

21. RESEARCH AND DEVELOPMENT

The American innovation ecosystem is the envy of the world. Federal research and development (R&D) strengthens the U.S. innovation base and contributes to job growth, national security, and continued prosperity. While recognizing the continued importance of R&D spending to support innovation, fiscal prudence demands a more focused approach to the Federal R&D budget in the context of America's multi-sector R&D enterprise. This approach prioritizes maintaining peace through strength and ensures U.S. leadership in the Industries of

the Future. The President's 2020 Budget provides \$134.1 billion for Federal R&D, including the conduct of R&D and investments in R&D facilities and equipment. It continues support of investments in basic research, early-stage applied research, and technology transfer efforts for Agencies to accomplish their missions and support the President's priorities while reducing spending in lower priority areas. Table 21-1 shows a breakout of FY 2020 R&D funding by Agency.

Table 21-1. TOTAL FEDERAL R&D FUNDING BY AGENCY AT THE BUREAU OR ACCOUNT LEVEL
(Mandatory and discretionary budget authority^{1,2}, dollar amounts in millions)

	2018 Actual	2019 Estimate ³	2020 Proposed	Dollar Change: 2019 to 2020	Percent Change: 2019 to 2020
By Agency					
Agriculture	2,618	2,666	2,464	-202	-8%
Agriculture Research Service	1,387	1,421	1,275	-146	-10%
Animal and Plant Health Inspection Service	39	34	34	0	0%
Economic Research Service	87	87	61	-26	-30%
Forest Service	272	269	229	-40	-15%
National Agricultural Statistics Service	9	9	9	0	0%
National Institute of Food and Agriculture	824	846	856	10	1%
Commerce	2,029	2,194	1,694	-500	-23%
Bureau of the Census	122	165	138	-27	-16%
National Institute of Standards and Technology	975	973	898	-75	-8%
National Oceanic and Atmospheric Administration	923	1,048	650	-398	-38%
National Telecommunications and Information Administration	9	8	8	0	0%
Defense⁴	52,386	55,832	59,463	3,631	7%
Military Construction	38	22	0	-22	-100%
Military Personnel	467	416	435	19	5%
Defense Health Program	1,616	1,774	376	-1,398	-79%
Research, Development, Test, and Evaluation	50,265	53,620	58,652	5,032	9%
Education	257	258	224	-34	-13%
Institute of Education Sciences	230	230	197	-33	-14%
Office of Innovation and Improvement	1	0	0	0	n/a
Office of Postsecondary Education	1	1	0	-1	0%
Office of Special Education and Rehabilitative Services	24	24	24	0	0%
Office of Career, Technical, and Adult Education	1	3	3	0	0%
Energy	17,482	17,793	14,718	-3,075	-17%
Fossil Energy Research and Development	683	682	551	-131	-19%
Science	6,200	6,517	5,475	-1,042	-16%
Electricity Delivery	172	136	163	27	20%
Nuclear Energy	1,172	1,293	742	-551	-43%
Energy Efficiency and Renewable Energy	1,757	1,842	322	-1,520	-83%
Advanced Research Projects Agency--Energy ⁵	354	366	-287	-653	-178%
Cybersecurity, Energy Security, and Emergency Response	0	49	36	-13	n/a
Defense Environmental Cleanup	38	28	13	-15	-54%
National Nuclear Security Administration	7,093	6,873	7,701	828	12%

Table 21–1. TOTAL FEDERAL R&D FUNDING BY AGENCY AT THE BUREAU OR ACCOUNT LEVEL—Continued
(Mandatory and discretionary budget authority^{1,2}; dollar amounts in millions)

	2018 Actual	2019 Estimate ³	2020 Proposed	Dollar Change: 2019 to 2020	Percent Change: 2019 to 2020
Power Marketing Administration	13	7	2	-5	-71%
Environmental Protection Agency	492	489	285	-204	-42%
Science and Technology	476	473	266	-207	-44%
Hazardous Substance Superfund	15	15	18	3	20%
Inland Oil Spill Programs	1	1	1	0	0%
Health and Human Services	36,942	38,647	33,693	-4,954	-13%
Administration for Children and Families	5	4	5	1	25%
Centers for Disease Control and Prevention	437	435	435	0	0%
Centers for Medicare and Medicaid Services	20	20	0	-20	-100%
Departmental Management	131	154	18	-136	-88%
Food and Drug Administration	495	410	410	0	0%
Health Resources and Services Administration	30	30	26	-4	-13%
National Institutes of Health ⁶	35,824	37,594	32,799	-4,795	-13%
Homeland Security	725	737	507	-230	-31%
Science and Technology	589	588	369	-219	-37%
Transportation Security Administration	20	20	21	1	5%
United States Coast Guard	31	31	7	-24	-77%
United States Secret Service	2	0	11	11	n/a
Management Directorate	3	3	0	-3	-100%
Cybersecurity and Infrastructure Security Agency	15	15	31	16	107%
Countering Weapons of Mass Destruction Office	65	80	68	-12	-15%
Interior	885	884	753	-131	-15%
Bureau of Land Management	21	25	19	-6	-24%
Bureau of Reclamation	90	100	84	-16	-16%
Bureau of Safety and Environmental Enforcement	27	21	21	0	0%
Department-Wide Programs	3	3	0	-3	-100%
National Park Service	26	27	26	-1	-4%
Office of Surface Mining Reclamation and Enforcement	1	1	1	0	0%
United States Fish and Wildlife Service	33	33	15	-18	-55%
United States Geological Survey	600	592	482	-110	-19%
Bureau of Ocean Energy Management	79	77	100	23	30%
Bureau of Indian Affairs	5	5	5	0	0%
National Aeronautics and Space Administration	11,755	10,698	11,280	582	5%
Science	5,983	6,154	5,974	-180	-3%
Aeronautics	560	565	575	10	2%
Low Earth Orbit and Spaceflight Operations	2,227	1,586	1,611	25	2%
Safety, Security and Mission Services	272	272	242	-30	-11%
Deep Space Exploration Systems	1,864	1,288	1,883	595	46%
Construction and Environmental Compliance and Restoration	135	117	87	-30	-26%
Exploration Technology	714	716	908	192	27%
National Science Foundation	6,327	6,315	5,760	-555	-9%
Research and Related Activities	5,687	5,684	5,079	-605	-11%
Education and Human Resources	457	448	458	10	2%
Major Research Equipment and Facilities Construction	183	183	223	40	22%
Transportation	1,043	1,146	1,076	-70	-6%
Federal Aviation Administration	471	571	510	-61	-11%
Federal Highway Administration	376	376	404	28	7%
Federal Motor Carrier Safety Administration	9	9	9	0	0%
Federal Railroad Administration	43	45	23	-22	-49%
Federal Transit Administration	28	28	28	0	0%
Maritime Administration	0	0	3	3	n/a
National Highway Traffic Safety Administration	76	76	65	-11	-14%
Office of the Secretary	19	19	13	-6	-32%
Pipeline and Hazardous Materials Safety Administration	21	22	21	-1	-5%

Table 21–1. TOTAL FEDERAL R&D FUNDING BY AGENCY AT THE BUREAU OR ACCOUNT LEVEL—Continued

(Mandatory and discretionary budget authority^{1,2}; dollar amounts in millions)

	2018 Actual	2019 Estimate ³	2020 Proposed	Dollar Change: 2019 to 2020	Percent Change: 2019 to 2020
Smithsonian Institution	357	336	315	-21	-6%
Veterans Affairs	1,286	1,342	1,325	-17	-1%
Medical Care Support	563	563	563	0	0%
Medical and Prosthetic Research	723	779	762	-17	-2%

¹ This table shows funding levels for Departments or Independent Agencies with more than \$200 million in R&D activities in 2020.

