Estimates of R&D in FY 2022 House and Senate Appropriations To Date

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All twelve annual spending bills have been approved by the House Appropriations Committee and nine by the full House, while Senate Democrats have proposed a full slate of their own. Here are estimates of R&D spending in these bills based on OMB, agency, and legislative data.

Estimated Totals

Our current estimates[1] for aggregate R&D in annual appropriations are shown in Table 1. In House appropriations, including floor amendments for spending legislation adopted by the full chamber, we estimate $169.4 billion in R&D appropriations, an increase of $11.2 billion or 7.1% above FY 2021 estimated levels. For the Senate Democrats' slate of proposed legislation, we estimate a slightly higher total of $171.1 billion, an increase of $12.9 billion or 8.2% above FY 2021 estimates.

Both the House and Senate R&D estimates are somewhat lower than the White House R&D request. They also suggest R&D appropriations may grow more slowly than overall discretionary spending, which was slated for an 8.6% increase in the White House budget and the FY 2022 budget resolution.

Broken down by type of R&D, appropriations for basic and applied research would each fall short of the White House request, while the Senate Democrats' proposals would provide an additional $2 billion above the request for development activities, primarily within the Department of Defense.

Should final R&D appropriations end up within the range described, it would represent one of the larger increases of the past decade in both dollars and percentage increase, though not unprecedented. Historical R&D budget authority data has indicated similar or larger increases in FY 2016 and FY 2018. Federal R&D also saw larger growth in FY 2020, though much of that increase was driven by emergency COVID-19 R&D.

Under these growth estimates, we would expect federal R&D to reach 0.70% of U.S. gross domestic product (GDP) in FY 2022. This would represent a slight decline from FY 2021 levels due to strong economic growth projected by the Congressional Budget Office,[2] but also a modest improvement from recent pre-COVID levels (see Graph 1 on the next page).

Table 1: Estimated R&D in FY 2022 Appropriations
(budget authority in billions of dollars)

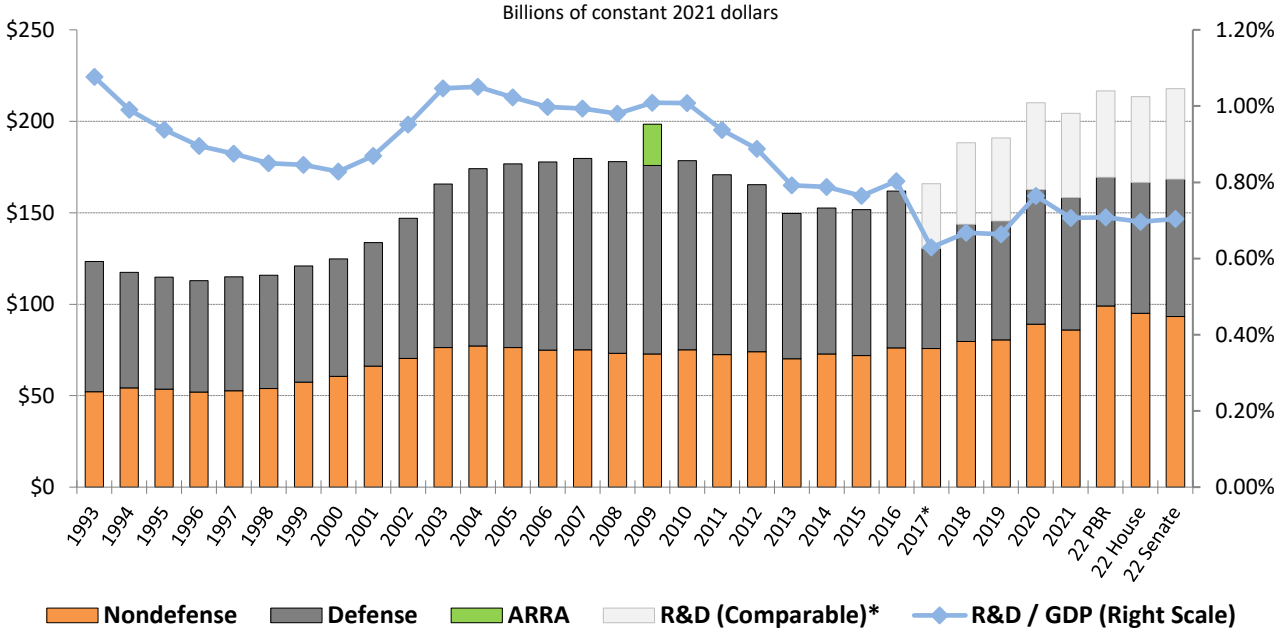
	FY 2021	FY 2022	**FY 2022**	FY21 Change		**FY 2022**	FY21 Change	
	Estimate	Request	**House**	Amount	%	**Senate (D)**	Amount	%
Basic Research	42.5	47.4	45.9	3.4	8.0%	45.8	3.3	7.7%
Applied Research	45.8	52.2	50.8	5.0	10.9%	50.5	4.7	10.2%
Development	65.7	68.1	68.0	2.3	3.5%	70.2	4.5	6.8%
R&D Facilities	4.1	4.6	4.6	0.4	10.6%	4.6	0.5	11.8%
Total R&D	158.2	172.3	169.4	11.2	7.1%	171.1	12.9	8.2%
Defense R&D*	72.2	71.5	72.7	0.4	0.6%	76.3	4.1	5.7%
Nondefense R&D	86.0	100.8	96.7	10.7	12.5%	94.8	8.8	10.2%

*Includes Defense Dept., NNSA, FBI, and DHS CISA.

All figures rounded to the nearest billion. Changes calculated from unrounded figures.

Graph 1: Federal R&D Budget Authority

Billions of constant 2021 dollars



*Beginning in FY 2017 late-stage development, testing, evaluation, and support, mostly in DOD, is no longer counted as R&D. The "comparable" series adds this funding back in for illustrative purposes. Based on OMB, agency, CBO, and appropriations data. House and Senate figures are estimates. | AAAS December 2021

R&D Breakdowns

As seen in Table 1, research (including both basic and applied) would receive larger increases than development in both chambers: a combined $8.4 billion or 9.5% increase for research in the House, and a combined $7.9 billion or 9.0% increase under the Senate Democrats' proposals. For research funding, these figures would represent, roughly, the largest non-emergency increase in inflation-adjusted dollars and as a percentage since the National Institutes of Health (NIH) doubling period.

Relatedly, the nondefense R&D growth estimates seen in Table 1 are also historically large. An increase within the higher end of the House-Senate range would likely yield the largest growth for nondefense R&D since the Space Race, again excluding emergency increases.

Table 2 below displays R&D estimates by agency, while Table 3 displays estimates of R&D by budget function, the definitions of which generally match those used by OMB and the budget committees.

Table 2: Estimated R&D in FY 2022 Appropriations by Agency

(budget authority in billions of dollars)

	FY 2021	FY 2022	**FY 2022**	FY21 Change		**FY 2022**	FY21 Change	
	Est.	Request	**House**	Amount	Percent	**Senate (D)**	Amount	Percent
Defense	64.29	63.80	64.69	0.40	0.6%	68.40	4.11	6.4%
HHS	43.49	51.23	49.12	5.63	12.9%	47.64	4.14	9.5%
Energy	19.29	21.44	20.44	1.15	5.9%	20.43	1.14	5.9%
NASA	13.23	14.57	14.66	1.44	10.9%	14.45	1.23	9.3%
NSF	6.88	8.17	7.77	0.89	12.9%	7.66	0.78	11.3%
USDA	2.96	3.61	3.27	0.31	10.3%	3.18	0.21	7.1%
Commerce	2.12	2.78	2.61	0.49	23.0%	2.61	0.49	23.1%
Interior	1.02	1.34	1.38	0.35	34.5%	1.28	0.26	25.3%
Veterans	1.42	1.50	1.54	0.12	8.1%	1.50	0.08	5.5%
All Others	3.48	3.87	3.88	0.40	11.6%	3.95	0.47	13.6%
Total R&D	158.19	172.32	169.35	11.16	7.1%	171.11	12.91	8.2%

*Includes Defense Dept., NNSA, FBI, and DHS CISA

All figures rounded to the nearest million. Changes calculated from unrounded figures.

