks to pay for much of the increase he seeks for the R&D programs of the agencies. The 2010 budget proposes \$3.7 billion for the more than 100 federal science, technology, engineering, and mathematics education programs, an increase of \$98 million, or 2.7%, over the current level for those programs. In addition for those programs, ARRA provides \$276 million, which will be spent over 2009 and 2010.

Following are some highlights for the agencies that supply most of the funding for physical sciences research.

Department of Energy. Arguably, no federal scientific agency has seen such a reordering of its priorities with the change of administrations as has DOE. That shift was presaged by Obama's choice of Steven Chu to head the agency; the Nobel laureate physicist refocused his career in 2004 on using clean energy sources more efficiently to combat climate change. DOE's share of ARRA is more than \$38 billion, with energy efficiency and renewable energy programs alone receiving \$16.8 billion next year. Another \$4.5 billion is allocated to the electricity delivery and energy reliability office, primarily to support the development of a "smart grid," which will be needed to accommodate major increases in solar and wind electricity generation. The fossil energy research program is getting \$4.5 billion in ARRA funds.

But only a fraction of the stimulus funding—\$5.5 billion—goes to energy R&D, according to the American Association for the Advancement of Science. The AAAS calculates that \$2.5 billion of the ARRA monies are for R&D to increase energy efficiency and improve the competitiveness of renewable energy sources such as wind, solar, geothermal, and biofuel. Another \$1 billion will support R&D toward reducing or eliminating emissions of carbon dioxide from fossil fuel burning.

Separately, basic physical sciences programs administered by DOE's Office of Science will receive \$1.6 billion from ARRA. Most of that will pay for long-needed upgrades to the infrastructure and equipment at the national laboratories. However, the three largest national labs—Sandia, Lawrence Livermore, and Los Alamos—are not eligible for ARRA funding because they are operated by DOE's National

Department of Energy R&D programs				
	FY 2008 actual	FY 2009 estimate	FY 2010 request	FY 2009–10 percent change
	(millions of dollars)*			
Total DOE	24 032	33 748	26 394	–21.8
DOE R&D	9 807	10 621	10 740	1.1
Office of Science R&D programs	4 083	4 758	4 942	3.9
Total high-energy physics (HEP)	703	796	819	2.9
Proton accelerator-based physics	372	402	443	10.1
Research	123	126	127	1.2
University research	55	57	58	1.2
National laboratory research	66	68	69	1.2
University service accounts	1	1	1	0.0
Facilities	249	277	316	14.1
Tevatron operations and improvements	171	203	239	17.7
Large Hadron Collider project and support	66	74	87	16.2
Alternating Gradient Synchrotron support	1	1	1	0.0
Other facilities	12	11	10	–9.4
Electron accelerator-based physics	57	31	26	–14.7
Research	21	17	14	–13.0
University research	9	7	7	–10.0
National laboratory research	11	9	8	–15.5
Facilities	36	14	12	–7.5
Nonaccelerator physics	76	101	99	–1.5
Theoretical physics	60	65	67	3.7
Advanced tech R&D (accelerators and detectors)	138	197	183	–6.9
Total nuclear physics	424	512	552	7.8
Medium-energy nuclear physics	107	122	131	7.6
Research	33	43	47	10.2
University research	18	19	20	7.5
National laboratory research	15	18	20	10.2
Other research	0.5	6	7	18.7
Operations	74	79	84	6.2
Heavy-ion nuclear physics	182	200	219	9.6
Research	36	47	53	12.6
University research	13	14	15	9.8
National laboratory research	23	27	30	12.2
Other research	—	6	7	21.5
Operations (primarily RHIC)	146	154	167	8.6
Low-energy nuclear physics	83	95	117	23.5
Research	53	53	70	32.9
University research	19	21	26	24.5
National laboratory research	31	29	42	43.4
Other research	4	2	2	–20.9
Operations (primarily ATLAS and HRIBF)	29	42	46	11.5
Nuclear theory	34	40	43	10.3
Isotope research and development†	—	25	19	–6.0
Construction	17	31	22	–29.2
Total fusion energy sciences	295	403	421	4.6
Science	155	172	176	3.4
Facility operations‡	117	207	222	7.0
Enabling R&D	23	23	23	1.2
Total basic energy sciences (BES)§	1 253	1 572	1 685	7.2
Materials sciences	234	342	381	11.5
Chemical sciences, geosciences, and energy biosciences (CGEB)	217	293	338	15.5
Scientific user facilities operations	708	792	812	2.5
Research	11	20	24	21.3
Major items of equipment	30	34	25	–26.4
Advanced Light Source, LBNL	50	52	54	3.6
Advanced Photon Source, ANL	112	118	127	7.7
National Synchrotron Light Source, BNL	38	41	42	3.6
National Synchrotron Light Source-II, BNL	20	10	2	–80.0
Center for Nanophase Materials Sciences, ORNL	19	20	21	5.6
Center for Integrated Nanotechnologies, SNL/LANL	18	20	21	5.6
Molecular Foundry, LBNL	18	20	21	5.5
Center for Nanoscale Materials, ANL	18	21	22	5.5
Center for Functional Nanomaterials, BNL	18	20	21	5.5
Stanford Synchrotron Radiation Laboratory, SLAC	32	34	35	3.4
High Flux Isotope Reactor, ORNL	54	59	61	3.6
Intense Pulsed Neutron Source, ANL	8	4	4	0.0
Manuel Lujan Jr Neutron Scattering Ctr, LANL	11	11	11	3.6
Spallation Neutron Source, ORNL	174	177	184	3.6
Combustion Research Facility, SNL II	7	—	—	—