² The Experimental Development definition is used in this table across all three fiscal years.

³ The FY 2019 Estimate column applies the main FY 2020 President’s Budget volume approach of estimating the FY 2019 level using FY 2019 enacted appropriations where available and annualized Continuing Resolution for agencies without enacted appropriations prior to Feb. 15, 2019.

⁴ Totals for Experimental Development spending in FY 2018–2020 do not include DOD Budget Activity 07 (Operational System Development) due to a change in the definition of development first implemented in the FY 2018 Budget. These DOD Budget Activity 07 funds support development efforts to upgrade systems that have been fielded or have received approval for full rate production and anticipate production funding in the current or subsequent fiscal year.

⁵ The -\$287 million in FY 2020 for ARPA-E is the result of a one-time cancellation of unobligated balances.

⁶ NIH includes Agency for Healthcare Research and Quality (AHRQ) funding as the FY 2020 Budget proposes that AHRQ be consolidated within NIH as a new institute.

I. PRIORITIES FOR FEDERAL RESEARCH AND DEVELOPMENT

The President’s Budget provides support for Federal R&D to keep America strong, safe, and prosperous. This section highlights key areas of R&D funding in the 2020 Budget.

Security of the American People

As adversaries leverage American R&D outcomes and emerging technologies to threaten the Nation, it is imperative that we invest in R&D to strengthen our security. The National Security Strategy, as well as the 2018 National Defense Strategy, prioritize investments in technologies that ensure we will be able to keep the American people safe. The President’s 2020 Budget continues to encourage programs with dual-use potential to be leveraged for Federal nonmilitary advancements. The Department of Defense (DoD) will invest more than \$59 billion in research, engineering, and prototyping activities in 2020 to maintain technical superiority and promote U.S. national security innovation, including in priority areas of trusted and assured microelectronics; hypersonics research for non-nuclear weapons; kinetic and non-kinetic technologies able to disrupt and defeat missiles prior to launch; missile detection, defeat, and defense capabilities; and R&D to advance the Industries of the Future.

The 2020 Budget also supports critical investments to protect the Nation at the Department of Homeland Security (DHS) and the Department of Health and Human Services (HHS). At DHS, the President’s Budget requests \$120 million in R&D funding to further detect and defend against radiological, nuclear, chemical, and biological threats; \$57 million in R&D to improve border surveillance and law enforcement capabilities to detect and interdict illegal activity; and \$37 million for cybersecurity R&D. To bolster transportation security, the 2020 Budget will invest \$82 million in R&D to counter emerging threats to our aviation, surface, and intermodal transportation systems. At HHS, the Budget provides over \$1 billion to develop enhanced medical countermeasures to respond to public health emergencies.

American Leadership in the Industries of the Future

The unique science and technology enterprise of the United States has positioned the Nation to pursue, realize, and dominate in emerging technologies. The private sector responds to new opportunities and markets, bringing forward ideas, products, and services that outperform existing technologies or, in some cases, create new industries. Federal contributions in early-stage R&D can help lay the technical and scientific foundation for truly revolutionary new technologies, particularly those that require sustained support before becoming attractive for private sector investment. The President’s 2020 Budget prioritizes investments for four key Industries of the Future: artificial intelligence, quantum information sciences, advanced communication networks (including fifth generation networks and beyond), and advanced manufacturing.

Artificial intelligence (AI) is transforming every segment of American life, with applications ranging from medical diagnostics and precision agriculture, to autonomous transportation and national defense. The Administration has taken a forward-looking approach to fortify American leadership in AI, including considerations about its effective and ethical use. It formed the National Science and Technology Council’s Select Committee on AI to coordinate the wide range of Federal R&D efforts, and Federal agencies continue to advance the development and use of AI across multiple domains. The President recently signed an Executive Order (EO) launching the American AI Initiative, which will take a multipronged approach to accelerating our national leadership in AI. The FY 2020 Budget funding for this Initiative includes approximately \$850 million at the Department of Energy (DOE), National Institutes of Health (NIH), National Institute of Standards and Technology (NIST), and National Science Foundation (NSF).

