

## 21. RESEARCH AND DEVELOPMENT

Scientific discovery and technological innovation are major engines of increasing productivity and are indispensable for promoting economic growth and job creation, advancing toward a clean energy future, improving the health of the population, and safeguarding our national security in the technologically driven 21<sup>st</sup> Century.

The President's 2011 Budget proposes \$147.7 billion for Federal research and development (R&D). This investment reinforces the Administration's commitment to science, technology, and innovation that will help the country make progress toward these national goals.

This investment is a cornerstone of the President's *Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs*, announced in

September 2009. This investment moves the Nation toward the President's long-term goal that R&D investments in the United States should reach three percent of the Gross Domestic Product (GDP). The additional funding provided in the 2011 Budget will make progress toward this goal by increasing Federal funding for R&D as a percentage of GDP for non-defense activities. The 2011 Budget's proposed permanent extension of the research and experimentation tax credit will spur private investment in R&D by providing certainty that the credit will be available for the duration of the R&D investment.

In general, the Budget's priorities align with the conclusions in the report from the National Science and Technology Summit held in August 2008.

### I. PRIORITIES FOR FEDERAL RESEARCH AND DEVELOPMENT

The Budget provides support for multidisciplinary research and promising, but exploratory and high-risk, research proposals that could fundamentally improve our understanding of nature, revolutionize fields of science, and lead to radically new technologies.

#### Investing in the Sciences for a Prosperous America

The Administration recognizes the Government's role in fostering scientific and technological breakthroughs, and has committed resources to ensure America leads the world in the innovations of the future. Federally supported research expands the frontiers of human knowledge and has been a reliable source of new knowledge to drive economic recovery, job creation, and economic growth. The Budget proposes \$61.6 billion for basic and applied research, an increase of 5.6 percent above the 2010 enacted level.

The President's Plan for Science and Innovation, announced in April 2009, seeks to double Federal investment for basic research in key agencies: the National Science Foundation (NSF); the Department of Energy (DOE) Office of Science; and the laboratories of the Department of Commerce (DOC) National Institute of Standards and Technology (NIST). The American Recovery and Reinvestment Act and the 2010 appropriations provided critical down payments toward this doubling. The Budget proposes \$13.3 billion in 2011 for these three agencies. This level is an increase of 6.6 percent above the 2010 enacted level of \$12.4 billion. Priorities for 2011 include multidisciplinary research targeted at the jobs and industries of the future and at sustainability at NSF, basic energy sciences at DOE, and cybersecurity, biomanufacturing, and innovative energy technologies at NIST.

The Budget also supports research investments in other Federal agencies. The Budget proposes \$429 million, an increase of 63 percent, for the Agriculture and Food Research Initiative, a competitively awarded research program within the U.S. Department of Agriculture's (USDA) new National Institute of Food and Agriculture (formerly the Cooperative State Research, Education and Extension Service). The Budget also proposes a 30-percent increase in funding for the National Center for Education Research, part of the Department of Education's Institute of Education Sciences. These funds will support much needed R&D investments to generate solutions to critical problems in education.

The Federal R&D effort needs complementary R&D investments from business to translate scientific discoveries into commercially successful, innovative products and services. In order to provide businesses with greater confidence to invest, innovate, and grow, the Budget proposes to make the Research and Experimentation tax credit permanent.

#### A Clean Energy Future

The Administration envisions the United States leading the world in research, development, demonstration, and deployment of clean-energy technology to reduce dependence on energy imports and to mitigate the impact of climate change while creating clean energy jobs and new businesses.

The 2011 Budget builds upon substantial clean energy R&D investments in the Recovery Act and 2010 appropriations to forge a comprehensive approach to transforming energy supply and slowing global climate change through cutting-edge science and technology. R&D funding will support renewable energy and energy efficiency technolo-

gies such as advanced batteries, solid-state lighting, solar, biomass, geothermal, and wind power. The 2011 Budget proposes \$438 million for research and development of advanced coal-fueled power systems and carbon capture and storage technologies that reduce the carbon emission intensity of fossil fuel-based power systems. To further support achievement of clean energy and climate goals, the Budget supports strong, science-based nuclear energy R&D programs to advance nuclear technologies and improve their market competitiveness, including a broad new effort to encourage the development of creative, cutting-edge solutions. Longer-term nuclear R&D programs complement the near-term strategy to support the revitalization of the nuclear industry through loan guarantees. The Budget also proposes \$170 million for bioenergy research in USDA to develop next-generation biofuels like cellulosic and algae-based biofuels that displace oil consumption and reduce greenhouse gas emissions.