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Department of Energy R&D programs (continued)

	FY 2008 actual	FY 2009 estimate	FY 2010 request	FY 2009–10 percent change
	(millions of dollars)*			
Linac Coherent Light Source, SLAC	15	20	20	2.5
Linac for LCLS	60	92	95	3.6
SBIR/STTR	—	19	19	3.7
Construction	93	145	154	6.0
Advanced scientific computing research	342	369	409	10.9
Biological and environmental research	531	602	604	0.4
Advanced Research Projects Agency–Energy	—	15	10	—#
Energy efficiency and renewable energy	1 236	1 447	2 018	39.4
Fossil energy R&D**	727	876	618	–29.5
Nuclear energy	714	515	403	–21.7
Total National Nuclear Security Administration R&D	3 017	3 035	3 040	0.2
Total weapons activities R&D	1 863	1 843	1 740	–5.6
Science campaigns	286	317	317	0.0
Engineering campaigns	168	150	150	0.0
Advanced simulation and computing	575	556	556	0.0
Inertial confinement fusion	470	437	437	0.0
All other weapons R&D	363	280	383	–27.0
Nonproliferation and verification R&D	380	364	297	–18.3
Naval reactors	775	828	1 003	21.1
Environmental management R&D	21	32	55	70.2

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

†Transferred from the Office of Nuclear Energy in FY 2009.

‡FY 2010 request includes \$135 million for the US contribution to ITER. The FY 2009 appropriation was \$124 million.

§Starting in FY 2010, BES adopted a new budget structure, including the creation of a new line item for scientific user facilities, to better reflect its subprogram activities. Budgets for those facilities were formerly included in the materials sciences and CGBB budgets. The table shows FY 2008 and FY 2009 funding adjusted to the new budget structure to facilitate year-to-year comparisons.

|| Starting in FY 2009, the Combustion Research Facility funding is included in the request for the chemical physics research program.

#New office established in FY 2009 with \$15 million appropriation and \$400 million in funding from the American Recovery and Reinvestment Act.