Quantum information science (QIS) has the potential to revolutionize our scientific knowledge, improve our

industrial base, and provide substantial economic and national security benefits. QIS applications are expected to affect many areas of technology within the next two decades. Recognizing the potential of QIS, the President recently signed into law the National Quantum Initiative Act and will establish a 10-year plan to accelerate the development of QIS and technology applications. The FY 2020 Budget funding for this Initiative includes approximately \$430 million at the DoD, DOE, NIST, and NSF.

American leadership in emerging wireless networks is a critical global advantage, both for the economy and national security. U.S. leadership in fourth generation (4G) networks has led to significant GDP growth and job creation. Deploying fifth generation (5G) wireless connectivity is even more imperative because it will enable a wide range of transformational technologies, from smart

cities to the Internet of Things. The 2020 Budget supports R&D to manage spectrum, secure networks, and increase access to high-speed internet.

Advanced manufacturing—which includes both new manufacturing methods and the production of new products enabled by cutting-edge technologies—is an engine of America’s economic power and a pillar of its national security. The 2020 Budget prioritizes R&D aimed at advances in manufacturing and the integration of those advances into the domestic supply chain to reduce U.S. reliance on foreign sources of critical products. Budget priorities include intelligent manufacturing systems, materials and processing technologies, advances in semiconductor design and fabrication, and innovations in food and agricultural manufacturing.

II. FEDERAL R&D DATA

R&D is the collection of efforts directed toward 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 (OMB) has used those or similar categories in its collection of R&D data since 1949. Starting with the FY 2018 Budget, OMB implemented a refinement to the categories by more narrowly defining “development” as “experimental development” to better align with the data collected by the National Science Foundation on its multiple R&D surveys, and to be consistent with international standards. An explanation of this change is included below. Please note that R&D cross-cuts in specific topical areas as mandated by law will be reported separately in forthcoming Supplements to the President’s 2020 Budget.

Background on Federal R&D Funding

More than 20 Federal agencies fund R&D in the United States. The character 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 20-2 shows agency-by-agency spending on basic research, applied research, experimental development, and R&D equipment and facilities.

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.

Experimental development is creative and systematic work, drawing on knowledge gained from research

and practical experience, which is directed at producing new products or processes or improving existing products or processes. Like research, experimental development will result in gaining additional knowledge.

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 includes 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.

Comprehensive government-wide efforts are currently underway to increase the accuracy and consistency of the R&D budget via a collaborative community of practice of Federal agencies, which have been working to identify best practices and standards for the most accurate classification and reporting of R&D activities. For example, to better align with National Science Foundation R&D surveys and international standards, starting with the FY 2018 Budget OMB narrowed the definition of development to “experimental development.” This definition, unlike the previous definition of development, excludes user demonstrations of a system for a specific use case and pre-production development (i.e., non-experimental work on a product or system before it goes into full production). Because of this earlier change, the experimental development amounts reported are significantly lower than the development amounts shown in past Budgets.¹

¹ The change in definition of experimental development reduces R&D spending compared to what it would have been under the previous definition by approximately \$40.6 billion in the FY 2020 Budget.

Table 21-2. FEDERAL RESEARCH AND DEVELOPMENT SPENDING(Mandatory and discretionary budget authority¹, dollar amounts in millions)

	2018 Actual	2019 Estimate ²	2020 Proposed	Dollar Change: 2019 to 2020	Percent Change: 2019 to 2020
By Agency					
Defense ³	52,386	55,832	59,463	3,631	7%
Health and Human Services	36,942	38,647	33,693	-4,954	-13%
Energy	17,482	17,793	14,718	-3,075	-17%
NASA	11,755	10,698	11,280	582	5%
National Science Foundation	6,327	6,315	5,760	-555	-9%
Agriculture	2,618	2,666	2,464	-202	-8%
Commerce	2,029	2,194	1,694	-500	-23%
Veterans Affairs	1,286	1,342	1,325	-17	-1%
Transportation	1,043	1,146	1,076	-70	-6%
Interior	885	884	753	-131	-15%
Homeland Security	725	737	507	-230	-31%
Smithsonian Institution	357	336	315	-21	-6%
Environmental Protection Agency	492	489	285	-204	-42%
Education	257	258	224	-34	-13%
Other	1,181	1,258	540	-718	-57%
TOTAL	135,765	140,595	134,097	-6,498	-5%
Basic Research					
Defense	2,282	2,545	2,337	-208	-8%
Health and Human Services	18,278	19,172	16,785	-2,387	-12%
Energy	5,005	5,155	4,647	-508	-10%
NASA	3,636	4,948	4,538	-410	-8%
National Science Foundation	5,066	5,060	4,568	-492	-10%
Agriculture	1,085	1,116	1,073	-43	-4%
Commerce	222	222	192	-30	-14%
Veterans Affairs	530	553	546	-7	-1%
Transportation .....	.....	.....	.....	.....	.....
Interior	77	77	68	-9	-12%
Homeland Security	47	42	23	-19	-45%
Smithsonian Institution	277	267	269	2	1%
Environmental Protection Agency .....	.....	.....	.....	.....	.....
Education	58	67	66	-1	-1%
Other	53	54	52	-2	-4%
SUBTOTAL	36,616	39,278	35,164	-4,114	-10%
Applied Research					
Defense	5,690	6,190	5,440	-750	-12%
Health and Human Services	18,414	19,187	16,624	-2,563	-13%
Energy	7,998	7,813	6,410	-1,403	-18%
NASA	2,112	2,743	2,864	121	4%
National Science Foundation	758	752	687	-65	-9%
Agriculture	1,072	1,099	1,037	-62	-6%
Commerce	963	996	757	-239	-24%
Veterans Affairs	727	758	749	-9	-1%
Transportation	697	703	634	-69	-10%
Interior	669	664	548	-116	-17%
Homeland Security	188	189	98	-91	-48%
Smithsonian Institution .....	.....	.....	.....	.....	.....
Environmental Protection Agency	415	415	220	-195	-47%
Education	124	119	107	-12	-10%
Other	880	942	268	-674	-72%
SUBTOTAL	40,707	42,570	36,443	-6,127	-14%

Table 21-2. FEDERAL RESEARCH AND DEVELOPMENT SPENDING—Continued
(Mandatory and discretionary budget authority¹, dollar amounts in millions)

	2018 Actual	2019 Estimate ²	2020 Proposed	Dollar Change: 2019 to 2020	Percent Change: 2019 to 2020
Experimental Development					
Defense ³	44,363	47,075	51,686	4,611	10%
Health and Human Services	35	35	35	0	0%
Energy	2,549	2,598	1,952	-646	-25%
NASA	5,872	2,890	3,791	901	31%
National Science Foundation .....	.....	.....	.....	.....	.....
Agriculture	180	180	174	-6	-3%
Commerce	211	278	179	-99	-36%
Veterans Affairs	29	31	30	-1	-3%
Transportation	302	403	404	1	0%
Interior	137	137	135	-2	-1%
Homeland Security	490	506	386	-120	-24%
Smithsonian Institution .....	.....	.....	.....	.....	.....
Environmental Protection Agency	74	74	65	-9	-12%
Education	75	72	51	-21	-29%
Other	248	262	220	-42	-16%
SUBTOTAL	54,565	54,541	59,108	4,567	8%
Facilities and Equipment					
Defense	51	22	0	-22	-100%
Health and Human Services	215	253	249	-4	-2%
Energy	1,930	2,227	1,709	-518	-23%
NASA	135	117	87	-30	-26%
National Science Foundation	503	503	505	2	0%
Agriculture	281	271	180	-91	-34%
Commerce	633	698	566	-132	-19%
Veterans Affairs .....	.....	.....	.....	.....	.....
Transportation	44	40	38	-2	-5%
Interior	2	6	2	-4	-67%
Homeland Security .....	.....	.....	.....	.....	.....
Smithsonian Institution	80	69	46	-23	-33%
Environmental Protection Agency	3	0	0	0	n/a
Education .....	.....	.....	.....	.....	.....
Other .....	.....	.....	.....	.....	.....
SUBTOTAL	3,877	4,206	3,382	-824	-20%

¹ This table shows funding levels for Departments or Independent Agencies with more than \$200 million in R&D activities in 2020.

² The FY 2019 Estimate column applies the main FY 2020 President’s Budget volume approach of estimating the FY 2019 level using FY 2019 enacted appropriations where available and annualized Continuing Resolution for agencies without enacted appropriations prior to Feb. 15, 2019.

³ Totals for Experimental Development spending in FY 2018–2020 do not include DOD Budget Activity 07 (Operational System Development) due to a change in the definition of development first implemented in the FY 2018 Budget. These DOD Budget Activity 07 funds support development efforts to upgrade systems that have been fielded or have received approval for full rate production and anticipate production funding in the current or subsequent fiscal year.

III. OTHER SOURCES OF FEDERAL SUPPORT FOR R&D

The President's 2020 Budget seeks to build on strong private sector R&D investment by prioritizing Federal resources on areas that industry is not likely to support over later-stage applied research and development that the private sector is better equipped to pursue. A key means of stimulating private sector investment and bridging Federal government research with industry development is through the transfer of technology. Federal technology transfer seeks to help domestic companies develop and commercialize products derived from government-funded R&D, which can lead to greater productivity from U.S. R&D investments and ultimately promote the Nation's economic growth. Recognizing the benefits of this mechanism, the 2020 Budget sustains funding for technology transfer efforts where appropriate. In addition, the Administration launched a new initiative to enable and enhance the Federal government's transition of discoveries from laboratory to market as a Cross-Agency Priority Goal under the President's Management Agenda (PMA).

Because much of the Federally funded R&D is conducted outside of the government, the Administration seeks to reduce the associated burdens to funding recipients and partners in order to promote greater effectiveness and efficiency in our Federal spending. A significant effort to reduce the administrative and regulatory burdens associated with Federal R&D funding is currently underway through an interagency working group on research regulation (as required by the Research and Development

Efficiency Act), which is examining ways to reduce the administrative burden on those performing Federally funded research. More broadly, beyond just R&D, the Administration launched a Cross-Agency Priority Goal under the PMA aimed at reducing administrative burdens for all Federal grant recipients and promoting results-oriented accountability.

The Federal Government also stimulates private investment in R&D through tax preferences. Historically, dating back to the 1950s, the private sector has performed the majority of U.S. R&D. As of 2017, it is estimated that businesses performed 73% of total U.S. R&D.² The research and experimentation (R&E) tax credit, which was made permanent through the Protecting Americans from Tax Hikes Act of 2015 (P.L. 114-113) and modified in the Tax Cut and Jobs Act of 2017 (P.L. 115-97), essentially provides a credit to qualified research expenses. R&E tax credit claims have at least doubled over the past two decades, growing from an estimated \$4.4 billion in 1997 to \$11.3 billion in 2013.³ The manufacturing and the professional, scientific, and technical services sectors account for about 70% of total claims in 2013.

² NSF National Center for Science and Engineering Statistics (Feb 2019). National Patterns of R&D Resources: 2016-2017 Data Update. NSF-19-309.

³ IRS Statistics of Income Division (Sept 2016). 1990-2013 Corporate Returns Data.