The 2011 Budget proposes \$300 million for the Advanced Research Projects Agency-Energy within DOE to support transformational discoveries and accelerate the development of clean energy.

### Healthy Lives for All Americans

The Administration is committed to funding Federal R&D investments in biomedical and health research and supporting policies to increase the impact of these investments on health outcomes. The 2011 Budget strongly supports research that builds and expands upon recent discoveries in genomics and other high-throughput technologies to increase scientific knowledge and translate discoveries into better, more cost-effective medical treatments.

The 2011 Budget proposes \$32 billion for the National Institutes of Health (NIH), an increase of \$1 billion. The Budget will support bold and innovative efforts in research on diseases such as cancer and autism spectrum disorders.

The Budget also proposes \$286 million for patient-centered health research in the Agency for Healthcare Research and Quality and \$590 million for medical research in the Department of Veterans Affairs.

### A Safe and Secure America

Federal R&D investments in security assure that we have the technologies needed to protect our troops, citizens, and national interests, including those needed to verify arms control and nonproliferation agreements essential to our security.

The 2011 Budget sustains the Department of Defense's (DOD) critical role in supporting technological advances with \$3.1 billion for the Defense Advanced Research Projects Agency for its support of longer-term breakthrough research. The Budget proposes \$6.5 billion for DOD basic and applied research, 2.3 percent above the 2010 enacted level of \$6.3 billion. The Budget maintains scientific and technological preeminence for our Armed Forces.

The Budget invests in the technological capabilities necessary to monitor nuclear nonproliferation compliance

and to prevent weapons of mass destruction from entering the country. The Budget proposes \$352 million for DOE's nonproliferation and verification R&D portfolio, an increase of 11 percent over the 2010 level.

The Budget invests in the science and technology needed to combat natural and manmade threats to our Nation's food supply, including \$113.6 million in the U.S. Department of Agriculture for research associated with the safety of the U.S. food supply.

In order to address these priorities effectively, the Administration recognizes the need to strengthen key cross-cutting areas.

**Science, technology, engineering, and mathematics (STEM) education:** The Administration is committed to strengthening STEM education, from pre-college to post-graduate to lifelong learning. The Budget invests \$3.7 billion in STEM education programs throughout the Federal government. The Budget proposes \$74 million for a coordinated DOE-NSF RE-ENERGYSE education campaign to inspire tens of thousands of young Americans to pursue STEM careers in clean energy. These Federal programs complement an expanding array of Federal-private partnerships in STEM education announced by the President in November 2009 in the "Educate to Innovate" campaign.

The Budget emphasizes support for researchers at the beginning of their careers to sustain and expand the Nation's scientific and technical workforce, including sustained investments toward tripling the number of NSF's Graduate Research Fellowships by 2013.

The Budget also proposes significant investments in STEM education at the Department of Education. Through the reauthorization of the Elementary and Secondary Education Act, the Administration is seeking to create the Effective Teaching and Learning: STEM program, which would support State and local efforts to implement a comprehensive STEM strategy for the provision of high-quality STEM instruction to students from preK-12. The Budget also dedicates \$150 million within the Investing in Innovation program to competitive grants for school districts, nonprofits, and other organizations to test, validate, and scale promising strategies to improve student learning in STEM subjects.

**Productive research institutions:** The Administration recognizes the need for strong, productive research institutions, including our research universities and major public and private laboratories and research centers. The Budget sustains critical investments in university research from the NIH, NSF, DOD, and USDA, among others.

**Space capabilities:** The Administration is committed to enhancing our capabilities in space, which are essential for communications, geopositioning, intelligence gathering, Earth observation, and national defense. As part of this commitment, the National Aeronautics and Space Administration (NASA) will embark on vigorous new technology development and test programs aimed at increasing the capabilities and reducing the cost of NASA, other government, and U.S. commercial space activities.

**Infrastructure:** The Administration places a high priority on improving and protecting our information, communication, and transportation infrastructure, which

is essential to our commerce, science, and security alike. As an example, the Administration is investing heavily in broadband infrastructure by implementing \$7.2 billion

provided for this purpose in the Recovery Act to USDA and DOC.

## II. FEDERAL R&D DATA

R&D is the collection of efforts directed towards gaining greater knowledge or understanding and applying knowledge toward the production of useful materials, devices, and methods. R&D investments can be characterized as basic research, applied research, development, R&D equipment, or R&D facilities. The Office of Management and Budget has used those or similar categories in its collection of R&D data since 1949.

### Federal R&D Funding

**Basic research** is systematic study directed toward a fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind. Basic research, however, may include activities with broad applications in mind.

**Applied research** is systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met.

**Development** is systematic application of knowledge or understanding, directed toward the production of useful materials, devices, and systems or methods, including

design, development, and improvement of prototypes and new processes to meet specific requirements.

**Research and development equipment** includes acquisition or design and production of movable equipment, such as spectrometers, research satellites, detectors, and other instruments. At a minimum, this category should include programs devoted to the purchase or construction of R&D equipment.

**Research and development facilities** include the acquisition, design, and construction of, or major repairs or alterations to, all physical facilities for use in R&D activities. Facilities include land, buildings, and fixed capital equipment, regardless of whether the facilities are to be used by the Government or by a private organization, and regardless of where title to the property may rest. This category includes such fixed facilities as reactors, wind tunnels, and particle accelerators.

There are more than 20 Federal agencies that fund R&D in the United States. The nature of the R&D that these agencies fund depends on the mission of each agency and on the role of R&D in accomplishing it. Table 21–1 shows agency-by-agency spending on basic and applied research, development, and R&D equipment and facilities.

## III. MULTI-AGENCY R&D ACTIVITIES

A number of research investments are being addressed through multi-agency research activities coordinated through the National Science and Technology Council (NSTC) and other interagency forums. Many of the challenges simply cannot be addressed by a single agency.

Moreover, innovation often arises from combining the tools, techniques, and insights from multiple agencies. Table 21–2 shows details of three such interagency efforts: networking and information technology R&D, nanotechnology R&D, and climate change R&D.

**Networking and Information Technology R&D:** The Budget proposes \$4.0 billion for the multi-agency Networking and Information Technology Research and Development (NITRD) Program, which plans and coordinates agency research efforts in cyber security, high-end computing systems, advanced networking, software development, high-confidence systems, information management, and other information technologies.

The 2011 Budget retains the important focus on investment in high-end computing research for both national security and large-scale scientific applications, particularly in advanced scalable simulations. The 2011 Budget also continues to emphasize foundations for assured comput-

ing and secure hardware, software and network design and engineering to address the goal of making Internet communications more secure and reliable. Reports and general information about NITRD are available at [www.nitrd.gov](http://www.nitrd.gov).

**Nanotechnology R&D:** The Budget proposes \$1.7 billion for the multi-agency National Nanotechnology Initiative (NNI). The NNI focuses on R&D that creates materials, devices, and systems that exploit the fundamentally distinct properties of matter as it is manipulated at the nanoscale (roughly 1 to 100 nanometers). The results of NNI-supported R&D are enabling breakthroughs in biomedical detection and treatment, advanced manufacturing at or near the nanoscale, environmental monitoring and protection, sustainable energy production as well as energy conversion and storage, and more powerful electronic devices, among many others.

Guided by the NNI strategies developed by the Nanoscale Science, Engineering, and Technology Subcommittee of the NSTC, participating agencies will continue to support nanoscience and nanotechnology development through investigator-led research; multidisciplinary centers of excellence; education and training; and infrastructure and standards development, including user facilities and net-

works that are broadly available to support research and innovation. In addition, consistent with the *NNI Strategy for Nanotechnology-Related Environmental Health, and Safety Research*, agencies continue to maintain a focus on the responsible development of nanotechnology, with attention to the human and environmental health impacts, as well as ethical, legal, and other societal issues. Reports and general information about NNI are available at [www.nano.gov](http://www.nano.gov).

**Climate Change R&D:** The Budget proposes \$2.6 billion for the U.S. Global Change Research Program (USGCRP), which integrates Federal research and solutions for climate and global change. The 2011 Budget supports scientific research and applications to support the goals set forth in the program's strategic plan. These activities can be grouped under the following areas: improve our knowledge of Earth's past and present climate

variability and change; improve our understanding of natural and human forces of climate change; improve our capability to model and predict future conditions and impacts; assess the Nation's vulnerability to current and anticipated impacts of climate change; and improve the Nation's ability to respond to climate change by providing climate information and decision support tools that are useful to policy makers and the general public. Reports and general information about the USGCRP are available on the program's website, [www.globalchange.gov](http://www.globalchange.gov).

The Climate Change Technology Program (CCTP) provides planning and analysis on the portfolio of federally funded climate change technology R&D. Reports and general information about the CCTP are available on the program's website, [www.climatetechnology.gov](http://www.climatetechnology.gov).