**Does not include \$3.4 billion in ARRA funding for clean coal and carbon sequestration demonstrations.

ANL, Argonne National Laboratory. ATLAS, a Toroidal LHC Apparatus. BNL, Brookhaven National Laboratory. HIRIBF, Hollifield Radioactive Ion Beam Facility. LANL, Los Alamos National Laboratory. LBNL, Lawrence Berkeley National Laboratory. ORNL, Oak Ridge National Laboratory. RHIC, Relativistic Heavy Ion Collider. SBIR, Small Business Innovative Research program. SNL, Sandia National Laboratories. STTR, Small Business Technology Transfer program.

Nuclear Security Administration.

For FY 2010, the budget for the Office of Science comes back to Earth, with a request of \$4.9 billion, a 3.9% increase from the current year's base budget. The basic energy sciences pro-

gram, which administers the numerous scientific user facilities at the national labs, would get a 7% increase from the current year's base—not counting its \$555 million share of ARRA funding—to \$1.7 billion next year. Advanced sci-

entific computing research would jump almost 11% next year, to \$409 million.

The request includes a new budget line of \$10 million for the Advanced Research Projects Agency–Energy, a DOE entity that Congress first authorized in 2007 to stimulate research on radically new ways to produce energy. Although Bush ignored the congressional authorization, Obama has embraced ARPA-E and has already provided \$400 million for it through ARRA. According to the DOE request, ARPA-E will identify and promote “radical or breakthrough advances that can potentially produce transformative results and complement other ongoing research focusing on driving known technological solutions toward their fundamental limits.” Patterned after the successful Defense Advanced Research Projects Agency (DARPA), ARPA-E is expected to hasten advances in energy technologies to the proof-of-concept and prototyping phases and, for smaller-scale projects, into the demonstration phase. The search for an ARPA-E director, who will be a presidential appointee requiring Senate confirmation, was under way at press time. Eschewing peer review, the new office will empower carefully chosen program managers to pick and choose research proposals.

The FY 2010 budget proposal includes \$70 million for two of the eight proposed “energy innovation hubs” that will be administered by the Office of Science. Those centers, which will employ multidisciplinary teams of experts, will focus on two grand energy challenges: the creation of fuels directly from sunlight without the use of plants or microbes, and advanced methods of electrical energy storage. Chu told a Senate committee in May that he strongly hopes the researchers who will staff the hubs will be housed in a single location.

The budget request proposes \$115 million for a new DOE–NSF program to encourage US students to take up careers in science, technology, engineering, and mathematics, with an emphasis on fields that work on clean energy.

NSF. The \$3 billion in ARRA funding appropriated for NSF amounted to half the agency's 2008 total budget. Two-thirds of the supplement will be used to fund thousands more research proposals, the majority of which either have already been reviewed and deemed to be of high quality or are currently in the review process. Those grants are expected to be awarded by September. Highly rated proposals that

Department of Homeland Security R&D programs

	FY 2008 actual	FY 2009 estimate	FY 2010 request	FY 2009–10 percent change
	(millions of dollars)*			
Total DHS	47 330	52 482	55 115	5.0
Total DHS R&D	1 315	1 447	1 334	–7.7
Science and technology				
Border and maritime	25	33	40	21.6
Chemical and biological countermeasures	208	200	207	3.2
Command, control, and interoperability	57	75	80	7.2
Explosives countermeasures	78	96	121	25.6
Homeland Security Institute†	0	5	0	–100.0
Human factors	14	12	15	21.0
Infrastructure and geophysical	64	76	45	–41.0
Innovation	33	33	44	33.3
Laboratory facilities	104	162	154	–4.6
Test and evaluation standards	28	29	29	0.0
Transition	30	29	45	56.5
University programs	49	50	46	–8.5
Management and administration	139	132	142	7.6
Total science and technology	830	933	968	3.8
Domestic Nuclear Detection Office	485	514	366	–28.8
Coast Guard	19	18	20	11.1

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

†Funding transferred to transition category in FY 2009.

were rejected on or after 1 October 2008 due to a lack of available funding will be reconsidered. All ARRA-funded grants will be standard NSF grants, with durations of up to 5 years, and funding of new principal investigators and high-risk, high-return research projects will be a top priority, according to NSF director Arden Bement. But ARRA monies will not be used to supplement existing grants.

