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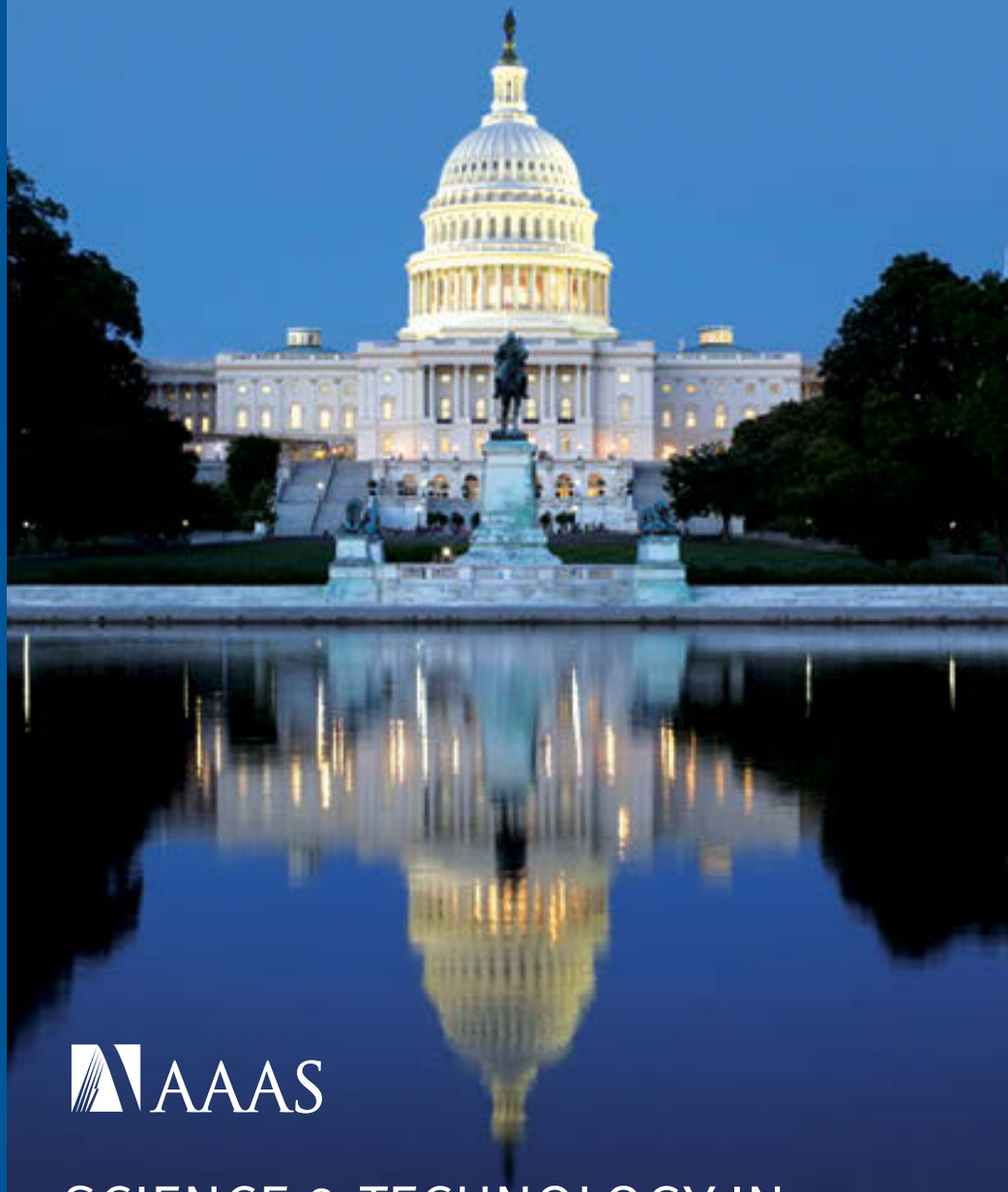

SCIENCE & TECHNOLOGY IN CONGRESS FY 2017

Intersociety Working Group

The AAAS Board of Directors, in accordance with Association policy, has approved publication of this report as a contribution to the understanding of an important process. The interpretations and conclusions are those of the authors and do not purport to represent the views of the Board or the Council of the Association.

Intersociety Working Group

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Preface

Research and development (R&D) continues to be of vital importance to the United States in the 21st century, and the federal role in supporting the national science enterprise remains substantial. The President's annual budget and the Congressional debate around it are the mechanisms through which that role is defined and embellished. This report is intended to foster understanding of those mechanisms among the science and engineering community. Within this volume, readers will find a broad assortment of essays on an array of topics. These include debates over facilities and disciplines at the National Science Foundation; science and exploration priorities for NASA; recent support for biomedical research at the National Institutes of Health; and continuing conflicts over climate and environmental science funding. In addition to these are surveys of policy and funding debates in advanced computing, agriculture, chemistry, and other topics.

The report was assembled by the AAAS Office of Government Relations in collaboration with more than two dozen scientific, engineering, and higher education institutions known collectively as the Intersociety Working Group (see Appendix 2). This volume continues the working group's long-running efforts, now in their fourth decade, to highlight and explain ongoing issues in Washington science funding. In addition, AAAS budget and policy work falls under the auspices of our Committee on Science, Engineering, and Public Policy (Appendix 1). Readers should be aware that the chapters have been prepared largely independently of one another. Although efforts have been made to assure a high-quality product, some overlap and variation among the chapters are, unfortunately, inevitable.

On behalf of the Intersociety Working Group, we would like to express our appreciation to the officers, members, and staffs of the participating organizations for their support and assistance in this report. We are also grateful to individuals in federal offices, on Congressional staffs, and elsewhere who aided us in collecting the information and advised us on its interpretation.

Joanne Padrón Carney
October 2016

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The Political and Policy Context for the FY 2017 R&D Budget

Joanne Padrón Carney
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When the President requested $154.2 billion, an increase of 4.0 percent or $6 billion, in his FY 2017 research and development budget, one might have expected applause from science advocates, even as Congressional opposition declared the budget dead on arrival. But in reality the reception was rather more muted, given the unorthodox funding approach pursued by the Administration.

Last year, the final FY 2016 omnibus bill provided sufficient increases to bring most major research agencies at or near their pre-sequestration spending levels. This increase was due in large part to the additional fiscal room created by the Bipartisan Budget Act of 2015, allowing spending caps to grow $80 billion above the sequestration-level baseline over two years.[1] However, the majority of that increase was loaded on to year one, which meant only flat discretionary spending in FY 2017.

In response, President Obama took an unorthodox approach for federal R&D by proposing that $4 billion of the total $6 billion increase be funded via mandatory spending. The rationale was clear: by relying on mandatory rather than discretionary dollars, the Administration could attempt to increase the R&D budget without running afoul of the discretionary spending caps or sacrificing other parts of the discretionary budget for science and innovation.

Previously, the Obama Administration had tried circumventing budget caps in FY 2015, when it proposed a separate Opportunity, Growth and Security Initiative (OGSI), a discretionary spending package above the spending caps that would have supported a range of federal R&D budget activities, in addition to many other non-R&D programs.[2] Though it relied on discretionary funding instead of mandatory, the OGSI request

1 See https://www.aaas.org/news/two-year-budget-deal-means-room-rd-growth

2 See https://www.aaas.org/news/president%E2%80%99s-opportunity-growth-and-security-initiative-what%E2%80%99s-it

was a similar means to defy the caps as laid out in a separate 2013 budget agreement.

But just as the OGSI proposal was doomed two years ago, this year's mandatory request faced uncertain odds. As the AAAS Guide to the President's Budget: R&D in FY 2017 noted,[3] funding programs via mandatory spending would require new legislation written and approved by an authorizing committee rather than through an appropriations committee.

The odds of that occurring in a divided Congress during an election year were remote at best.

Thus the FY 2017 budget request went from a 4.0 percent increase to a 1.2 percent reality check. The statements from the scientific community upon the release of the President's budget request reflected dismay that his final budget submission to Congress did not live up to his prior commitments to science and technology, and disbelief that the Administration would submit a concept that lacked political viability.

While the President's proposal may have been politically unworkable, it could be argued that its inspiration came from other congressional proposals and legislative trends. For example, in 2014, Senator Richard Durbin (D-IL) proposed creating a mandatory trust fund to support a steady budget for the National Institutes of Health (NIH). And in 2015, the House of Representatives overwhelmingly passed the bipartisan 21st Century Cures Act that includes a mandatory spending account for NIH.

Nonetheless, the research community looked to appropriators to secure federal research agency funding as a priority, as was customary. However, anyone who follows the federal budget process should also have grown accustomed to the annual tradition of Congress attempting to pass individual appropriation bills, only to watch the process grind to a halt in the midst of debates over what constitutes appropriate discretionary spending levels.

That did not deter the House majority leadership from setting a very aggressive goal to pass each appropriations bill before the chamber recessed in July for the conventions. The House Appropriations Committee has for a number of years run a very productive timetable, so it was not surprising that by mid-July the House

3 http://www.aaas.org/sites/default/files/AAAS R%26D Report FY17 web.pdf

Appropriations Committee had passed all twelve of its appropriations. It should be noted, however, that only five of the appropriations bills actually passed the full chamber.

What was truly astounding was that the Senate Appropriations Committee managed to pass eleven of its twelve appropriations bills by mid-July, a much larger number than that chamber typically manages to move. Even more shocking was that both the House and Senate Appropriation Committees had succeeded in favorably passing their respective Labor, Health and Human Services (Labor-HHS) bills, which includes funding for NIH.

Typically, the Labor-HHS bill is one of the more controversial bills for Congress to tackle during austere fiscal times given the large number of domestic discretionary programs that some politicians may view as lower in national priority. In some cases it never sees the light of day until an omnibus bill is presented and passed. This year, the Labor-HHS bill was buoyed by the earlier passage in the full House of the bipartisan 21st Century Cures Act as well as parallel movement of a bundle of complementary bills by Senate HELP Committee. For additional details readers should refer to the NIH Chapter in this volume.

The Labor-HHS bill also demonstrated that Congress could and would ignore the mandatory spending requests included in the President's budget proposal and provide increases to favored agencies and programs — such as NIH — through regular appropriations. At the time of this writing, appropriators had set federal research spending levels approximately $3-4 billion above the Administration's request. However, that increase comes at a price as agencies such as NIH, NASA and parts of the Defense budgets would benefit from congressional largesse while other agencies would remain flat or see decreases.

Despite this relative progress on spending levels, Congress was no nearer to returning to regular order than it had been in prior years. The confluence of a divided Congress and a presidential election season that has broken almost every political prognostication has served only to energize both parties in seeking to raise the tenor of their messages.

The first battle lines were drawn when the House Republican leadership failed to pass a budget resolution when it faced opposition by Freedom Caucus fiscal hawks eager to cut total discretionary spending an additional $30 billion below the caps secured in the 2015 bipartisan budget agreement. The intraparty fighting forced the House to miss the April 15 deadline and House Speaker Paul Ryan (R-WI) left to rebuild unity within his caucus.

A second series of battles arose as both parties turned to the use of "poison-pill" amendments to drive home political differences. The Energy & Water appropriations bill stalled over arguments to include financial aid to Flint, MI, and a separate debate on gay rights stopped any further movement on the funding package.

The Commerce, Justice, Science appropriations bill, which funds NSF, NASA, NIST and NOAA, became mired over a policy rider on gun control. And the Veterans/Transportation bill almost failed due to policy riders on LGBT rights and display of the Confederate flag at Veteran Cemeteries.

Finally, the looming threat of the Zika virus became a political football with both parties arguing over the proper amount and whether or not to include offsets. An initial compromise ultimately failed, and House and Senate Republicans argued that the Administration should continue to utilize existing funds before seeking additional monies. Those arguments were buoyed by HHS updates that revealed only a fraction of the original $589 million of funding approved to be reallocated for Zika had been utilized.

At the same time, the Administration announced that it had tapped all the funding available in hand, and so a renewed effort to seek emergency funding arose when Congress returned in September just as the spread of the Zika virus began to expand across the southern states.

When Congress returned after Labor Day, it had only sixteen days to complete its business before recessing again for the final presidential campaign push. To compound the pressure to complete its business, Senate leadership attempted to pass a compromise bill a week before the September 30 fiscal deadline in order to recess and get back to the campaign trail. This may have reflected more the nervousness of Senators facing tight reelections rather than to show voters that it could work to reach a compromise.

That effort failed as disagreements over Zika, funding for Flint, and assistance to the victims of Louisiana flooding took precedent.

In addition to these debates, Congress also needed to determine how many months the government should be funded under a continuing resolution (CR). Some members of the Freedom Caucus advocated for a six-month CR, gambling to place the final decision into the hands of a new administration to determine the details of an FY 2017 omnibus as well as a new FY 2018 budget request. Others urged passage of a CR to carry the government into early December and allow the lame duck session of the 114th Congress to put the finishing touches on the budget before a new administration and Congress settled into Washington, DC in January 2017.

As is par for the course, with just a couple of days to spare, the U.S. Congress ultimately passed a short-term CR that would fund the government for ten weeks at FY 2016 levels.[4] The legislation (H.R. 5325) included $1.1 billion to respond to the Zika threat, below the Administration's request, and full-year appropriations for the Military Construction and Veterans Affairs spending bill.

While all eyes will now turn fully to the November elections, Congress will soon have to return to finish the work of FY 2017 appropriations. For a full account of the status of federal R&D appropriations as the debate plays out, visit the AAAS R&D Budget and Policy Program website.[5]

[4] https://www.aaas.org/news/congress-approves-short-term-continuing-resolution-cr-zika-and-veterans-funding

[5] http://www.aaas.org/page/research-and-development-funding-fy-2017-appropriations

An Analysis of Defense Science & Technology Funding for FY 2017

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The U.S. Department of Defense's (DOD) fiscal year (FY) 2017 budget request for Defense Science & Technology (S&T) continues to support relatively flat funding. Based on the Future Year Defense Program (DOD's five-year budget plan), we can continue to expect DOD to request essentially flat Defense S&T funding.[i] There are several reasons for this. First, as the Undersecretary for Acquisition, Technology and Logistics indicated in testimony in 2015, DOD believes the $10 - $12 billion range is the appropriate funding level for Defense S&T.[ii] The Undersecretary went on to say that DOD has worked diligently to protect Defense S&T from cuts, particularly basic research, as DOD recognizes it serves as the foundation for all future capabilities.[iii] Second, DOD leaders are concerned that the U.S. military is beginning to lose its technological superiority. Foreign nations such as China and Russia are currently fielding technologies specifically designed to defeat U.S. military technologies. As a result, DOD is increasing funding to advance technologies that can be deployed in about five years to address emerging near-term threats.

One of the initiatives DOD is pursuing to advance deployable technologies quickly is the Third Offset Strategy. An "offset strategy" is intended to develop military technologies and strategies that allow our armed forces to sustain global military dominance. The First Offset arose out of the Cold War, when military leaders believed the Soviet Union had the geographical edge over the United States, particularly in Europe.[iv] In order to overcome this geographical edge, the United States significantly enhanced its nuclear arsenal.[v] The Second Offset began in the 1970s and 1980s, and focused on conventional munitions and technologies that could better utilize recent breakthroughs such as the microprocessor.[vi] Precision-guided weapons, stealth, global positioning system (GPS) and improved reconnaissance, communications, and battle management techniques all stem from the Second Offset Strategy.[vii] The

technologies developed from these offset strategies gave the U.S. military significant technological and tactical advantages over our adversaries for decades, and DOD is now trying to duplicate that success with the Third Offset Strategy.

While much of the Third Offset Strategy is classified, DOD has released five common technological areas on which the strategy will focus: Deep-Learning Systems; Human-Machine Collaboration; Human-Machine Combat Teaming; Assisted Human Operations; and Network-Enabled, Cyber-Hardened Weapons.[viii] According to testimony given by the Assistant Secretary of Defense for Research and Engineering, the FY 2017 budget request includes $3.6 billion to "help spur research, development, test and evaluation, and procurement of advanced capabilities our military will need to deter and if necessary fight and win high-end conflicts in the future."[ix] Ultimately, as long as the Third Offset remains a priority for DOD, we are unlikely to see increases for Defense S&T in future budget requests.

With DOD focused on dedicating resources more towards development and testing of military technologies, it puts Congress in a difficult position when appropriating funding for Defense S&T. On one hand, Congress could reject DOD's efforts to address near-term concerns by not funding the efforts, but some would argue that could put our national security in jeopardy. On the other hand, Congress could cut funding from other areas of DOD's budget and use those funds to support Defense S&T. Unfortunately, the DOD's budget has already been dramatically cut thanks to the Budget Control Act. According to DOD, the Department has endured approximately $800 billion in cuts below its projections in FY 2012.[x] Additionally, the Research, Development, Test and Evaluation (RDT&E) account has been cut by more than $10 billion since FY 2010.[xi] Simply put, there are very few areas of the DOD budget for Congress to cut to steadily increase Defense S&T funding.

However, in spite of these fiscal challenges, Congress in fact has found ways to increase Defense S&T funding the past few years. For FY 2017, both the House and Senate Defense Appropriations subcommittees have increased funding for the 6.2

funding account (applied research, referred to as "6.2" in the DOD nomenclature) and the 6.3 account (advanced technology development) in their respective bills. The Senate Defense subcommittee has been particularly strong for its support of the 6.1 account (basic research). One of the reasons the subcommittee has been so supportive of Defense basic research is because of Senator Dick Durbin (D-IL).

The Senator has introduced several pieces of legislation designed to increase investments in research and development in order to enhance U.S. competitiveness globally.[xii] Specifically, Senator Durbin's American Innovation Act ties defense S&T funding to inflation plus five percent.[xiii] With the support of Senate Appropriations Committee Chairman Senator Thad Cochran (R-MS) each appropriations cycle, Senator Durbin attempts to include that level of increase for Defense S&T, with basic research benefiting from this effort.

	President's Budget		Senate Appropriations Committee	
	Dollars in Millions	Change from Prior Year	Dollars in Millions	Change from Prior Year
FY 2016	$2,089	-8.3%	$2,317	1.7%
FY 2017	$2,102	-8.0%	$2,265	-1.9%

Source: DOD budgets and appropriations materials.

The basic research accounts have an added advantage with Senator Durbin's approach of trying to increase defense S&T by five percent plus inflation. The majority of the basic research accounts fund competitive opportunities, while the 6.2 and 6.3 accounts tend to fund specific research projects, and adding additional money to these may not complete the project any quicker. On the other hand, increasing the number of competitive basic research opportunities simply results in additional scientists receiving grants, and would not impact a project's deadline.

Going forward, we can anticipate that the Senate Appropriations Committee will continue to support Defense S&T funding as a result of Senator Durbin's efforts as long as Senator Cochran remains supportive. However, given the position of senior DOD leadership and constraints of the Budget Control Act, we are unlikely to see defense S&T funding to receive steady increases.

i http://docs.house.gov/meetings/AS/AS26/20160224/104518/HHRG-114-AS26-Wstate-WelbyS-20160224.pdf

ii https://www.gpo.gov/fdsys/pkg/CHRG-114shrg59104645/pdf/CHRG-114shrg59104645.pdf

iii Ibid

iv http://www.dodlive.mil/index.php/2016/03/3rd-offset-strategy-101-what-it-is-what-the-tech-focuses-are/

v Ibid

vi Ibid

vii http://thediplomat.com/2014/11/a-tale-of-two-offset-strategies/; see also

viii http://www.aaas.org/news/driving-legacy-sector-innovation-qa http://www.dodlive.mil/index.php/2016/03/3rd-offset-strategy-101-what-it-is-what-the-tech-focuses-are/

ix http://www.armed-services.senate.gov/imo/media/doc/Welby_04-12-16.pdf

x http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2017/FY2017_Budget_Request.pdf

xi http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2012/FY12_Green_Book.pdf

xii https://www.gpo.gov/fdsys/pkg/CHRG-114shrg59104645/pdf/CHRG-114shrg59104645.pdf

xiii Ibid

Funding Debates and Outlook for the National Science Foundation in FY 2017

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Throughout his presidency, President Obama has been an ardent supporter of the federal government's investment in R&D. While the aspirational nature of the FY 2017 Presidential Budget Request was not a surprise, the decision to request discretionary and mandatory spending to support new investments in domestic areas was to many in Congress and the scientific community.

To many legislators, the Administration's FY 2017 budget runs contrary to the 2015 Bipartisan Budget Act, a measure that was enacted to provide some relief from sequestration for fiscal years 2016 and 2017 (see the overview chapter on the political and policy context elsewhere in this volume). Thus, Congress showed little appetite for Obama's mandatory spending proposals.

The Administration's FY 2017 NSF Budget Proposal

For FY 2017, the Administration requested nearly $8 billion in funding for the National Science Foundation (NSF). This includes $7.6 billion in discretionary spending and $400 million in new mandatory spending to support young scientists and engineers in the early stages of their careers. Given the negative response from Congress to using mandatory funding to support research budgets and the fact that appropriations committees can only allocate discretionary (not mandatory) spending to federal agencies, many in the science and broader stakeholder communities also dismissed the additional $400 million in mandatory spending proposed by the Administration for NSF. When compared with the FY 2016 enacted level ($7.5 billion) of funding for the agency, the proposed FY 2017 discretionary level ($7.6 billion) would be only a 1.3 percent increase. Throughout the FY 2017 appropriations process, many stakeholders advocated for at least $8 billion for NSF.

The FY 2017 Appropriations Process

Both the House and Senate Appropriations Committees passed their respective versions of the Commerce, Justice, Science and Related Agencies (CJS) bills (H.R.5393 and S.2837) early in the appropriations process.[1] The Senate committee-passed bill appropriated $7.5 billion for NSF, a modest $46 million increase above the FY 2016 enacted level. One aspect of the Senate bill that has received attention from the science community is the $159 million appropriation for the design and construction of three new regional class research vessels (RCRVs). Though there has been some debate in the scientific community about the number of new vessels needed, the committee appropriated funding for three vessels for the Pacific, Atlantic, and Gulf Coasts.

The House Appropriations Committee approved $7.4 billion for NSF, $57 million below the FY 2016 enacted level and $11 million below the Senate committee-passed bill. This dramatic drop in funding is due to the significant cut received by the Major Research Equipment and Facilities Construction (MREFC) account. Unlike the Senate bill, the House bill does not appropriate any funding for RCRVs. Both bills do, however, appropriate funds for the Large Synoptic Survey Telescope and the Daniel K. Inouye Solar Telescope.

Both committee reports underscore the importance of NSF's peer review process and encourage NSF to "include criteria that evaluates how a proposal will advance our Nation's national security and economic interests, as well as promote the progress of science and innovation in the United States." This language is consistent with the House-passed "Scientific Research in the National Interest Act" (H.R.3293), introduced by Rep. Lamar Smith (R-TX), Chairman of the House Science, Space and Technology Committee. This legislation has sparked concerns within the scientific community. Despite these concerns and a strong statement by the White House saying the legislation was unnecessary, the bill has garnered growing bipartisan support. In response to this mounting congressional pressure, NSF is implementing new measures to ensure transparency and accountability by requiring that information included in every NSF award abstract articulates how an NSF-funded project serves the national interest.

[1] http://appropriations.house.gov/uploadedfiles/hrpt-114-hr-fy2017-cjs.pdf; https://www.congress.gov/114/crpt/srpt66/CRPT-114srpt66.pdf

Status: At press time, H.R. 5393 has not come to the House floor. While S. 2837 was on the Senate floor for more than a week, the tragic shootings in Orlando quickly became the primary focus. In September, House and Senate leaders agreed on a short-term continuing resolution to fund the government through December 9.

House and Senate NSF Authorization Bills

Since the passage of the America COMPETES legislation in 2007, the approach taken by both congressional chambers has been to reauthorize NSF programs and funding levels as a part of a broader legislative package that provides the legal authority for other research agencies such as NIST and the DOE Office of Science.

Prior to 2007, NSF was usually reauthorized in a separate bill for which the jurisdiction in the House lies entirely within the House Science, Space and Technology Subcommittee. In the Senate, however, under a March 1988 unanimous consent agreement, measures authorizing the NSF must first be referred to the Senate HELP Committee with reported versions of the bill sequentially referred to the Senate Commerce, Science, and Transportation Committee. As NSF reauthorization has been combined with that for other research agencies, however, the Senate HELP committee has chosen not to exercise its primary jurisdiction, choosing instead to defer to the Senate Commerce, Science and Transportation Committee to craft more comprehensive legislative packages authorizing NSF and its programs.

In keeping with this trend, the Senate Commerce, Science, and Transportation Committee recently approved the "American Innovation and Competitiveness Act" (S. 3084), a bill that authorizes $7.5 billion (FY 2017) and $7.8 billion (FY 2018) for NSF, as well as programs at NIST and the White House Office of Science and Technology Policy. For the last year, Senators Cory Gardner (R-CO) and Gary Peters (D-MI) have led an inclusive and transparent process in which they welcomed substantive ideas and comments from the scientific community in the drafting of this bill. The bill includes several positive provisions, including a reaffirmation of the merit-review process, support for midscale projects, and increased support for STEM education for women and minorities through the establishment of Centers for Excellence for Inclusion in STEM. The bill also seeks to improve the transfer of ideas from the laboratory to the marketplace by supporting NSF's existing I-Corps program along with new early stage proof-of-concept funding.

In May 2015, the House passed its version of the America COMPETES Reauthorization Act (H.R. 1806) by a vote of 217-205; unlike the COMPETES bills of 2007 and 2010, the bill was met with significant opposition from the research and university community.[2] As a result, the vote was particularly close, with 23 Republicans voting against the bill. This two-year bill authorizes funding for the Department of Energy's Office of Science, ARPA-E, NIST, and NSF. The bill funds NSF at $7.5 billion for FY 2016 and FY 2017. Much to the chagrin of the scientific community, the bill also includes directorate-level funding that significantly cuts funding for the Social, Behavioral, and Economic Sciences Directorate by $150 million and also reduces funding for the Geosciences Directorate and climate science. The legislation includes other troubling provisions including those addressing reproducibility and replication of research results and stronger scientific misconduct sanctions. On a positive note, the House bill does take steps to streamline, harmonize and eliminate unnecessary and duplicative federal regulatory requirements and agency policies currently imposed on scientific researchers. Similar provisions calling for regulatory reforms are also included in the Senate bill.

The House also passed the NSF Major Research Facility Reform Act of 2016 (H.R. 5049), a bill that directs NSF to make a series of reforms to the management of its large facilities. The bill comes as a result of congressional concerns about the management of the National Ecological Observatory Network (NEON). Over the last few years, the House Science, Space and Technology Committee has held several hearings on NEON and representatives from both Democrats and Republicans have expressed serious concerns about the $80 million cost overrun for the project and the fact that the project is 18 months behind schedule. The Senate has not acted on H.R. 5049.

Status: Senators John Thune (R-SD), Gardner, and Peters have expressed an interest in moving S. 3084 via unanimous consent before the end of the year. Given the limited number of legislative days left in the session and the significant differences that exist between the House and Senate bills, it will be challenging to develop a compromise bill that can be approved by both chambers before the 114th Congress adjourns.

[2] https://www.congress.gov/bill/114th-congress/house-bill/1806/text

NIH's Big Year

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After more than a decade of stagnant funding, the National Institutes of Health snagged a $2 billion budget boost this fiscal year, placing NIH firmly in the winner's circle for FY 2016. Like all U.S. research agencies, NIH must operate within the context of dwindling discretionary dollars, but the agency continues to enjoy bipartisan support in Congress.

Background

NIH is the world's largest biomedical research agency, housed in Bethesda, MD. It is divided into 27 Institutes and Centers, many of which focus broadly on particular conditions (e.g., the National Cancer Institute), body parts (National Heart, Lung, and Blood Institute), or fields of science (National Center for Advancing Translational Sciences).

Compared to many other federal research agencies, NIH is a juggernaut, reaching a funding level of $32.3 billion in FY 2016. To put its size in perspective, its R&D spending is more than 20 times that of the other medical research agencies (such as CDC, FDA and AHRQ) combined. There are good reasons for this: the work of NIH is inspiring, lifesaving, and relatable. But a large budget can be difficult to sustain, as even a 1 percent increase involves a significant pot of funds.

This proved to be true in recent years. NIH was the recipient of serious congressional largesse in the late 1990s and into the next decade: from 1998 to 2003, its budget doubled in size. But afterward the NIH budget stagnated in real dollars. In 12 years it lost 22 percent of purchasing power, as many federal agencies struggled in an increasingly tight budget climate. Now, in FY 2016, NIH is again enjoying a show of significant bipartisan support with a funding boost of 6.6 percent over FY 2015.

21st Century Cures

One of the major narratives of the 114th Congress — one that may have helped put NIH funding front and center in the minds of members — was the 21st Century Cures Act. In April of 2014, House Energy

and Commerce Chairman Fred Upton, a Republican from Michigan, and his fellow committee member Diana DeGette, a Democrat from Colorado, announced an initiative that seemed relatively bold in a Congress known for gridlock: a bipartisan effort to advance the discovery, development, and delivery of cures to patients. (Health policy is a primary issue for the Energy and Commerce Committee, despite its name.) After a series of hearings and roundtable discussions featuring a variety of biomedical stakeholders, they released the resulting 21st Century Cures Act.

The Cures Act proposed some significant changes in areas such as clinical trials and drug development, but what really seemed to galvanize biomedical research advocates was its push to boost funding for NIH (as well as the FDA). The bill authorized annual 1.5 billion increases for NIH over three years, but more interestingly proposed a mandatory funding stream of $8.75 billion over five years. This was an exciting development for the biomedical research community — and apparently for the House as well, because it passed the bill by a significant bipartisan margin.

The action then moved to the Senate, where the legislation has faced a rockier path. The Health, Education, Labor and Pensions Committee took a piecemeal approach, passing several bills out of committee relating to biomedical innovation, but funding for NIH remained a central sticking point. At press time, with few working days left in the 114th, health research advocates are pushing hard for Congress to move the bill to the finish line.

Cross-Cutting Initiatives

Also generating excitement are a number of cross-cutting federal initiatives in which NIH plays a leading role. First is the Precision Medicine Initiative, announced by President Obama in his 2015 State of the Union address. At the core of the PMI is an ambitious plan to recruit a million or more volunteers to participate in a landmark longitudinal research study. The hope is to engage research participants, utilizing modern technology like smart phones and electronic health records, and unlock new discoveries in human health. The National Cancer Institute at NIH is also a significant player in the PMI.

Continuing in its third year is the BRAIN Initiative, involving five federal agencies in an effort to better understand the mysteries of the human brain. As the public health burden of conditions like Alzheimer's

disease continues to grow, Congress remains committed to funding this initiative. Even more agencies have banded together to tackle the public health threat of antibiotic resistance, focused on surveillance, prevention and control, research and product development. And in May, the White House announced a project involving research on the microbiome, representing the collection of microbes that live in, on or around humans and their environments.

Perhaps the most high-profile trans-agency health research initiative to launch in 2016 is the National Cancer Moonshot, spearheaded by Vice President Joe Biden. NIH is on tap to play a major role in this latest federal effort to eliminate cancer. Heartbreakingly, 45 years after the Nixon White House declared its War on Cancer, there is still much progress to be made. However, future funding of this initiative remains unclear, as appropriators have yet to provide the requested $680 million sum during FY 2017 appropriations proceedings.

Year in Review

Beyond the cross-cutting initiatives, NIH continues to prioritize areas that have been central to Director Francis Collins' tenure as agency chief. These include harnessing big data, maximizing the potential of the biomedical workforce, fostering diversity, partnering with federal agencies and the private sector, and smoothing the path of discoveries from bench to bedside.

The past year has seen some interesting policy developments. Perhaps the most game-changing proposal from the Department of Health and Human Services involved updating the rules that govern federally funded clinical trials. The "Common Rule," as the policy on human subjects research is called, has been in place since 1991, but evolving technologies, such as genomic sequencing, have prompted the government to reexamine it. The HHS proposal would make significant changes to the way scientists conduct research involving people and has generated much discussion, as well as its share of controversy; in June, a National Academies report aimed at reducing red tape in research recommended the government put the brakes on the proposal.

NIH has also grappled with problems at its Clinical Center. Last year the discovery of fungal contamination in compounds slated for patient use prompted an investigation that found "substantial operations issues" involving patient safety, regulatory compliance and leadership. Collins

took prompt action following the initial discovery and oversaw a series of changes to address the report's findings.

In late 2015, NIH came out with its first agency-wide strategic plan in two decades following a congressional mandate. As one of its recommendations, NIH announced it would move away from setting aside 10 percent of its budget to HIV/AIDS research — a 20-year-old practice — and shift focus to vaccines and therapies.

NIH generated headlines in late 2014 by fulfilling one of its basic missions, helping patients–in this case, patients caught up in the West African Ebola epidemic. Researchers continue to work on Ebola as well as the growing threat of Zika virus. Other hot topics in biomedical science include gene editing utilizing a tool known as CRISPR, as well as chimeras (early-stage animal embryos into which scientists introduce human stem cells). NIH recently proposed to proceed with certain chimera experiments using a special review process.

The Future

NIH funding is again looking promising for FY 2017, should appropriations move through the process to a final omnibus. (All bets are off if Congress decides to pass a long-term continuing resolution to keep funding levels as they are now.) This year, the President's budget request featured two amounts for some federal research agencies, a base budget and a mandatory funding add-on. The base budget represented a billion-dollar cut for NIH, while the mandatory funding stream took the agency up to $33.1 billion. Buoyed by champions on both sides of the aisle, Congress opted to best even the larger number: the House bill allocates $33.6 billion for NIH and the Senate bill allocates $34.3 billion. Both bills have passed committee. The Senate mark, should it go through, would be a second $2 billion boost in a row.

After years of stagnant funding, the bipartisan support for NIH has translated into a budget win for FY 2016. With luck it will continue a steady and sustained upward funding trajectory in the coming years — patients, after all, are counting on it.

Department of Energy

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INTRODUCTION

President Obama's fiscal year 2017 Department of Energy budget request reflected little change in the policy focus of the last eight years: heavier on energy technologies, applied research and national security, and lighter on basic research and discovery. However, the budget did contain two new wrinkles.

One of them, a proposal to use "mandatory spending" to augment funding of several department activities, smacked of gimmickry. And it is no surprise that Congress treated it just that way, ignoring it totally in developing spending plans for the coming fiscal year. The other, known as "Mission Innovation," seemed to have the potential for garnering some bipartisan support. But Republican enthusiasm quickly evaporated, and the Administration's commitment to doubling energy research over the next five years, as part of the 2015 Paris climate change accord, seems inexorably headed for budgetary oblivion.

Although the White House adhered to the budget agreement it struck with congressional leaders last fall and offset its proposed increases for DOE research and development with reductions in non-DOE accounts, appropriators ignored the requested reallocations and proceeded with legislation that would cap the department's spending at a level below an inflationary increase.

Although the United States is rapidly falling behind Europe and Asia in scientific infrastructure and world-class 21st-century research facilities, Congress is showing little appetite for addressing the challenges this year. As a result, by 2020, with some few exceptions, scientists from industry and academia will have to venture abroad to carry out cutting edge research. It seems inevitable that

America's global innovation ranking will remain mired in mediocrity for several years to come.

MISSION INNOVATION

On November 15, 2015, the leaders of 20 nations plus the European Commission acting on behalf of all members of the European Union committed to doubling government investment in clean energy. Unlike previous climate change accords, the 2015 Paris agreement did not focus directly on carbon emissions, but rather on mechanisms that would spur the development of transformational energy technologies. The signatories hoped that the altered emphasis would elicit broad support for an economically beneficial way of tackling climate change. At the suggestion of India, they named the accord "Mission Innovation."

The timing of the accord was propitious: it allowed the Obama Administration to begin addressing the energy research goal in fiscal year 2017. At the insistence of Energy Secretary Ernest Moniz, all DOE research programs were incorporated under the Mission Innovation umbrella, even if they did not directly target the development of clean energy. As a result, the entire Office of Science, including the 10 national laboratories it supports, found a home in the Paris initiative. That allowed the White House to request increases well above the inflation rate for the department's basic research programs.

Although many Republican leaders have been consistently hostile to policies that would limit carbon emissions in order to address climate change, Secretary Moniz held out hope that an emphasis on energy research would get a better reception, even from climate change critics. And reactions from many Republican House and Senate members suggest he was correct.

Senate Report 114-236 accompanying the Energy and Water Appropriations Bill (S. 2804) explicitly notes, "The Committee supports the premise and goals set out by Mission Innovation: to support innovative clean energy research and development to accelerate access to affordable, deployable, and transformative technologies. The Committee also supports the goal to double Federal clean energy investment over the next 5 years. The recommendations in this bill take the first step in this effort, while working within the constraints on discretionary funding." But as the next section of the DOE budget analysis details, the Senate committee's support came at a significant

price, at least insofar as Fusion Energy Sciences is concerned.

Mission Innovation also engendered enthusiasm from the more conservative Republican House, with Report 114-532 accompanying the House appropriations bill (H.R. 5055) stating, "To finally free ourselves from our energy dependence, as well as to drastically cut our dangerous carbon emissions, we must continue to strongly fund DOE's efforts." But the report continues, "Unfortunately, constraints on the allocation did not allow additional funding for Mission Innovation — an effort to double clean energy research and development by 2021."

The Mission Innovation imperative seems to have resonated on Capitol Hill, but this year apparently not enough to translate into research dollars of any significance.

OFFICE OF SCIENCE

Unsurprisingly, neither the House nor the Senate Energy and Water Appropriations Bills match the Administration's topline number ($5.572 billion) for DOE's Office of Science. While both provide $5.4 billion (+0.9 percent) for Office of Science, the distribution of funds varies dramatically between the two chambers. It is a direct result of differing views of the U.S. commitment to ITER, an international nuclear fusion research megaproject. ITER has been plagued by escalating project costs and construction timeline delays, making it a contentious budgetary line item and putting future U.S. participation in doubt.

The House remained supportive of ITER in its FY17 appropriation bill, which matched the President's request of $125 million. With the vast majority of ITER's budget slated to fund the manufacturing of specialty equipment and instrumentation by U.S. companies located in congressional districts, some Representatives have a vested interested in seeing the project continue. But committing to ITER — and the spending constraints stemming from the FY16-17 budget deal — resulted in the other Office of Science programs' receiving cuts, flat funding or modest increases, some of which do not even keep pace with inflation.

The Senate Energy and Water Appropriations Subcommittee viewed ITER differently. Led by Chairman Lamar Alexander (TN) and Ranking Member Dianne Feinstein (CA), the Subcommittee, as it has in the past three years, once again zeroed out funding for ITER in FY17. Report

language accompanying the bill relays the Subcommittee's concern that ITER is starting to consume other programs' budgets. The report states, "Funding for the contribution to ITER continues to crowd out other Federal science investments, including domestic fusion research, as well as high-performance computing and materials science…"

The Senate bill redistributed the $125 million stripped from ITER to other Office of Science programs, resulting in stronger increases than provided by the House for all programs except Fusion Energy Sciences. The Senate provided a 5.7 percent increase for the Advanced Scientific Computing Research program, which is led by Oak Ridge National Laboratory (ORNL) in Mr. Alexander's home state.

A disagreement between the House and Senate concerning ITER's funding is nothing new, and in previous years the Senate has relaxed its position and agreed to continue to fund the project. With Secretary Moniz's recommending the U.S. remain committed to ITER through FY18 — and reevaluating its participation prior to FY19, affording new Director-General Bernard Bigot sufficient time to demonstrate the project can adhere to its new timeline — ITER's funding is likely to survive yet another budget cycle.

But if $125 million is allocated to ITER, the distribution of funding for the Office of Science is likely to more closely resemble the House Energy and Water Appropriations Bill than the Senate's version. The result would be a lack of support necessary to keep the U.S. competitive on the global stage of large scientific facilities. Plans to upgrade the Advanced Light Source at Lawrence Berkley Laboratory, for example, would continue to be put on hold, as would any plan to add a second target station at the Spallation Neutron Source.

APPLIED ENERGY RESEARCH

Addressing climate change is a central tenet of the Obama Administration, and it is showcased again with this year's budget request. The Administration continues to emphasize applied research and the development of clean energy technologies over discovery science. The President's proposed budget increase (+39.8 percent) for the Office of Energy Efficiency and Renewable Energy (EERE) — which includes R&D for solar and wind energy, as well as

vehicle and bioenergy technologies — dwarfs the increases provided for Office of Science. But taking action on climate change is not a priority for the vast majority of House and Senate Republicans, and they have long stated that applied research is best left to industry. House Republican Appropriators on the Energy and Water Subcommittee voiced this opinion by offering steep budget reductions for several EERE programs, including Solar Energy, Water Power, Building Technologies and Advanced Manufacturing. With their Senate counterparts' bill providing flat funding for EERE, the best option for EERE's proponents might be a continuing resolution.

The high-risk, high-reward premise of the Advanced Research Projects Agency-Energy, of ARPA-E, appears to have support on both sides of the aisle. While neither the House nor the Senate matched the Administration's ambitious request for the agency, both bodies displayed strong support for the program. Recognized as research areas that are "too risky to attract sufficient private sector investment" in the House Energy and Water bill's report language, the House Subcommittee provided a 5.1 percent increase for FY17. And thanks to a successful floor amendment by Senator Schatz (D-HI), the Senate version passed with an 11.7 percent increase.

NATIONAL NUCLEAR SECURITY ADMINISTRATION

Spending on atomic weapons activities, including Defense Environmental Cleanup, remains the largest single element in the DOE budget, engendering general support from both sides of the aisle. Some of the strongest Republican proponents of NNSA nonetheless argue that the funding levels continue to fall short of the promise President Obama made to former Sen. Jon Kyl (R-Ariz.) in 2010 when he committed the Administration to an $85 billion boost in NNSA spending over a decade in return for crucial GOP votes on ratification of the New START Treaty with Russia. But critics have not suggested where any additional sources of funding might be found.

Apart from budget matters, policymakers express concern about the nuclear workforce, which has seen a spate of retirements in recent years. To address the concern, the Senate specifically directs the Secretary of Energy "to carry out the requirements of 42 U.S.C. 16274a in support of university research and development in areas relevant to the NNSA's mission. Within available funds, the Committee recommends not less than $5,000,000 for the Integrated University Program to cultivate the

next generation of leaders in nonproliferation, nuclear security, and international security.

Finally, members of Congress who have nuclear waste sites within their jurisdictions continue to press DOE for added attention to remediation. The twin Cold War legacies of nuclear waste and proliferation will likely occupy the department for years to come, in the process, draining resources from civilian energy science and technology programs.

National Aeronautics and Space Administration

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In his final annual budget submitted to Congress earlier this year, President Obama took an unusual approach to funding many federal agencies, including the National Aeronautics and Space Administration (NASA). The Fiscal Year (FY) 2017 request includes both discretionary ($18.262 billion) and mandatory ($663 million) funding for a combined total of $19.025 billion for the space agency, $260 million less than the $19.285 billion appropriated in the Consolidated Appropriations Act of FY 2016. The Administration used this tactic as a way to provide $4 billion in research and development funding without violating the discretionary budget caps that the President and Congress agreed to in December 2015. NASA would receive an additional $100 million from the 21st Century Clean Transportation System — paid for by a proposed fee on oil. Absent the $763 million in mandatory funding, however, this year's request is approximately $1 billion less than the FY2016 funding level.

At the time of publication, both the House and Senate Appropriations Committees had passed their versions of the FY2017 Commerce, Justice, Science, and Related Agencies (CJS) Appropriations Act—the annual spending package that funds NASA. Appropriators in both chambers have proposed over $1 billion more than the President's discretionary request for NASA. The committee reports accompanying both bills describe Congress's displeasure with the Administration's mandatory funding proposal, and corresponding cut to the agency's discretionary funding by 5.3 percent compared to FY 2016 appropriations. It is important to note that appropriations committees do not have jurisdiction over mandatory spending. Funding tactics aside, conflicts over NASA's spending levels and priorities have continued this fiscal year between the majority and minority parties in Congress as well as between the two branches of government.

There is significant disagreement in Congress particularly on funding allocations within NASA's Science Mission Directorate. The Earth

Science Division has been a particular target for congressional Republicans over the last few years. They contend that NASA should focus on continuing to understand and explore the universe, not Earth, and that adequate funds are already being allocated toward Earth sciences via other federal agencies. Supporters of the division at NASA and in Congress reference the 1958 National Aeronautics and Space Act, which lists "expansion of human knowledge of phenomena in the atmosphere and space" first among the agency's objectives. The Ranking Member of the Senate Appropriations Committee, Sen. Barbara Mikulski (D-MD) has Goddard Space Flight Center — home to much Earth Science research — in her state and has regularly used her leadership position to defend Earth Science from cuts.

The dispute among policymakers over Earth Science is apparent in the proposed FY 2017 budgets from the Administration, which requested $2.032 billion (including new mandatory funding); the House, which included $1.69 billion in its bill (a 12 percent cut comparted to FY 2016); and the Senate, which included an increase over FY 2016 to $1.98 billion. In recent years, the NASA Administrator has criticized the cuts to Earth sciences, explaining that a considerable reduction in funding would "threaten to set back generations-worth of progress in better understanding our changing climate, and our ability to prepare for and respond to earthquakes, droughts, and storm events." Shaun Donovan, Director of the Office of Management and Budget, has publically echoed similar concerns.

Conversely, the Planetary Science Division typically receives bipartisan support in Congress, but garners less support from the Administration. Congressional appropriators have repeatedly rejected proposed cuts to the program from the Administration, including in FY 2017. A particular program within planetary sciences—the robotic exploration of Jupiter's moon Europa — has the backing of Congressman John Culberson (R-TX), the Chairman of the House Commerce, Justice, and Science Appropriations Subcommittee. For the past few years, including before he became the Chairman, Culberson has used his position to add substantial funding to NASA's budget specifically allocated for a Europa mission. FY 2017 is no different with Rep. Culberson's panel increasing planetary science funding to $1.82 billion and calling for "a Europa Orbiter launch no later than 2022 and a Europa Lander launch no later than 2024" in the committee report. The Planetary Science Division lacks a similar champion

in the upper chamber, where the CJS Subcommittee bill funds the division at just $1.36 billion, a 16.9 percent cut.

Unlike Planetary Science, NASA's proposed Asteroid Redirect Mission (ARM) has been met with significant opposition in Congress. The controversial Administration-supported program calls for a robotic probe to retrieve a boulder-sized sample from an asteroid and then deliver to an orbit around the moon where astronauts would then go and study the asteroid. House appropriators propose cutting all ARM funding and state in their committee report "that neither a robotic nor a crewed mission to an asteroid appreciably contribute to the over-arching mission to Mars." Instead, the report calls for a return to the moon to test the capabilities that will be needed for Mars. Advocates of the ARM program claim its cancellation will mean that there will be no human space exploration earlier than 2030. Despite funding uncertainties, NASA is continuing to make progress on mission development.

Another bipartisan congressional priority is the development of the Space Launch System (SLS) and the Orion Multi-Purpose Crew Vehicle, which will launch astronauts beyond low Earth orbit. To the chagrin of lawmakers on Capitol Hill the President's FY 2017 request for SLS is $1.31 billion, $700 million less than the $2 billion appropriated in FY2016, and $1.12 billion for Orion. NASA officials, including NASA Associate Administrator for the Human Exploration and Operations Directorate Bill Gerstenmaier, have assured Congress that the request has adequate funding to meet NASA's commitment to hold the first SLS launch in 2018 and the second in 2023. With the additional program funds allocated by Congress last fiscal year NASA has said it may move up the date of the second launch to 2021.

Strong congressional support of SLS stems from the fact that many prominent lawmakers have constituents contributing to the development of the rocket. Senator Richard Shelby (R-AL), the powerful chairman of the Senate Appropriations Commerce, Justice, and Science Subcommittee, is the principal advocate for SLS, which is predominately being designed and built at the NASA Marshall Space Flight Center located in his home state. Appropriators in both chambers have once again provided significant increases for SLS (House: $2 billion, Senate: $2.15 billion) and moderate increases for Orion (House: $1.31 billion, Senate: $1.3 billion). Of relevance is language in the Senate committee report directing Orion to be ready for its first crewed mission in 2021. The White House has issued a veto threat against the Senate bill, in part

citing the money allocated for SLS and Orion in excess of the President's request and underfunding of other priorities.

One major priority for the Administration has been the Commercial Crew program — a public-private partnership intended to stimulate development of privately operated crew vehicles — that will ferry astronauts from U.S. soil to the International Space Station (ISS). Congress has been skeptical of this program, citing potential cost overruns that would be borne by taxpayers. Commercial Crew and SLS/Orion have historically competed for funds within the Exploration Account, but in FY 2016 Congress moved the commercial crew program to the Space Operations Account, a decision that some hope will lessen competition between the two programs.

FY 2016 was the first year Congress appropriated the full amount requested for Commercial Crew, likely due to NASA's announcement that they and their two partners, Boeing and SpaceX, would conduct the first test launches in FY 2017. The first test of Boeing's CST-100 Starliner has since been delayed to 2018. Appropriators in both chambers would fully fund the request for the Commercial Crew program again in FY 2017, but continue to express concern about tight schedules.

As civil aviation markets have grown significantly over the last decade, funding for NASA's Aeronautics Research Mission Directorate has declined significantly — from a high of $2.8 billion in FY 2003 to a low of $529 million in FY 2007, recovering slightly to $640 million in FY 2016. The reduced funding has meant NASA could not contribute substantively to help the United States keep pace with near-peer nations who have invested heavily in aviation. The agency recently rolled out a new ten-year Strategic Implementation Plan that would significantly accelerate aeronautics research, with the FY 2017 request of $790.4 million for aeronautics, still only 3.3 percent of the agency's top-line budget, proposing funding to develop and fly "X-plane" demonstrators, begin the development of a series of ultra-efficient subsonic transport experimental aircraft, and initiate the detailed design and assembly of the world's first low boom supersonic flight demonstrator. The House and Senate are split widely on Aeronautics funding, with the House funding the account at $712 million, $72 million above FY 2016, and the Senate cutting the budget to $601 million, $39 million below FY 2016.

appropriations bill as of the time of publication, nor is it certain when the necessary negotiations will take place. Many expect Congress to pass a continuing resolution — funding the federal government at FY 2016 levels — and push the budget debate until after the 2016 election. The use of stopgap funding measures have been quite common over the last decade, and while NASA's FY 2017 request is not far off from last year's enacted level no new programs would be able to commence under a continuing resolution.

U.S. Geological Survey

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Advocates for the U.S. Geological Survey (USGS), the largest research agency in the Department of the Interior, cheered the increases contained for the agency in the Administration's FY 2017 request. The budget requested $1.17 billion for USGS, an increase of $106.8 million over the enacted FY 2016 budget- the second consecutive request that proposed increases larger than 10 percent. In contrast to many science agencies that mainly saw increases in new mandatory spending proposals that were immediately dismissed by Congress, the USGS relied only on discretionary funding.

Approximately two thirds of the USGS budget is allocated for research and development. In addition to underpinning the science activities and decisions of the Department of the Interior, this research is used by communities across the nation to make decisions regarding land use planning, emergency response, natural resource management and engineering.

For the first time in several years, the agency had a confirmed Director throughout the funding cycle. After two positive nomination hearings, the Senate confirmed Dr. Suzette M. Kimball as Director of the U.S. Geological Survey in December 2015. She had been leading the agency in an acting capacity since February 2013. Prior to becoming the Director, Dr. Kimball served the USGS for more than a decade as Deputy Director, Associate Director for Geology, and Director of the USGS Eastern Region.

But as in recent years, the requested increases have not materialized in appropriations decisions. The House would fund USGS at $1.08 billion, $18 million above the FY 2016 enacted level, while the Senate would provide an increase of just $6 million. While the budget caps have pressured all spending, appropriators have the additional hurdle of finding money for increases for USGS in the Interior and Environment bill, which has seen relatively low allocations in recent years. In addition, this bill has contained many policy riders in recent

years — unrelated to USGS — that have dominated hearings and negotiations on the bill.

Because of these funding constraints, the USGS budget has been relatively flat for a decade and has not again reached its peak of $1.1 billion that it received in FY 2010. Maintenance and facilities have been particularly crunched. The USGS is faced with approximately $400 million in deferred maintenance. This backlog has resulted in damage to research facilities and lost data, leading Kimball to call the issue "a very, very, significant problem" at a Senate Energy and Natural Resources Committee hearing. House and Senate appropriators declined to appropriate the requested increase in facilities.

Both appropriators and authorizers have lauded the agency in hearings but several members have questioned whether the agency has "mission creep" with new and expanded research. The Senate report notes, "While the USGS appears to be adapting to new demands by expanding its research capacity in program areas such Ecosystems and Climate and Land Use Change, the Committee wants to ensure that the agency is taking a balanced approach towards implementing its program areas." The report directs the Survey to report on new studies and projects over $500,000. Furthermore, the Senate bill reduces funding for Ecosystems, where ecosystem restoration initiatives and research on invasive species have been prioritized in the request, and Climate Variability.

Several mission areas and initiatives received increases across the board. The House, Senate and Administration all endorsed increases for the Natural Hazards mission area, including a new earthquake early warning system. Both the House and Senate reports direct the USGS to better monitor and prepare for hazards in the Cascadia subduction zone and increase monitoring and warning for high-threat volcano hazards.

Research in Core Science Systems, such as geologic mapping and data preservation, underpin many of the other USGS mission activities. Both the House and Senate provide increases to this mission area and specifically to increase the amount of high-quality topographic data available through the 3D Elevation program.

The USGS is the sole federal source of information on mineral potential, production, and consumption. And minerals research has drawn the attention of Senator Lisa Murkowski (R-Alaska), who chairs both the appropriations and authorizing committees for USGS.

In particular, she has directed USGS to focus resources on critical minerals for which the nation is dependent on foreign sources in appropriations language. She was also one of the authors of the American Mineral Security Act of 2015, which aims to improve understanding of critical minerals and to develop robust scientific and statistical information and forecasting capability to identify and anticipate threats to supply chains. This bill was included in the committee's bipartisan energy bill, which is in conference committee with the House.

Questions and challenges remain about the future of Landsat. For over 50 years, the Landsat satellites have amassed the largest archive of remotely sensed land data in the world, used for natural resource exploration, land use planning, and assessing water resources, the impacts of natural disasters, and global agriculture production. Contained in the Climate and Land Use Change account, the request included increases to develop the Landsat 9 ground system to accelerate the satellite's launch from 2023 to 2021 in an effort to avoid data gaps as Landsat 7 and 8 finish their planned lifecycle. The budget also includes funding for the USGS to continue to work with NASA to develop a next-generation technology for future Landsat missions. Although the House and Senate reports are supportive of this plan, tight funds and the possibility of a continuing resolution may put the schedule in jeopardy.

Veterans Affairs R&D

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Highlights

The Department of Veterans Affairs (VA) Medical and Prosthetic Research account received $675 million for FY 2017, a $44 million or 7 percent increase over FY 2016. $65 million of that funding is newly dedicated to the Million Veteran Program (MVP) to advance the president's Precision Medicine Initiative, and as a result, VA research grants receive $610 million, a decrease of $21 million or 3.3 percent below FY 2016 levels.

The administration requested $663.4 million in direct R&D appropriations for the VA Medical and Prosthetic Research account in FY 2017.

DEPARTMENT OF VETERANS AFFAIRS (VA)

VA research is organized into four main divisions: biomedical laboratory, clinical science, health services, and rehabilitation. These areas cover a spectrum of topics ranging from lung, kidney, and autoimmune disorders, to mental health, to bioterrorism. Ongoing and more recent research priorities for the VA include pain, sensory loss, spinal cord injury, women's health, prosthetics, Gulf War illness, aging and chronic disease, post deployment health and mental health (including traumatic brain injury or TBI, post-traumatic stress disorder or PTSD, and suicide prevention), rehabilitation, employment, "big data" and bioinformatics, and genomics.

Despite the documented success of VA investigators across many fields, the amount of appropriated funding for VA research has lagged far behind annual biomedical research inflation rates, which has resulted in a net loss of the program's overall purchasing power.

More than sixty percent of VA's researchers also are clinicians providing care for Veterans within the VA, providing unique opportunities to move more quickly and successfully between scientific discovery and clinical care. Additional resources are necessary to expand research on emerging conditions prevalent among newer veterans, as well as to continue the VA's inquiries into chronic conditions of aging veterans from previous wartime periods. For FY 2017, the MilCon-VA bill provides $7.2 billion for the new Medical Community Care account, which consolidated mechanisms for acquiring veteran care at non-VA facilities. For FY 2018, the bill provides $9.4 billion in advanced appropriations for VA Medical Community Care.

Moreover, the VA is uniquely positioned to advance genomic medicine through the MVP, which seeks to understand how genes and military exposures ultimately affect the health in Veterans population. Once this large-scale, national study is completed, the program will contain the world's largest repository of human genetic material. Of the $675 million provided by Congress for VA medical and prosthetic research, the VA directs $65 million toward the MVP. Scientific groups and Veterans' Service Organizations welcome VA's achievement of enrollment milestones for the MVP. The VA noted that as of June 2016 "nearly 500,000" veterans have enrolled in the program. The VA has noted that "several studies using MVP data are already underway in VA, on topics ranging from mental health to heart disease. The program has developed an impressive informatics infrastructure to ensure secure, efficient access to data for authorized researchers."

Astronomy and Astrophysics

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INTRODUCTION

The astronomical science community seeks to understand the Universe. How do stars and planets form and evolve? Could there be life on those planets? What can we learn from gravitational waves? What are dark matter and dark energy? Answering these questions requires a fleet of space-based and ground-based instruments — most of which depend on federal investment.

Decisions to invest in new programs and to continue to support existing programs are largely guided by community-based advice from the National Academy of Sciences and agency federal advisory committees. The NAS decadal surveys[1] in particular represent a broad community consensus of the current state of understanding and technology and present prioritized lists of projects, programs, and missions important for the next decade. The National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), and Department of Energy (DOE), the primary funders of the astronomical sciences, look to these reports for guidance as they develop their agency plans.

While NASA, NSF, and DOE provide the lion's share of federal support for the astronomical sciences, the Department of Defense and the Smithsonian Institution also provide important federal support, but minimal extramural funding. NSF funding focuses on ground-based telescopes and related research. NASA supports space-based missions and research, including some mission-related facilities on the ground. DOE's Office of Science supports research and experiments on the ground and in space that are focused on fundamental science questions at the boundaries between cosmology, astrophysics, and particle/nuclear physics.

This chapter will focus on the support for the astronomical sciences in the FY 2017 request and in the House and Senate appropriations for FY

[1] https://aas.org/policy-resources/decadal-surveys

2017, with an emphasis on the differences between these versions. There is relative agreement on funding for DOE's Cosmic Frontier program, so it is not discussed in detail here. For more information about the agencies more broadly, please refer to the relevant agency chapter.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

The high water mark for NASA funding overall is an increase of 1.8 percent (House) compared to the FY 2016 levels and for the Science Mission Directorate (SMD) is +0.2 percent (request). Both increases fall below the White House's FY 2017 inflation estimate of 1.8 percent, so spending power in these programs will decrease. SMD provides funding for the Astrophysics, Planetary Science, and Heliophysics divisions and for the James Webb Space Telescope (JWST) mission. In the Administration's request and the Senate bill, Planetary Science is down and in the House, Earth Science (also a division within SMD) is down. This is a continuation of a recent pattern that appears to pit Earth Science against Planetary Science. For more details about the Planetary Science Division, please read below; for more details about the Earth Science Division, please see the Geosciences chapter.

The FY 2017 request for the Astrophysics Division (APD) would provide funding for all ongoing missions — including a 4.3 percent increase for research and analysis (R&A) grant funding, which supports individual investigators. One of the challenges for APD has been achieving the balanced program envisioned by the 2010 astrophysics decadal survey *New Worlds New Horizons* (NWNH).[2] NWNH recently underwent a midterm assessment,[3] which concluded that APD has executed an overall balanced program within the confines of flat budgets. The assessment also concluded that the main area of concern for APD in the next several years will be the technical, cost, and schedule risks posed by WFIRST, the Wide-Field Infrared Space Telescope, the top space-based priority in NWNH. In terms of the FY 2017 budget, this risk would be mitigated by maintaining a funding profile for WFIRST that optimally balances the cost and schedule. The FY 2017

[2] http://www.nap.edu/catalog/12951/new-worlds-new-horizons-in-astronomy-and-astrophysics

[3] http://sites.nationalacademies.org/SSB/CurrentProjects/SSB_161177

request would fund WFIRST at $90 million, the same as the FY 2016 appropriated level, and would support a launch by 2020. Similar to years past, the Senate includes an increase for the project ($120 million), while the House prioritizes other projects like the airborne SOFIA telescope and the Exoplanet Exploration Program. Congressional increases for specific programs, like WFIRST, will require other programs and missions within APD to absorb offsetting cuts since the APD topline is insufficient to fully fund all of the programmatic increases.

Education and Public Outreach (EPO) activities across SMD have been another source of recent division between branches of government. As in years past, the President's request proposes a major cut (-32 percent), while both the House and Senate bills include an increase for these activities, with the Senate returning funding to pre-FY 2015 levels of $42 million. This back and forth continues a now annual battle that dates back to the Administration's largely failed attempt to consolidate federal STEM programs in the FY 2014 request.

All sides agree on funding JWST at $569 million, which fully supports the project and keeps it on schedule for a launch in 2018. The Congress has been closely monitoring progress on the mission, including annual GAO reviews, and retains the $8.0 billion U.S. cost cap in bill language.

The FY 2017 request for the Planetary Science Division (PSD) would provide $112 million less than was appropriated in FY 2016. Most of this funding difference is accounted for in decreases to a mission to Jupiter's moon Europa and the Explorer program, though there is an increase to Mars Exploration. The Europa mission and Mars Exploration are high priorities in the planetary sciences decadal survey[4] and are of interest to a wide variety of stakeholders, especially to key members of the House, evidenced by the $215 million increase to PSD over FY 2016 in the House bill. That increase is shared across most of the programs within PSD, and includes an $85 million increase to the Europa mission and a $199 million increase to Mars exploration. The Senate bill would cut PSD even deeper than the request (-$275 million), but includes increases to Mars Exploration

[4] http://www.nap.edu/catalog/13117/vision-and-voyages-for-planetary-science-in-the-decade-2013-2022

and Near-Earth Object Observations at the expense of the rest of the Division's programs.

The Heliophysics Division (HPD) would see an increase of 7.5 percent over FY 2016 in the FY 2017 request and in the House mark. This increase would fully support the launch costs for two high priority missions, Solar Probe Plus and Solar Orbiter Collaboration, and provide at least modest increases to most of the rest of HPD. Full funding for a top-priority decadal survey recommendation[5] — the Diversify, Realize, Integrate, Venture, Educate (DRIVE) initiative — is still not realized.

NATIONAL SCIENCE FOUNDATION (NSF)

The Astronomical Sciences (AST) division of the Mathematical and Physical Sciences (MPS) Directorate has been struggling to balance funding for research facilities with that for grants to researchers, and AST is continuing to work on recommendations delivered by an ad hoc portfolio review panel in 2012[6] to divest from some of its currently operating telescopes. NSF is currently evaluating divestment alternatives studied in a recent feasibility review, and in FY 2017 will identify viable options, which may include partnerships to keep the facilities running, and conduct necessary environmental impact reviews. The midterm assessment of NWNH reiterated the importance of following the divestment recommendations, but notes that the US science community's ability to use facilities will be compromised without moderate increases to the AST budget even with divestment.

The President and Congress would provide the Major Research Equipment and Facilities Construction (MREFC) account with sufficient funds for continued construction of two new ground-based telescopes, the next-generation solar telescope, the Daniel K. Inouye Solar Telescope (DKIST), and the top ground-based priority from the astronomy decadal survey, the Large Synoptic Survey Telescope (LSST), though other disputes exist in the account.

DKIST, scheduled for completion in 2019, and LSST, scheduled for completion in 2022, have both passed their construction funding peaks.

[5] http://www.nap.edu/catalog/13060/solar-and-space-physics-a-science-for-a-technological-society

[6] https://www.nsf.gov/mps/ast/ast_portfolio_review.jsp

	FY 2015 Actual	FY 2016 Actual	FY 2017 Request[14]	Change FY 17-16 Amount	Change FY 17-16 Percent	FY 2017 House	Change FY 17-16 Amount	Change FY 17-16 Percent	FY 2017 Senate	Change FY 17-16 Amount	Change FY 17-16 Percent
NASA	18,010	19,285	19,025	-260	-1.4	19,508	223	1.2	19,306	21	0.1
Science	5,243	5,589	5,601	11	0.2	5,597	7.6	0.1	5,395	-194	3.5
Heliophysics	636	650	699	49	7.5	699	49	7.5	679	29	4.4
Planetary Science	1,447	1,631	1,519	-112	-7	1,846	215	13	1356	-275	-17
Astrophysics	731	731	782	19	7	793	31	8.5	807	45	10
JWST	645	620	569	-51	-8	569	-51	-8	569	-51	-8
NSF[15]	7,398	7,493	7,964	501	6.7	7,406	-57	-0.8	7,510	46	0.6
MPS	245	1,349	1,436	87	6.5	--	--	--	--	--	--
AST	145	247	263	16	6.4	--	--	--	--	--	--
GEO	1,319	1,319	1,399	80	6.1	--	--	--	--	--	--
AGS	252	254	268	14	5.6	--	--	--	--	--	--
PLR	443	442	465	23	5.2	--	--	--	--	--	--
MREFC	145	200	193	-7	-3.6	87	-113	-57	247	46	23.1
Astro	105	119	87	-33	-33	87	-33	-33	87	-33	-33
DOE	27,403	29,603	32,490	2,887	9.8	29,963	360	1.2	30,741	1,138	4
Science	5,068	5,347	5,672	325	6.1	5,400	53	1	5,400	53	1
HEP	745	795	818	23	2.9	823	28	3.5	833	38	5
Cosmic Frontier	107	131	130	-0.5	-0.4	130	-0.5	0.4	136	5	3.8

[14] We are using the total request for FY 2017, which includes the mandatory budget authority, for our analysis.
[15] Neither the House nor the Senate marks typically include budget lines for directorates/divisions within R&RA.

Federal Issues in Weather and Climate

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Introduction and Political Background

Weather and climate information helps society manage risks and realize opportunities associated with existing weather patterns and changes to the climate system (natural and human caused). