special report

Obama's 2011 budget proposes one more year of growth for science and technology

Swollen with stimulus monies, 2010 R&D totals are a tough act to follow. And the president's call for a spending freeze points to austere times ahead.

With the release of the fiscal year 2011 budget request to Congress on 1 February, President Obama completed his first full budget cycle and his first chance to fully flesh out his policy proposals for science and technology (S&T). At the time of his inauguration in January 2009, federal agencies had already submitted their budget requests to the White House, and opportunities for major course changes were limited. But the American Recovery and Reinvestment Act (ARRA) presented the new president with an unprecedented opportunity to channel billions of extra dollars into his R&D priorities. By far the biggest recipient of stimulus R&D funding—more than $21 billion—were the Department of Energy's (DOE's) clean energy development programs (see the ARRA table on page 31).

The ARRA windfall makes year-to-year comparisons problematic at best in the budgets of key S&T funding agencies. While the ARRA surge will continue to be felt for months and in some cases years to come, the act's idiosyncrasies require that all stimulus money be obligated before 1 October 2010 (see PHYSICS TODAY, January 2010, page 18). When the flood of ARRA money begins to ebb, S&T can be expected to enter an austere environment, as Obama and Congress turn their attention to deficit reduction. Obama has proposed freezing nondefense discretionary spending, a category that includes nearly all nonmilitary R&D, at FY 2011 levels. John Holdren, Obama's science adviser and director of the White House Office of Science and Technology Policy, admitted that some agencies will confront a "falling off the cliff" phenomenon as ARRA funds start to dry up and budget belt-tightening begins. At a briefing on the budget's release date, he said that agencies are staggering the timing of grants and have used some ARRA monies to make enduring investments in upgrading laboratory facilities and equipment.

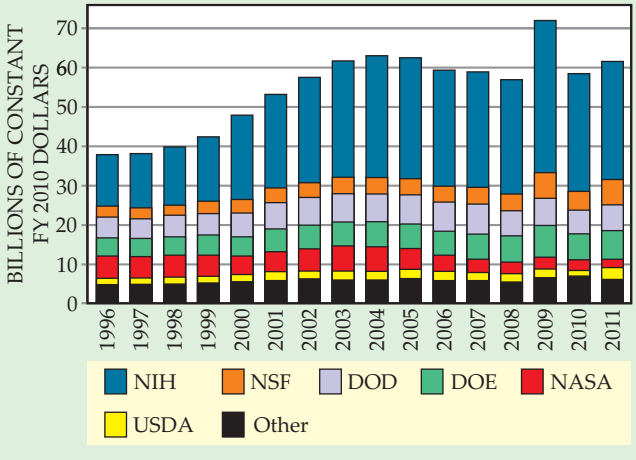
But at least for next year, the White House has decided that increased support for S&T is warranted and has requested $66 billion for civilian research—topping this year's mark by nearly 6%. The basic and applied research programs—defense and nondefense—would receive $61.6 billion, a $3.3 billion increase, or 5.6% above current levels. "The president understands that more than ever before, science holds the key to the prosperity of our nation, the security of our people, and the richness of our lives," said Holdren.

Offsetting those increases is $3.5 billion in proposed cuts to Department of Defense R&D programs, a reduction of 4.4% from FY 2010. The $77.5 billion Obama has requested for Pentagon R&D (a figure that includes medical research not reported in the table) is a reduction of $3.3 billion, or 3.9%, from the current-year spending. All the cuts would be taken from weapons systems development programs that are moving toward procurement; DOD's basic and applied research programs would grow by 2.3% next year, to $6.5 billion, after excluding the congressional earmarks that were added to the current year's appropriation. And the nuclear weapons and nonproliferation R&D programs at DOE's National Nuclear Security Administration (NNSA) would swell 12%, reversing years of steady declines.