Of the remaining \$1 billion from ARRA, \$400 million will supplement NSF's major research facilities and equipment construction account, \$300 million will go for competitively selected grants to help universities finance major research instrumentation, and \$200 million will pay for grants to upgrade academic infrastructure. Science and mathematics education programs will receive \$100 million.

Although another \$3 billion increase for NSF isn't in the cards for FY 2010, Obama's request does propose an 8.5% increase, taking the agency to slightly more than \$7 billion. The 2010 request will increase by 11% the amount of funding available for grants, Bement told the National Science Board in May. Investments in networking and information technology research reach \$1.1 billion in the 2010 budget, an increase of 11%. Research in large-scale networking, high-end computing, human-computer interaction, and the social, economic, and workforce aspects of advanced computing and communications technologies receive the largest increases.

For 2010 NSF will invest \$390 million in three programs to strengthen America's science and engineering workforce. During Obama's first term, Bement said, the agency will triple the number of new graduate research fellowships to support outstanding young students. New fellowships will number 1654 in 2010, up from this year's 1228 and on course to reach 3000 in 2013. More funding will be available for the faculty early career development program, which supports the teaching and research efforts of junior faculty deemed likely to become future academic leaders. NSF also plans to expand its advanced technology education program for expanding the nation's high-tech workforce.

The change in administrations is evidenced by proposed increases for NSF's climate change research activities. The NSF budget requests \$10 million in FY 2010 funding for a climate change education program whose goal is to encourage a new generation of en-

NASA R&D programs

	FY 2008 actual	FY 2009 estimate	FY 2010 request	FY 2009–10 percent change
	(millions of dollars)*			
Total NASA	17 402	17 782	18 686	5.1
NASA R&D	11 182	10 401	11 439	10.0
R&D programs				
Science, aeronautics, and exploration	8 544	8 508	8 947	5.1
Total science	4 733	4 903	4 477	–8.7
Planetary science				
Discovery	136	247	213	–13.7
New Frontiers	115	264	264	0.0
Technology	65	65	89	37.1
Planetary science research	183	162	162	–0.2
Mars exploration	709	382	416	9.0
Lunar quest program	41	105	104	–1.3
Outer planets	62	101	98	–2.5
Total planetary science	1 313	1 326	1 346	1.5
Astrophysics†				
Astrophysics research	102	135	152	12.5
Cosmic Origins	870	819	667	–18.5
Physics of the Cosmos	149	128	148	15.1
Exoplanet Exploration	157	68	46	–32.1
Astrophysics Explorer	118	131	108	–17.4
Total astrophysics	1 396	1 281	1 121	–12.5
Earth science				
Earth systematic missions	546	899	715	–20.4
Earth system science pathfinder	107	118	64	–46.5
Multimission operations	143	148	150	1.2
Earth science research	358	437	397	–9.1
Applied sciences	40	48	32	–32.6
Earth science technology	43	54	46	–15.1
Total Earth science	1 237	1 705	1 405	–17.6
Heliophysics‡				
Heliophysics research	183	196	179	–8.8
Deep space mission systems	210	0	0	—
Living with a star	218	239	212	–11.1
Solar terrestrial probes	72	123	143	16.2
Heliophysics explorer program	48	31	69	121.0
Near Earth networks	41	0	0	—
New Millennium	15	3	2	–33.3
Total heliophysics	788	592	605	2.3
Exploration systems§				
Constellation systems	2 676	3 033	3 505	15.5
Advanced capabilities#	623	472	458	–3.1
Total exploration systems	3 299	3 505	3 963	13.0
Aeronautics research	511	650	507	–22.0
Space operations				
International Space Station	1 685	2 060	2 267	10.0
Space shuttle	3 295	2 982	3 157	5.9
Space and flight support	446	723	751	4.0
Total space operations	5 427	5 765	6 176	7.1
Cross-agency support**	3 251	3 356	3 401	1.3

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

†Reflects a reorganization of NASA's astrophysics programs beginning in FY 2009.