**Table 21-1. FEDERAL RESEARCH AND DEVELOPMENT SPENDING**

(Budget authority, dollar amounts in millions)

	2009 Actual <sup>1</sup>	2010 Estimate	2011 Proposed	Dollar Change: 2010 to 2011	Percent Change: 2010 to 2011 <sup>2</sup>
<b>By Agency</b>					
Defense .....	81,121	81,090	77,548	-3,542	-4%
Health and Human Services .....	41,658	31,177	32,156	979	3%
Energy .....	13,268	10,693	11,219	526	5%
NASA .....	11,677	9,286	10,986	1,700	18%
National Science Foundation .....	7,576	5,092	5,571	479	9%
Agriculture .....	2,613	2,591	2,448	-143	-6%
Commerce .....	1,969	1,516	1,727	211	14%
Veterans Affairs .....	1,020	1,162	1,180	18	2%
Homeland Security .....	1,096	1,150	1,046	-104	-9%
Transportation .....	976	1,012	1,018	6	1%
Interior .....	775	755	772	17	2%
Environmental Protection Agency .....	559	622	651	29	5%
Education .....	312	348	383	35	10%
Smithsonian Institution .....	226	208	236	28	13%
Other .....	625	651	755	104	16%
<b>TOTAL .....</b>	<b>165,471</b>	<b>147,353</b>	<b>147,696</b>	<b>343</b>	<b>0%</b>
<b>Basic Research</b>					
Defense .....	1,727	1,830	1,998	168	9%
Health and Human Services .....	21,140	16,981	17,502	521	3%
Energy .....	4,505	3,862	4,003	141	4%
NASA .....	1,830	884	977	93	11%
National Science Foundation .....	6,107	4,291	4,684	393	9%
Agriculture .....	907	999	1,018	19	2%
Commerce .....	152	121	150	29	24%
Veterans Affairs .....	406	464	470	6	1%
Homeland Security .....	268	227	173	-54	-24%
Transportation .....	.....	.....	.....	.....	.....
Interior .....	47	50	52	2	4%
Environmental Protection Agency .....	107	90	95	5	6%
Education .....	3	6	7	1	17%
Smithsonian Institution .....	152	162	178	16	10%
Other .....	26	35	34	-1	-3%
<b>SUBTOTAL .....</b>	<b>37,377</b>	<b>30,002</b>	<b>31,341</b>	<b>1,339</b>	<b>4%</b>

**Table 21–1. FEDERAL RESEARCH AND DEVELOPMENT SPENDING—Continued**  
(Budget authority, dollar amounts in millions)

	2009 Actual <sup>1</sup>	2010 Estimate	2011 Proposed	Dollar Change: 2010 to 2011	Percent Change: 2010 to 2011 <sup>2</sup>
<b>Applied Research</b>					
Defense .....	5,066	4,500	4,479	-21	-0%
Health and Human Services .....	18,836	14,051	14,479	428	3%
Energy .....	3,686	3,131	3,728	597	19%
NASA .....	990	683	1,336	653	96%
National Science Foundation .....	471	343	435	92	27%
Agriculture .....	1,214	1,232	1,216	-16	-1%
Commerce .....	834	833	900	67	8%
Veterans Affairs .....	548	618	636	18	3%
Homeland Security .....	413	475	425	-50	-11%
Transportation .....	726	748	781	33	4%
Interior .....	652	624	637	13	2%
Environmental Protection Agency .....	367	437	458	21	5%
Education .....	189	205	225	20	10%
Smithsonian Institution .....	.....	.....	.....	.....	.....
Other .....	447	447	541	94	21%
<b>SUBTOTAL .....</b>	<b>34,439</b>	<b>28,327</b>	<b>30,276</b>	<b>1,949</b>	<b>7%</b>
<b>Development</b>					
Defense .....	74,100	74,676	70,974	-3,702	-5%
Health and Human Services .....	20	20	25	5	25%
Energy .....	3,050	2,612	2,560	-52	-2%
NASA .....	6,677	5,452	6,126	674	12%
National Science Foundation .....	.....	.....	.....	.....	.....
Agriculture .....	165	175	180	5	3%
Commerce .....	208	197	346	149	76%
Veterans Affairs .....	66	80	74	-6	-8%
Homeland Security .....	415	448	448	.....	.....
Transportation .....	230	242	212	-30	-12%
Interior .....	66	74	81	7	9%
Environmental Protection Agency .....	85	95	98	3	3%
Education .....	120	137	151	14	10%
Smithsonian Institution .....	.....	.....	.....	.....	.....
Other .....	146	165	180	15	9%
<b>SUBTOTAL .....</b>	<b>85,348</b>	<b>84,373</b>	<b>81,455</b>	<b>-2,918</b>	<b>-3%</b>
<b>Facilities and Equipment .....</b>					
Defense .....	228	84	97	13	15%
Health and Human Services .....	1,662	125	150	25	20%
Energy .....	2,027	1,088	928	-160	-15%
NASA .....	2,180	2,267	2,547	280	12%
National Science Foundation .....	998	458	452	-6	-1%
Agriculture .....	327	185	34	-151	-82%
Commerce .....	775	365	331	-34	-9%
Veterans Affairs .....	.....	.....	.....	.....	.....
Homeland Security .....	.....	.....	.....	.....	.....
Transportation .....	20	22	25	3	14%
Interior .....	10	7	2	-5	-71%
Environmental Protection Agency .....	.....	.....	.....	.....	.....
Education .....	.....	.....	.....	.....	.....
Smithsonian Institution .....	74	46	58	12	26%
Other .....	6	4	.....	-4	-100%
<b>SUBTOTAL .....</b>	<b>8,307</b>	<b>4,651</b>	<b>4,624</b>	<b>-27</b>	<b>-1%</b>

<sup>1</sup> The amounts for 2009 include funding from P.L. 111-5, the American Recovery and Reinvestment Act of 2009.

<sup>2</sup> Percentages may be rounded.

**Table 21–2. AGENCY DETAIL OF SELECTED INTERAGENCY R&D EFFORTS**

(Budget authority, dollar amounts in millions)

	2009 Actual <sup>1</sup>	2010 Estimate	2011 Proposed	Dollar Change: 2010 to 2011	Percent Change: 2010 to 2011 <sup>2</sup>
<b>Networking and Information Technology R&amp;D</b>					
National Science Foundation .....	1,359	1,091	1,171	80	7%
Defense .....	1,368	1,278	1,107	-171	-13%
Health and Human Services <sup>3</sup> .....	1,238	986	1,019	33	3%
Energy .....	572	495	524	29	6%
Commerce .....	258	104	119	15	14%
National Aeronautics and Space Administration .....	100	82	82	.....	.....
Environmental Protection Agency .....	6	6	6	.....	.....
National Archives and Records Administration .....	5	5	5	.....	.....
<b>TOTAL .....</b>	<b>4,906</b>	<b>4,047</b>	<b>4,033</b>	<b>-14</b>	<b>-0%</b>
<b>National Nanotechnology Initiative</b>					
Energy .....	589	343	406	63	18
National Science Foundation .....	510	418	401	-17	-4%
Health and Human Services <sup>4</sup> .....	410	345	391	46	13%
Defense .....	459	436	349	-87	-20%
Commerce (NIST) .....	137	114	108	-6	-5%
Environmental Protection Agency .....	13	18	20	2	11%
National Aeronautics and Space Administration .....	17	17	17	.....	.....
Agriculture .....	15	15	14	-1	-7%
Homeland Security .....	9	12	12	.....	.....
Transportation .....	1	3	2	-1	-33%
Consumer Product Safety Commission .....	.....	.....	2	2	N/A
Justice .....	1	.....	.....	.....	.....
<b>TOTAL .....</b>	<b>2,161</b>	<b>1,721</b>	<b>1,722</b>	<b>1</b>	<b>0%</b>
<b>U.S. Global Change Research Program</b>					
National Aeronautics and Space Administration .....	1,323	1,071	1,285	214	20%
Commerce (NOAA) .....	594	360	437	77	21%
National Science Foundation .....	390	319	370	51	16%
Energy .....	233	165	191	26	16%
Agriculture .....	47	109	157	48	44%
Interior (USGS) .....	45	63	81	18	29%
Environmental Protection Agency .....	18	21	22	1	5%
Smithsonian Institution .....	6	7	11	4	57%
Health and Human Services (NIH) .....	5	4	4	.....	.....
Transportation .....	2	3	3	.....	.....
U.S. Agency for International Development <sup>5</sup> .....	17	36	43	7	19%
<b>TOTAL .....</b>	<b>2,663</b>	<b>2,122</b>	<b>2,561</b>	<b>439</b>	<b>21%</b>

<sup>1</sup> Amounts for 2009 include funding from P.L. 111-5, the American Recovery and Reinvestment Act of 2009.<sup>2</sup> Percentages may be rounded.<sup>3</sup> Includes funds from offsetting collections for the Agency for Healthcare Research and Quality.<sup>4</sup> Includes funds from the National Institutes of Health, National Institute of Occupational Safety and Health, and Food and Drug Administration.<sup>5</sup> USAID funding supports USGCRP and the Climate Change International Assistance (CCIA) effort. In the past, some USAID funding was counted under both crosscuts. These efforts will only be counted toward the CCIA total.