Borrowing from Bush

With his request, Obama has embraced an effort initiated by his predecessor to double the budgets of three agencies that supply most of the federal support for basic research in the physical sciences—namely, NSF, DOE's Office of Science, and NIST's core research program. The $13.3 billion sought for those three agencies in FY 2011 represents growth of $824 million, or 6.6%, from

Trends in research by agency, FY 1996–2011



OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Federal funding for basic and applied research will climb 5.6%, to a record high of $61.6 billion, under President Obama's budget request for fiscal year 2011. Overall, the budget proposes $147.7 billion for federal R&D, an increase of just 0.2% over 2010, with a 3.9% cut in defense weapons systems development programs to be offset by a 5.9% rise in civilian R&D. The FY 2009 funding total was swollen by the addition of $13.2 billion for basic and applied R&D programs from the American Recovery and Reinvestment Act (see chart at left), but ARRA monies won't be fully obligated until the end of the current fiscal year. The FY 2011 budget includes a $1.7 billion, 18.3% boost to NASA's R&D programs and proposes a major restructuring of that agency's human space exploration program. President George W. Bush's 10-year doubling of the budgets of NSF, the Department of Energy's Office of Science, and NIST's basic research programs would stay on track for completion in 2017. Substantial increases are requested for clean energy, climate change, and science and mathematics education. But bipartisan concerns with soaring federal debt and deficits could choke further growth in R&D budgets in future years.

the current-year level, and White House projections show the agencies reaching $19.5 billion in 2017—double their 2006 levels.

Obama's budget, however, also proposes to terminate a signature R&D program of George W. Bush's, NASA's Constellation program, which has been working to develop the rockets and the vehicle required to send US astronauts beyond low-Earth orbit and ferry them back and forth to the International Space Station (ISS). The budget proposal also seals the fate of the proposed nuclear waste repository at Yucca Mountain in Nevada. Both of those programs have consumed billions of taxpayer dollars and were unlikely to succeed without billions more invested.

Obama also has parted ways with Bush on budget treatment for the National Institutes of Health. Upon the 2003 completion of a five-year budget-doubling campaign started by his predecessor, no further increases for NIH were provided through the remainder of Bush's presidency. Obama has proposed an increase of $1 billion, or 3.2%, which would take the biomedical research behemoth's FY 2011 budget to $32.2 billion, just under half of the total federal funding for nondefense R&D.

Not surprisingly, given Obama's pledges to take on the threat posed by global warming, FY 2011 spending for the interagency US Global Change Research Program would leap next year by 21%, or $439 million, to $2.6 billion. The Department of Commerce's climate research programs, primarily at the National Oceanic and Atmospheric Administration (NOAA), would rise $77 million, or 21%, to $437 million. NASA's component of the climate program would jump 20%, to $1.3 billion, as the result of a directive from Obama for that agency to accelerate its development of new satellites that were named as Earth science priorities by the National Research Council. Government-wide funding for science, technology, engineering, and mathematics education at K–12 levels is proposed to surge 40%, or $300 million, reaching the $1 billion mark. Counting college-level programs, the total STEM education spending would increase by less than 1%, to $3.7 billion. NSF, with the largest STEM education portfolio, would receive $1.2 billion for those programs next year, an increase of 2.3%.

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

Department of Energy R&D programs

	FY 2009 actual	FY 2010 estimate	FY 2011 request	FY 2010–11 percent change
	(millions of dollars)*			
Total DOE	33 856	26 597	28 404	6.8
DOE R&D	11 549	11 562	12 513	8.2
Office of Science R&D programs	4 813	4 904	5 121	4.4
Total high-energy physics	776	810	829	2.3
Proton accelerator-based physics	401	434	439	1.2
Research	126	125	130	3.9
Grants research	60	60	61	1.7
National laboratory research	66	65	68	4.8
University service accounts	1	1	1	0.4
Facilities	275	309	309	0.0
Tevatron operations and improvements	195	218	214	–1.8
Large Hadron Collider project and support	72	80	84	4.8
Other facilities†	8	10	11	3.7
Electron accelerator-based physics	32	27	25	–9.9
Research	17	15	15	–2.8
University research	7	7	6	–2.7
National laboratory research	10	9	9	–2.8
Facilities	15	12	10	–19.0
Nonaccelerator physics	101	100	89	–11.1
Theoretical physics	66	67	70	3.8
Advanced tech R&D (accelerators and detectors)	175	182	190	4.2
Total nuclear physics	500	535	562	5.0
Medium-energy nuclear physics	117	128	130	1.6
Research	36	45	46	2.9
University research	19	20	21	5.7
National laboratory research	17	18	19	2.8
Other research	1	7	7	–4.5
Operations	80	83	83	0.9
Heavy-ion nuclear physics	195	212	218	3.0
Research	41	49	49	0.6
University research	14	14	16	7.2
National laboratory research	27	27	27	–2.8
Other research	0	7	7	0.6
Operations (primarily RHIC)	154	163	169	3.7
Low-energy nuclear physics	95	115	113	–1.0
Research	53	66	66	0.0
University research	21	22	23	1.8
National laboratory research	31	41	41	–0.7
Other research	1	2	2	–2.9
Facility for Rare Isotope Beams	7	12	10	–16.7
Operations (primarily ATLAS and HRIBF)	35	37	38	2.2
Nuclear theory	38	42	45	7.0
Isotope development and production	25	19	20	3.0
Construction	31	20	36	80.0
Total fusion energy sciences	395	426	380	–10.8
Science	163	182	186	2.1
Facility operations‡	208	221	170	–23.0
Enabling R&D	23	23	24	3.7
Total basic energy sciences	1 536	1 636	1 835	12.1
Materials sciences	1 108	364	433	19.0
Chemical sciences, geosciences, and energy biosciences	282	297	404	35.9
Energy frontier research centers (EFRCs)§	42	42	62	47.6
Energy innovation hub	0	0	34	—
Scientific user facilities operations‖	0	822	847	3.1
Advanced Light Source, LBNL	0	58	63	8.1
Advanced Photon Source, ANL	0	129	140	7.8
National Synchrotron Light Source, BNL	0	40	41	2.4
Center for Nanophase Materials Sciences, ORNL	0	21	22	4.6
Center for Integrated Nanotechnologies, SNL/LANL	0	21	22	4.6
Molecular Foundry, LBNL	0	21	22	4.6
Center for Nanoscale Materials, ANL	0	22	23	4.5
Center for Functional Nanomaterials, BNL	0	21	22	4.6
Stanford Synchrotron Radiation Laboratory, SLAC	0	35	37	6.7
High Flux Isotope Reactor, ORNL	0	61	61	1.1
Intense Pulsed Neutron Source, ANL	0	4	3	–25.0
Manuel Lujan Jr Neutron Scattering Ctr, LANL	0	11	12	4.1
Spallation Neutron Source, ORNL	0	183	186	2.0
Linac Coherent Light Source, SLAC#	0	10	123	1071
Linac for LCLS	0	94	0	–100.0

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Department of Energy R&D programs (continued)

	FY 2009 actual	FY 2010 estimate	FY 2011 request	FY 2010–11 percent change
	(millions of dollars)*			
Construction	145	154	152	–1.7
National Synchrotron Light Source-II, BNL	93	139	152	9.0
LCLS, SLAC#	37	15	0	–100.0
Advanced scientific computing research	359	394	426	8.1
Biological and environmental research	585	604	627	3.8
Advanced Research Projects Agency–Energy	15	0	300	—
Fossil energy R&D	863	672	587	–12.8
Nuclear energy R&D	791	787	824	4.7
Energy efficiency and renewable energy	2 157	2 242	2 355	5.0
Total National Nuclear Security Administration R&D	2 879	2 937	3 294	12.1
Total weapons science, technology, and engineering	1 490	1 471	1 624	10.4
Science campaigns	317	296	365	23.5
Engineering campaigns	150	150	142	–5.4
Advanced simulation and computing	556	568	616	8.5
Inertial confinement fusion	437	458	482	5.2
Science, technology, and engineering capability	30	0	20	—
Directed stockpile work R&D**	204	204	248	21.6
Nonproliferation and verification R&D	356	317	352	10.8
Naval reactors	828	945	1 070	13.3
Environmental management R&D	31	20	32	61.6

*Figures are rounded to the nearest million. Changes are calculated from unrounded figures.
†Includes funds for decontamination and decommissioning of the BNL Alternating Gradient Synchrotron, which ceased operations as an experimental facility in FY 2002.
‡Includes $80 million for the US contribution to ITER, a 41% reduction from the $135 million appropriated for ITER in FY 2010.
§In FY 2011 approximately $40 million will be available to fund additional EFRCs. The balance of the FY 2011 request will support ongoing operations at 30 EFRCs initiated in FY 2009. Sixteen other EFRCs were fully funded for five years with ARRA monies.
‖In FY 2009, funding of $771 million for scientific user facilities was included in the materials sciences and engineering research account ($82 million) and the facility operations activity ($689 million). From FY 2010 and beyond, this funding is shown separately in a scientific user facilities subprogram.
#Reflects completion of contruction and first full year of operation at the LCLS.
**Includes R&D support and R&D certification and safety activities in directed stockpile work.

ANL, Argonne National Laboratory. ARRA, American Recovery and Reinvestment Act. ATLAS, a Torroidal LHC Apparatus. BNL, Brookhaven National Laboratory. HRIBF, 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. SNL, Sandia National Laboratories.

Department of Homeland Security R&D programs

	FY 2009 actual	FY 2010 estimate	FY 2011 request	FY 2010–11 percent change
	(millions of dollars)*			
Total DHS†	52 709	55 348	56 336	1.8
Total DHS R&D	1 466	1 408	1 344	–4.5
Domestic Nuclear Detection Office (DNDO)	514	383	306	–20.2
Science and technology				
Border and maritime	33	44	40	–9.6
Chemical and biological countermeasures	200	207	201	–2.9
Command, control, and interoperability	75	82	75	–8.5
Explosives countermeasures	96	121	121	0.0
Homeland Security Institute‡	5	—	—	—
Human factors	12	16	13	–16.5
Infrastructure and geophysical	76	75	36	–51.8
Innovation	33	44	44	0.0
Laboratory facilities	162	150	122	–18.8
Radiological and nuclear§	—	—	109	—
Test and evaluation standards	29	29	23	–20.1
Transition	29	46	42	–8.7
University programs	50	49	40	–18.9
Management and administration	132	143	152	6.1
Recisions‖	—	–7	—	—
Total science and technology	933	999	1018	1.2
Coast Guard	20	25	20	–19.0

*Figures are rounded to the nearest million. Changes are calculated from unrounded figures.
†Excludes supplemental appropriations of $3.4 billion in FY 2009 and $296 million in FY 2010. Includes discretionary and mandatory federal funds, trust funds, and fee-funded activities.
‡Funding transferred to Transition category in FY 2010.
§Reflects transfer of DNDO transformational R&D program.
‖Recission of unexpended funds from prior-year appropriations.

Department of Energy. Funding for DOE's R&D programs would swell 8.2%, to $12.5 billion. The Office of Science, which supports DOE's nondefense basic research programs, would increase by 4.4%, to $5.1 billion. The 2011 budget proposes $34 million to establish a fourth "energy innovation hub" that will focus on batteries and energy storage. Each of the existing hubs—in advanced reactors, production of fuels from sunlight, and energy-efficient building designs—would get $24.3 million next year. Between six and eight new energy frontier research centers would be added to the existing suite of 46 EFRCs housed at universities, national laboratories, and other institutions around the country. The applied research programs that work to accelerate the adoption of renewable and other carbon-free energy sources would be boosted by 5%, to $2.4 billion. Still, funding for energy efficiency, renewable energy, fossil energy, and electricity delivery and reliability will plunge from the levels they attained with ARRA.

Nuclear energy R&D would grow 4.7%, to $824 million, as DOE continues to explore how to handle nuclear waste. Energy Secretary Steven Chu has appointed a commission to propose solutions, but the administration has made clear that its decision to shut down the Yucca Mountain repository is final. Testifying before the House Science and Technology Committee in February, Holdren argued that the $10 billion spent to study the site was not wasted, since much has been learned about the challenges of selecting a suitable repository location.

An attention-grabber in the request for DOE is the $357 million, 12.1% rise slated for R&D at the NNSA, the semiautonomous agency that operates the nuclear weapons, nonproliferation, and naval reactors programs. Vice President Joe Biden, who announced the increase in a *Wall Street Journal* oped published in late January, said the addition is part of a five-year, $5 billion investment in NNSA that is "long overdue." The FY 2011 request was released as the administration put the finishing touches on the first comprehensive review of US nuclear weapons policy since 2002.

The budget gives evidence that the NNSA made its case that ensuring the reliability and safety of the aging stockpile will require ongoing expenditures in the scientific programs of the nuclear weapons laboratories. Also receiving a substantial boost—10.8%, to

$352 million—is R&D to develop new methods to limit the proliferation of nuclear weapons and fissile materials abroad and for the verification of international arms control agreements.

The DOE request proposes $300 million for the Advanced Research Projects Agency–Energy, a new office that awards competitive grants to support high-risk R&D projects that could result in breakthrough energy technologies. Although less than the $389 million ARPA–E received in ARRA funds, the 2011 request would be the first significant appropriation for the entity since its establishment by law in 2007.

Department of Defense. Obama's budget includes an increase of 6.7%, to $2 billion, for basic research. That small slice of DOD's mammoth $76.7 billion R&D program provides 85% of all federal support to universities for mechanical engineering, 65% of the total for electrical engineering, 33% of ocean sciences, and 27% of computer sciences support, according to the Task Force on American Innovation, a coalition of businesses, trade associations, scientific societies, and universities.

The Defense Advanced Research Projects Agency would receive a 3.7% increase, to $3.1 billion. The budget request for DARPA contains no mention of a five-year, $1 billion plan to revitalize US manufacturing, a plan that DARPA director Regina Dugan described in January to a meeting of the President's Council of Advisors on Science and Technology. Dugan told PCAST her idea is to replicate in other US manufacturing sectors a model that had helped the US semiconductor industry to recover from near extinction by foreign competition. That model involved separating semiconductor design companies from manufacturing companies.

NASA. In a major overhaul of NASA's human space exploration program, the administration proposes to scrap the $3.8 billion project known as Constellation, which has been developing spacecraft to replace the space shuttles and provide transport to the Moon or other destinations. Constellation funding would be redirected to a new design, development, and production initiative to be carried out in the private sector under NASA supervision. The Bush administration had said that new launch capabilities could be readied for human flight by 2015, but a blue-ribbon review committee last fall said both that timetable and Bush's goal of sending astronauts back to the Moon by 2020 were infeasible. Obama's revamp would provide $500 million next year and a total of $6 billion over five years to spur the commercial development of manned spaceflight vehicles. The budget would also provide $312 million next year as incentives for NASA's existing commercial cargo providers.

Shuttering Constellation will be a tough sell on Capitol Hill, as Holdren confirmed when he defended the scheme before lawmakers. Holdren told the House Science and Technology Committee in late February that the plan equates to "changing the acquisition model" to one in which NASA pays commercial contractors to provide transportation services. He reminded lawmakers that the agency had, since its inception, relied on con-

NASA R&D programs

	FY 2009 actual	FY 2010 estimate	FY 2011 request	FY 2010–11 percent change
	(millions of dollars)*			
Total NASA	17 782	18 724	19 000	1.5
NASA R&D				
R&D programs				
Science, aeronautics, and exploration	9 308	8 781	9 848	12.1
Science	4 903	4 493	5 006	11.4
Planetary science				
Discovery	235	209	202	–3.4
New Frontiers	279	264	224	–15.2
Technology	72	89	106	19.7
Planetary science research	166	161	180	12.2
Mars exploration	362	416	533	28.0
Outer planets	105	99	103	5.0
Lunar quest	69	104	137	31.8
Total planetary science	1 288	1 341	1 486	10.8
Astrophysics				
Astrophysics research	136	149	156	4.8
Cosmic Origins	850	684	688	0.5
Physics of the Cosmos	111	117	103	–11.5
Exoplanet Exploration	72	46	42	–8.0
Astrophysics Explorer	136	108	87	–19.6
Total astrophysics	1 305	1 104	1 076	–2.5
Earth science				
Earth systematic missions	894	723	809	11.9
Earth system science pathfinder	122	86	304	253.0
Multimission operations	146	150	161	7.5
Earth science research	437	383	438	14.3
Applied sciences	48	32	37	13.7
Earth science technology	55	46	53	15.0
Total Earth science	1 702	1 421	1 802	26.8
Heliophysics				
Heliophysics research	205	173	167	–3.5
Living with a star	223	240	214	–10.8
Solar terrestrial probes	143	143	163	13.9
Heliophysics explorer program	35	69	98	40.7
New Millennium	3	2	0†	–94.0
Total heliophysics	608	627	642	2.3
Exploration systems‡				
Constellation systems	3 433	3 326	—	n/a
Constellation transition	—	—	1900	n/a
Advanced capabilities	472	454	—	n/a
Exploration R&D	—	—	1551	n/a
Commercial spaceflight	—	—	812	n/a
Total exploration systems	3 905	3 780	4 263	12.8
Aeronautics research	500§	507	580	14.3
Space technology‖	—	—	572	n/a
Space operations				
International Space Station	2 060	2 317	2 780	20.0
Space shuttle	2 979	3 139	989	–68.5
Space and flight support	725	724	1 119	54.5
Total space operations	5 765	6 181	4 888	–20.9
Cross-agency support	3 356	3 095	3 111	0.5

*Figures are rounded to the nearest million. Changes are calculated from unrounded figures.
†FY 2011 request for New Millennium is $100 000.
‡FY 2011 request terminates Constellation systems, which consisted of the Ares I and V rockets and Orion crew exploration vehicle, redirects resources to development of technologies required for extended human spaceflight, and encourages development of commercial crew and cargo transport capabilities.
§Does not include $150 million provided from the American Recovery and Reinvestment Act.
‖New line item for FY 2011.

Department of Defense R&D programs

	FY 2009 actual	FY 2010 estimate	FY 2011 request	FY 2010–11 percent change
	(millions of dollars)*†			
Research, development, test, and evaluation (RDT&E)				
Total basic research (6.1)	1 758	1 874	1 999	6.7
US Army				
In-house independent research	19	20	22	11.3
Defense research sciences	194	197	196	–0.1
University research initiatives	87	99	91	–8.3
University and industry research centers	121	115	98	–15.0
Total US Army	422	432	407	–5.8
US Navy				
University research initiatives	102	102	109	6.3
In-house independent research	17	18	18	0.1
Defense research sciences	406	429	430	0.1
Total US Navy	525	549	556	1.3
US Air Force				
Defense research sciences	300	328	351	6.9
University research initiatives	134	142	136	–3.7
High-energy laser research	13	13	13	–3.3
Total US Air Force	446	483	500	3.7
Defensewide basic research programs‡				
DTRA basic research initiative	29	41	47	16.1
Defense research sciences§	187	206	328	59.4
National defense education program	67	79	110	38.5
Government–industry cosponsorship of university research	4	5	0	–100.0
DEPSCoR	14	0	0	—
Chemical and biological defense research	60	79	50	–37.1
Total defensewide basic research programs	362	410	535	30.6
Applied research (6.2)	5 072	5 038	4 476	–11.2
Advanced technology development (6.3)	6 425	6 544	5 359	–18.1
Total science and technology (6.1–6.3)	13 255	13 456	11 833	–13.9
Other RDT&E‖	67 395	67 168	64 932	–3.3
Total RDT&E	80 651	80 916	76 765	–5.1

*Excludes congressional add-ons and earmarks that are included in previous years.
†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; 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 2011 budget would increase 3.7%, to $3.1 billion, from the FY 2010 appropriation of $3 billion.
‖Includes RDT&E categories 6.4 through 6.7.

American Recovery and Reinvestment Act R&D funding

	(millions of dollars)*†
Total Department of Energy R&D	23 290
Energy efficiency and renewable energy	16 772
Electricity delivery and energy reliability	4 496
Fossil energy	3 399
Office of Science	1 633
Advanced scientific computing research	162
Basic energy sciences	555
Biological and environment research	166
Fusion energy sciences	91
High-energy physics	232
Nuclear physics	155
Science laboratories infrastructure	198
Workforce development for teachers and scientists	12
Small Business Innovation Research	56
Science program direction	6
Advanced Research Projects Agency–Energy	389
Total NASA	950
Science	400
Earth science	325
Astrophysics	75
Aeronautics research	150
Exploration	400
Total NSF	2402
Research and related activities	2063
Major research equipment and facilities construction	254
Education and human resources	85
Total NIST	580
Scientific and technical research and services	220
Renovation and construction of labs and facilities	360
Total NOAA	170
Department of Defense‡	300

*Figures are rounded to the nearest million.
†Figures reflect R&D items only.
‡Funding for near-term energy-efficient technologies program.

tractors like Boeing and Lockheed Martin Corp. He noted that former Lockheed CEO Norman Augustine, who chaired last year's review committee, had endorsed the Obama plan. But congressional critics—including some who represent districts with large NASA workforces, and others who are upset by NASA's dependence on Russia to ferry astronauts to and from the ISS until new US capabilities are developed—complain that Constellation's demise will leave the space program without a clear destination. Bush's desire to return humans to the Moon was largely meant to provide the agency with a goal. Representative Frank Wolf (R-VA), ranking minority member of the Appropriations subcommittee with jurisdiction over NASA, hotly told Holdren that Obama's blueprint "leaves a program worthy of a lesser nation than the United States" and warned that it will be tantamount to "guaranteeing that the Chinese, Russians, and others will be closing the exploration gap."

Retirement of the remaining three space shuttles by the end of 2010 will free up more than $2 billion for use elsewhere in the agency. With its 2011 request, the administration has committed to keep the ISS in operation through at least 2020. Assembly of the ISS, which by some estimates has cost the US and its international partners $100 billion, is due for completion this year. Lacking a change in policy, NASA's official plan calls for the ISS to be deorbited in 2016. Partner nations of ISS are hoping to keep it going until 2028.

Obama's budget proposes an increase of $463 million for the ISS program in 2011 and $2 billion in additional support over the next four years. Upgrades to the station's ground support and onboard systems will aim to fully utilize its research capabilities, improve its operation, and demonstrate new technologies being developed by other NASA programs. The FY 2011 budget includes a new line item for space technology. Funded at $572 million, the program is to address the technological obstacles to long-term spaceflight, and feature an enhanced technology transfer component to push the commercialization of NASA inventions.

Two of NASA's four basic science programs are in store for big increases next year. Earth science, benefiting from the administration's focus on climate change, would swell nearly 27%. Planetary science would jump nearly 11%, but heliophysics research would rise only modestly, and astrophysics would decline 2.5%. Aeronautics research would increase 14.3%, to $580 million.

NSF. Now in its 61st year, NSF is in line for an 8% increase in FY 2011. The $7.4 billion proposal would keep the agency on track to attain the administration's goal for a 10-year doubling of its budget by 2017. Still, NSF clearly won't be able to sustain the ARRA-fueled spending of the past year and a half. NSF used the bulk of its $2.4 billion in stimulus money to make 4599 competitively awarded grants from its backlog of highly ranked proposals.

NSF R&D programs

	FY 2009 actual	FY 2010 estimate	FY 2011 request	FY 2010–11 percent change
	(millions of dollars)*			
Total NSF	6469	6873	7424	8.0
Research and related activities (R&RA)				
Mathematical and physical sciences (MPS)				
Mathematical sciences	225	241	252	5.0
Astronomical sciences	229	246	253	2.5
Physics	262	290	298	2.8
Chemistry	212	234	248	5.9
Materials research	283	303	319	5.5
Multidisciplinary activities	34	38	40	3.2
Total MPS	1244	1352	1410	4.3
Geosciences (GEO)				
Atmospheric and geospace sciences	245	260	281	8.1
Earth sciences	171	183	199	8.7
Ocean sciences	331	349	378	8.3
Integrative and collaborative education and research	61	98	98	–0.3
Total GEO	809	890	955	7.4
Engineering	665	744	826	11.0
Biological sciences	657	715	768	7.5
Computer & Information Science & Engineering (CISE)				
Computer and network systems	188	204	227	11.1
Computing and communication foundations	157	170	187	9.7
Information and intelligent systems	151	163	190	16.2
Information technology research	78	81	81	—
Total CISE	574	619	685	10.6
Office of cyberinfrastructure	199	214	228	6.4
US polar programs				
Arctic sciences	99	106	111	4.8
Antarctic sciences	69	71	75	5.8
Antarctic infrastructure and logistics	247	267	280	5.0
Polar environment, health, and safety	6	7	7	3.7
US Coast Guard polar icebreaking	54	[54]†	54	—
Total polar programs	474	451	528	17.0
Arctic research commission	1	2	2	1.3
Social, behavioral, and economic sciences	241	255	269	5.3
Office of international science and engineering	47	48	53	11.4
Integrative activities	242	275	296	7.6
Total R&RA	5152	5564	6019	8.2
Major research equipment and facilities construction	161	117	165	40.8
Education and human resources	846	873	892	2.2
Agency operations and award management	294	300	329	9.7
National Science Board	4	5	5	6.6
Inspector general	12	14	14	2.5

*Figures are rounded to the nearest million. Changes are calculated from unrounded figures.
†Excludes a one-time appropriation transfer of $54 million to US Coast Guard for icebreaking.

That's about half the number of awards it makes with regular appropriations. Outgoing NSF director Arden Bement said the ARRA-funded grants are providing jobs for 6762 investigators, including 2352 first-time awardees.

Describing NSF as the "tip of the spear in the nation's science and engineering research and education enterprise," Bement told reporters that NSF will increase emphasis on alternative energy and energy efficiency research. A portfolio of programs called "science, engineering, and education for sustainability," to be funded at $766 million, will seek integrated approaches to increase US energy independence, enhance environmental stewardship, and reduce energy use and carbon intensity, while also generating economic growth. In a partnership with DOE, NSF plans to initiate a new $19 million program, dubbed Re-Energyse (regaining our energy science and engineering edge), to train as many as 8500 scientists and engineers and thousands more technicians by 2015 for careers in clean energy.

Nearly 50% of the federal funding for academic research in the physical sciences and 82% of universities' research funding in computer sciences comes from NSF. The FY 2011 budget proposes doubling to $70 million the agency's "science and engineering beyond Moore's Law" program, which seeks alternatives to silicon chip technology, and would also further Obama's commitment to triple the number of new NSF graduate research fellowships to 3000 by 2013 by adding $158 million.

Also included in the budget request is $12 million for a new "innovation ecosystem" program to foster increased commercialization of inventions that originate in academia. It's proposed as a component of the agency's "partnerships for innovation" program, which seeks collaborations among universities, state and local governments, companies, and nonprofit organizations for developing the people, tools, and infrastructure needed to connect new scientific discoveries with practical uses. Funding for PFI would more than double next year, to $19 million.

NOAA and NIST. One of two Commerce Department S&T agencies, NOAA is to receive $1.1 billion for a newly named Joint Polar Satellite System next year. The restructured program proposes a new division of labor among NOAA, NASA, and DOD. The project, originally estimated to cost $6.5 billion in 2002, has ballooned to $13.9 billion and is five years behind schedule, despite a 2006 restructuring. NIST, also part of the Commerce Department, would receive $709 million, a 6.9% increase, in FY 2011 for its scientific and technical research services activities and for the construction of research facilities—the two portions of NIST whose funding Obama has pledged to double by 2017. NIST's Technology Innovation Program, formerly the Advanced Technology Program, would receive $80 million in FY 2011, a $5 million increase from this year.

David Kramer ■

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

	FY 2009 actual	FY 2010 estimate	FY 2011 request	FY 2010–11 percent change
	(millions of dollars)*			
National Oceanic and Atmospheric Administration R&D				
Total	790	872	959	10.0
NIST R&D				
Total	819	857	919	7.3
Scientific and Technical Research Services†	472	515	584	13.5
Technology Innovation Program‡	65	70	80	14.3
Construction of research facilities	172	147	125	–15.1

*Figures are rounded to the nearest million. Changes are calculated from unrounded figures.
†Includes NIST's laboratories.
‡Formerly the Advanced Technology Program.