‡Reflects a reorganization of NASA's heliophysics programs beginning in FY 2009.

§The Obama administration has commissioned an external review of NASA's human space flight development activities.

Based on that review, a revised budget request for exploration systems is expected in August.

||Constellation systems include the crew exploration vehicle, the crew launch vehicle, ground and mission operations, commercial cargo, and other related costs.

#Advanced capabilities include the lunar precursor robotic program, the human research program, and the exploration technology development program.

**Beginning in FY 2009, budgets for all NASA programs and projects include only direct costs, such as labor and travel. Indirect charges, such as operation and management of the NASA centers and agency headquarters, are provided in a cross-agency support category.

vironmentally engaged scientists and engineers. Its awards will go toward increasing public understanding and engagement; developing resources for learning; informing local and national science, technology, engineering, and mathematics education policy; and preparing a professional climate science workforce. Building on its \$299

million request—an increase of \$80 million, or 36%, from 2009—for the 13-agency climate change science program, NSF will spend \$198 million for interdisciplinary climate research. That research will address ecosystem vulnerability, the carbon cycle, ocean acidification, abrupt climate change, dynamics of water in the environment,

Department of Defense R&D programs

	FY 2008 actual	FY 2009 estimate	FY 2010 request	FY 2009–10 percent change
	(millions of dollars)*			
Research, development, test, and evaluation (RDT&E)				
Total basic research (6.1)	1 600	1 825	1 798	–1.5
US Army				
In-house independent research	20	20	20	0.0
Defense research sciences	165	198	173	–12.6
University research initiatives	79	90	88	–1.3
University and industry research centers	109	130	96	–26.2
Total US Army	373	438	377	–13.8
US Navy				
University research initiatives	97	109	99	–8.4
In-house independent research	16	17	18	4.8
Defense research sciences	377	420	414	–1.5
Total US Navy	490	546	531	–2.7
US Air Force				
Defense research sciences	275	314	321	2.2
University research initiatives	116	137	132	–3.5
High-energy laser research	12	13	13	–4.1
Total US Air Force	404	464	466	0.0
Defensewide basic research program†				
DTRA basic research initiative	15	22	48	117.0
Defense research sciences‡	168	202	226	11.7
National defense education program	42	69	90	30.2
Government–industry cosponsorship of university research	5	4	0	–100.0
DEPSCoR	20	15	0	–100.0
Chemical and biological defense research	82	61	59	–3.6
Total defensewide basic research programs	332	374	424	13.2
Applied research (6.2)	4 854	5 173	4 247	–17.9
Advanced technology development (6.3)	5 788	6 644	5 604	–15.6
Total science and technology (6.1–6.3)	12 243	13 643	11 649	–14.6
Other RDT&E§	67 205	68 087	67 295	–1.1
Total RDT&E	79 448	81 730	78 944	–3.4
Medical research	955	903	613	–32.0

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

†Includes the basic research budgets of DOD agencies such as DARPA, Defense Advanced Research Projects Agency; DTRA, Defense Threat Reduction Agency; MDA, Missile Defense Agency; and the Office of the Secretary of Defense.

‡DARPA's basic research budget. The bulk of DARPA's budget is provided from the applied research (6.2) and advanced technology development (6.3) categories. DARPA's overall FY 2010 budget would increase 3.8%, to \$3.2 billion.

§Includes RDT&E categories 6.4 through 6.7.

and weather extremes.

The budget would increase funding for the NSF-wide faculty early career development program by 11.6%, to almost \$209 million. And beginning next year, each of NSF's research divisions will set aside at least \$2 million (\$92 million across NSF) to explore methodologies and leverage ongoing activities that foster transformative research.

NASA. Although the space agency would receive a 10% increase for its R&D programs in FY 2010, it is nearly all designated for human spaceflight programs. The basic science programs would see a decline of 8.7%, with particularly sharp cuts proposed for Earth science and astrophysics. Acting administrator Christopher Scolese said NASA had followed guidance from the National Research Council in emphasizing space-based Earth science research, including the development of new sensors in support of the administration's goal of deploying a global climate research and monitoring system.

With the remaining space shuttles

scheduled to be retired in 2010, Obama has ordered an independent review and recommendations for the future of the space agency's human spaceflight program. Former Lockheed Martin Corp chairman Norman Augustine has been appointed to head the 10-member advisory panel, which is to deliver its recommendations to NASA in August. Under the current schedule, a replacement human space transport system won't become available until 2015, and during the interim US astronauts will have to rely on Soyuz vehicles operated by the Russian Federal Space Agency to get to and from the International Space Station. The FY 2010 request includes a placeholder budget of \$3.5 billion, a slight increase from current-year funding, for development of the new launch rocket and crew vehicle, which are collectively known as Constellation systems. Those numbers will be adjusted to comport with the Augustine committee findings. Another \$400 million from ARRA has been appropriated to the Constellation program.

American Recovery and Reinvestment Act R&D funding

	(millions of dollars)*
Total Department of Energy R&D	5500
Office of Science	
High-energy physics	232
Nuclear physics	155
Biological and environment research	166
Basic energy sciences	555
Advanced scientific computing research	157
Fusion energy sciences	91
Science laboratories infrastructure	198
Science program direction	2
Workforce development for teachers and scientists	12
SBIR/STTR	19
Unallocated ARRA funding	12
Total Office of Science	1600
Energy	
Energy efficiency and renewable energy	2500
Fossil energy	1000
Total energy	3500
Advanced Research Projects Agency–Energy†	400
Total NASA	1002
Science	
Earth science	325
Astrophysics	75
Total science	400
Exploration	400
Aeronautics research	150
Cross-agency support	50
Inspector general	2
Total NSF	3002
Research and related activities	2000
Major research equipment and facilities	400
Major research instrumentation	300
Academic research infrastructure	200
Education and human resources	100
Inspector general	2
Total NIST	580
Scientific and technical research and services	220
Construction of research facilities	360
Total NOAA	830
Department of Defense‡	200

*Figures are rounded to the nearest million.

†New office established in FY 2009.

‡R&D items only.

NASA's aeronautics research program, which has eroded steadily over the past several years, would finally level off at around \$500 million under the Obama budget. Despite the addition of \$150 million in ARRA funds, the program will fall far short of where it was in 2006, when nearly \$900 million was spent.

Department of Defense. The change at the White House seemingly did little to affect the presidential attitude toward basic research funded by the Pentagon. That relatively small slice of DOD's mammoth research, development, test, and evaluation (RDT&E) portfolio is of paramount interest to academic institutions, which perform the bulk of the department's

NSF R&D programs

	FY 2008 actual	FY 2009 estimate	FY 2010 request	FY 2009–10 percent change
	(millions of dollars)*			
Total NSF	6084	6490	7045	8.5
Research and related activities (R&RA)				
Mathematical and physical sciences (MPS)				
Mathematical sciences	212	226	246	8.9
Astronomical sciences	218	229	251	9.7
Physics	252	274	296	7.9
Chemistry	195	211	239	12.9
Materials research	263	282	309	9.5
Multidisciplinary activities	33	33	39	17.8
Total MPS	1171	1256	1380	9.9
Geosciences (GEO)				
Atmospheric sciences	230	245	269	10.0
Earth sciences	158	171	187	9.3
Ocean sciences	313	330	359	8.7
Innovation and collaborative education and research	57	61	94	53.5
Total GEO	758	807	909	12.6
Engineering (less SBIR/STTR)†	540	574	632	10.1
SBIR/STTR	109	119	133	11.2
Biological sciences	616	656	733	11.8
Computer & Information Science & Engineering (CISE)				
Computer and network systems	174	188	210	11.4
Computing and communication foundations	144	157	175	11.4
Information and intelligent systems	139	150	168	11.5
Information technology research	78	78	81	3.2
Total CISE	535	574	633	10.3
Office of cyberinfrastructure	185	199	219	9.9
US polar programs				
Arctic sciences	91	98	109	10.6
Antarctic sciences	59	65	72	11.1
Antarctic infrastructure and logistics	240	247	274	10.8
Polar environmental safety and health	6	6	7	14.5
US Coast Guard polar icebreaking	51	54	54	0.0
Total polar programs	447	471	516	9.6
Arctic research commission	1	1	2	6.7
Social, behavioral, and economic sciences	228	240	257	6.9
Office of international science and engineering	48	44	49	11.3
Integrative activities	214	241	271	12.3
Total R&RA	4853	5183	5733	10.6
Major research equipment and facilities	167	152	117	-22.8
Education and human resources	766	845	858	1.5
Agency operations and award management	282	294	318	8.3
National Science Board	4	4	4	7.7
Inspector general	12	12	14	16.7