Table 3: R&D by Budget Function
(budget authority in billions of dollars)

	FY 2021	FY 2022	**FY 2022**	Change from FY21		**FY 2022 Senate**	Change from FY21	
	Estimate	Request	**House**	Amount	Percent	**(D)**	Amount	Percent
Defense (050)*	72.2	71.5	72.7	0.4	0.6%	76.3	4.1	5.7%
Nondefense	86.0	100.8	96.7	10.7	12.5%	94.8	8.8	10.2%
Space (252)	12.6	13.8	13.9	1.3	10.6%	13.7	1.1	8.9%
Health (550)	43.5	51.2	49.1	5.6	12.9%	47.6	4.1	9.5%
Energy (270)	4.5	6.5	5.4	0.9	19.1%	5.3	0.8	16.6%
General Science (251)	13.8	15.4	14.9	1.1	8.2%	15.0	1.2	8.5%
Environment (300)	2.9	3.8	3.8	0.9	29.9%	3.5	0.6	21.3%
Agriculture (350)	2.7	3.2	2.9	0.2	7.6%	2.8	0.2	5.8%
All Other	6.0	6.7	6.7	0.7	11.5%	6.8	0.8	13.9%
Total R&D	158.2	172.3	169.4	11.2	7.1%	171.1	12.9	8.2%

*Includes DOD, National Nuclear Security Administration, FBI, and DHS CISA.
Numbers in parentheses are the federal government budget function codes.
All figures rounded to the nearest billion. Changes calculated from unrounded figures.

The Senate increase for defense R&D reflects higher defense spending overall proposed by Senate Democrats. The Senate bill would provide full-spectrum increases for R&D investment including a 15% increase for basic science, especially for university research instrumentation, when compared to White House- and House-backed cuts to defense basic science.

In raw dollars, health R&D would receive the largest increases among nondefense functions thanks to bicameral discretionary increases of over $5 billion for NIH. Nearly half of these increases would be for the new Advanced Research Projects Agency-Health (ARPA-H), while the remainder is spread across other NIH institutes in rough accord with request levels.[3]

Energy and environment R&D also emerge as major priorities based on relative increases. On the energy technology front, appropriators in both chambers provided major increases for Department of Energy (DOE) efficiency and renewables R&D (30+%); carbon capture, utilization and storage (40+%); grid modernization and resilience R&D, and the Advanced Research Projects Agency-Energy (ARPA-E). Environmental R&D is boosted by increased appropriations for the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA) research office, and others, including in the realm of climate science (see below).

Spotlight Areas

This section provides highlights in two cross-cutting areas of particular interest to policymakers and the public. These focus on major line items, but are not a complete accounting of all related spending.

STEM Education. Key accounts are shown in Table 4 (following page). The National Science Foundation (NSF)'s Education and Human Resources (EHR) Directorate provides the largest share through its assorted fellowships, training grants and education programs. The values shown in Table 4 are adjusted for comparability to account for the consolidation of the Graduate Research Fellowship Program (GRFP) entirely within EHR in FY 2022. The directorate requested a 16% increase from FY 2021 on a comparable basis with a particular focus on programs to broaden STEM participation, but has seen varied appropriations outcomes.

The Department of Defense (DOD) requested reduced funding for two of its primary STEM education accounts, but these have also faced varying results in appropriations so far. In the context of declining funding, DOD requested a nearly $12 million increase above FY 2021 for the SMART scholarship program.

Table 4: Select STEM Education Appropriations

(budget authority in millions of dollars)

		FY 2021 Estimate	FY 2022 Request	**FY 2022 House**	Change from FY21 Amount	Change from FY21 Percent	**FY 2022 Senate**	Change from FY21 Amount	Change from FY21 Percent
NSF	Education and Human Resources*	1,110.3	1,287.3	1,274.3	164.0	14.8%	1,100.0	-10.3	-0.9%
NASA	STEM Engagement	127.0	147.0	147.0	20.0	15.7%	147.0	20.0	15.7%
DOD	Natl Defense Ed Program	137.2	112.2	116.2	-21.0	-15.3%	147.2	10.0	7.3%
	Minority Institutions	81.3	31.1	85.0	3.7	4.6%	41.1	-40.1	-49.4%
NOAA	Sea Grant	88.0	128.8	99.5	11.6	13.1%	105.0	17.1	19.4%
	Office of Education	33.0	41.1	41.1	8.1	24.5%	38.5	5.5	16.7%
NIFA	STEM Ed Support**	63.0	64.1	73.9	10.9	17.3%	69.0	6.0	9.5%
DOE	Workforce Development for Teachers and Scientists	29.0	35.0	35.0	6.0	20.7%	35.0	6.0	20.7%
DOEd	Minority S&E Improvement	13.4	18	26.3	12.9	96.3%	18.7	5.3	39.6%
	Strengthening HBCU Masters	11	21	21.0	10.0	90.5%	19.8	8.8	79.9%

*Adjusted for comparability to reflect GRFP shift fully into EHR. **Includes the following programs: Education Grants for 1890 Institutions, Scholarships at 1890 Institutions, Education Grants for HIS, Education Grants for Alaska Native and Native Hawaiian-Serving Institutions, Multicultural Scholars, Graduate Fellowship and Institution Challenge Grants, Secondary and 2-year Post-Secondary Education, Women and Minorities in STME fields and Ag in the Classroom. Compiled by AAAS.

STEM education appropriations for both the NASA and DOE Office of Science matched their respective requests. NASA requested a 15.7% increase to the Office of STEM Engagement to expand Space Grant, the Minority University Research and Education Project (MUREP), and K-12 programs. Appropriators matched the NASA STEM office topline, though House appropriations provided a larger increase for Space Grant and smaller for K-12. DOE's Workforce Development for Teachers and Scientists program request included $5 million for a new initiative, Reaching a New Energy Sciences Workforce (RENEW), to pursue outreach and training to underrepresented populations, alongside existing programs for training and experiential learning among students and faculty.

NOAA's increase for its Office of Education focuses on expanding education and outreach in underrepresented and underserved areas. Appropriations provided a smaller expansion of the core Sea Grant program than requested while slightly more than requested for Sea Grant aquaculture research.

Figures for the National Institute of Food and Agriculture (NIFA) include several individual line items. While generally seeing increases, appropriations were diverged for education grants for Hispanic-Serving Institutions and Alaska Native and Native Hawaiian-Serving Institutions, among others.

The Department of Education (DOEd) funds STEM education activities across several offices and programs. Two of note with a specific STEM focus shown in Table 4 are the Minority Science and Engineering Improvement Program (MSEIP) and the Strengthening Historically Black Colleges and Universities (HBCU) Masters Program, the latter of which focuses on engineering and computer science graduate degree programs.

Like the DOEd, NIH also funds substantial STEM education work to foster the biomedical workforce as part of its mission, typically with Congressional backing. Even so, many of these do not receive defined appropriations and thus do not appear in Table 4. Key line items include the Ruth L. Kirschstein Training Grants, with a billion-dollar request in FY 2022, as well as the National Institute of General Medical Sciences' IDeA, MOSAIC, RISE and other early career scholarships. Additionally, the NIH Office of the Chief Officer on Scientific Workforce Diversity, a smaller account, requested more than triple its FY 2021 funding to $22.2 million, which has been matched in appropriations.

Table 5: Select Climate Science Appropriations

(budget authority in millions of dollars)

		FY 2021 Estimate	FY 2022 Request	**FY 2022 House**	Change from FY21 Amount	Change from FY21 Percent	**FY 2022 Senate**	Change from FY21 Amount	Change from FY21 Percent
NASA	Earth Science	2000.0	2250.0	2250.0	250.0	12.5%	2230.0	230.0	11.5%
NOAA	Climate Research*	180.7	293.7	253.0	72.3	40.0%	232.9	52.3	28.9%
	NESDIS**	1513.9	2029.0	1830.2	316.3	20.9%	1636.6	122.8	8.1%
NSF	Climate Research	520.8	762.0	762.0	241.2	46.3%	762.0	241.2	46.3%
USGS	Climate Science Centers and Land Change	60.5	120.8	116.3	55.8	92.3%	108.3	47.8	79.0%
DOE	Earth and Environ Syst Sci	350.4	421.5	405.0	54.6	15.6%	421.5	71.1	20.3%
EPA	Air, Climate and Energy*	95.3	156.2	125.0	29.7	31.2%	114.5	19.2	20.1%
ARPA-Climate		--	500.0	30.0	--	- -	0.0	--	- -

*Request includes funding for ARPA-C. **National Environmental Satellite, Data, and Information Service. Compiled by AAAS.

Climate Science. Table 5 shows appropriations for select programs with a focus on study of the earth's changing climate. To be sure, this is not a comprehensive list, as climate science is interwoven throughout many other programs in the federal science enterprise as a major Biden Administration priority.

NASA's Earth Science program, the largest federal climate science funder, was slated for a 12.5% increase across several programs in the FY 2022 request, and has matched or nearly matched that in appropriations. NSF's request included a 46.3% increase for climate research mostly through the Geosciences and Biological Sciences directorates, and this funding has also been matched.

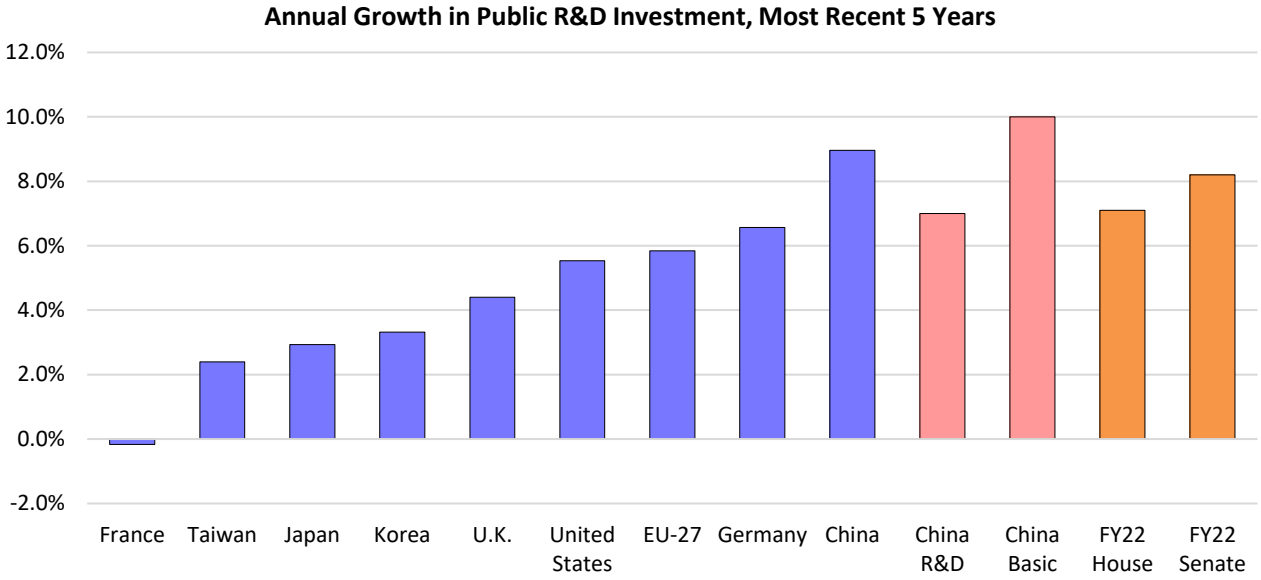
One through-line in climate science appropriations is the apparent lack of interest in a new Advanced Research Projects Agency-Climate (ARPA-C), to advance climate-relevant innovation and adaptation in emerging technology areas. This proposed office would be housed in the Department of Energy but funded via $500 million in appropriations across several agencies, including the Departments of Agriculture, Transportation, Commerce, and others. But virtually none of has been funded apart from $30 million in House appropriations for USGS (note this funding is in a different account than that shown for USGS in Table 5).

This lack of ARPA-C funding accounts for much of the shortfall below the request in climate science appropriations, including some accounts shown in Table 5. For instance, the NOAA climate research request included $40 million in ARPA-C, in addition to increased core program funding for atmospheric observations and modeling, decision tools, climate projections, and other activities. This core funding was matched or nearly matched in both House and Senate appropriations, while ARPA-C was left out. It's a similar story for EPA's Air, Climate, and Energy, which requested an additional $30 million in ARPA-C funding on top of its other core activities to understand emissions impacts. Another agency with ARPA-C funding embedded in its sizable climate science request is the U.S. Department of Agriculture (USDA, not shown in Table 5). Climate science, adaptation and resilience are topics prevalent across the USDA programmatic portfolio, through entities like the Agricultural Research Service and the Forest Service. Each of these requested funding for climate hubs as well as several million more for other climate research.

Within DOE's Earth and Environmental Systems Science program is a requested 7.3% increase for Earth and Environmental Systems Modeling, as well as creation of a new National Virtual Climate Laboratory to serve as a central access point for climate science across DOE labs.

International Comparisons

A major motivator underlying recent Congressional interest in R&D investment is competition with foreign economies to sustain U.S. preeminence in science and technology.



*Annual growth targets through 2026 in most recent 5-year plans, released in 2021.
Based on AAAS analysis of OECD and U.S. federal data.

While China gets the most attention, it is not alone in prioritizing R&D investment as a tool for prosperity and to tackle broader societal challenges like human health and security, or climate change.[4]

Graph 2 benchmarks our House and Senate R&D estimates against recent rates of investment by the nine economies with the largest total R&D expenditures (including the United States, which is #1 in total R&D dollars). This comparison mostly relies on R&D expenditure data provided by OECD.[5]

Average annual growth in public (i.e. government) R&D expenditure from 2014 to 2019, covering the most recent five years preceding the COVID-19 pandemic, is displayed in blue.

As can be seen, the United States has ranked close to the leaders in pre-COVID-19 public R&D growth. Over that time, China achieved 9% average growth in public R&D, Germany achieved 6.6% growth, and the EU achieved 5.8% growth, just ahead of 5.5% growth for the U.S.[6]

For additional context, China has specified five-year annual growth targets for economy-wide R&D and for basic science through 2026, both of which are displayed in red.[7] Under our estimate, both the House and Senate appropriations proposals would nudge U.S. public R&D investment upward (orange), though basic science appropriations (Table 1) are below China's basic science growth target.

[1] AAAS estimates are based on OMB, agency, and appropriations data and language. We update these based on amendments or additional data reporting from the agencies. For the latest, visit www.aaas.org/rd

[2] Based on the July update to the economic outlook, https://www.cbo.gov/publication/57218

[3] For more, see the AAAS appropriations dashboard: https://www.aaas.org/news/fy-2022-rd-appropriations-dashboard

[4] For additional information see https://www.aaas.org/news/snapshot-us-rd-competitiveness-2020-update

[5] *Main S&T Indicators*. (2021, March). OECD. https://www.oecd.org/sti/msti.htm

[6] This reflects adjustments for comparability, to account for recent changes to how the federal government counts R&D. For more, see https://www.aaas.org/news/federal-government-tweaking-what-counts-rd-qa

[7] Normile, D. (2021, March 5). China announces major boost for R&D, but plan lacks ambitious climate. *Science* | AAAS. https://www.sciencemag.org/news/2021/03/china-announces-major-boost-rd-plan-lacks-ambitious-climate-targets