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

†Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, a mandatory set-aside of 2.8% of NSF's external research budget.

basic research, known as 6.1. While Obama's request of \$1.8 billion for basic science falls 1.5% below the current year, the White House said its request would be a "substantial increase" if

\$150 million in congressional earmarks were excluded. As it has done in past years, Congress is likely to add to the Pentagon's basic research budget and to continue earmarking.

Department of Commerce (NOAA and NIST) R&D programs

	FY 2008 actual	FY 2009 estimate	FY 2010 request	FY 2009–10 percent change
	(millions of dollars)*			
National Oceanic and Atmospheric Administration R&D				
Total	625	700	644	-8.0
NIST R&D				
Total†	601	644	652	1.2
Scientific and Technical Research Services‡	440	472	535	13.3
Technology Innovation Program§	65	65	70	7.7
Construction of research facilities	160	172	117	-32.0

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

†Includes congressional earmarks of \$47 million in FY 2009 and \$52 million in FY 2008.

‡Includes NIST's laboratories.

§Formerly the Advanced Technology Program.

Overall, the \$78.9 billion request for RDT&E slashes \$1.9 billion, or 3.4%, from the FY 2009 budget. The budget attributes the decline to the lower priority given to several weapons systems and to the elimination of some earmarks. DARPA, which supports high-risk research, would receive a 3.8% increase, to \$3.2 billion.

Department of Homeland Security.

A 3.8% increase to the budget of DHS's science and technology directorate, to \$968 million, was offset by a 29% plunge in funding for the Domestic Nuclear Detection Office (DNDO), from \$514 million to \$366 million. Within S&T, R&D for explosives countermeasures would jump more than 25%, reaching \$121 million, and border and maritime security R&D would swell almost 22%. High-risk research that has the potential to produce breakthrough technologies would climb 33%, to \$44 million. DNDO's drop was due to an absence of acquisitions planned for 2010; a slight increase is proposed to the office's R&D program.

NIST. The \$652 million requested for NIST's intramural laboratories will enhance the agency's research capabilities by providing new equipment and facilities for basic research in health information technology, digital smart grid technology, carbon measurements, and other areas. Separately, the budget would sustain NIST's external programs, including \$125 million (a \$15 million increase over the 2009 enacted level) for the Manufacturing Extension Partnership (MEP), which aims to improve the competitiveness of US manufacturers. But Obama is seeking only a \$5 million increase for the Technology Innovation Program, a grants program that supports early-stage, high-risk technology development. Begun during the administration of President George H. W. Bush, the program was then known as the Advanced Technology Program. Once envisioned by President Clinton as growing to \$1 billion a year, the ATP became a perennial lightning rod for conservatives who branded it as corporate welfare. The younger Bush proposed to kill the program with each budget request, but Congress allowed it to limp along at a low level of funding—just \$65 million in the current year.

National Oceanic and Atmospheric Administration. Obama's \$644 million request for NOAA's R&D operations is 8% below the current-year level. Although the agency is receiving \$830 million from ARRA, none of that is for R&D purposes.

David Kramer ■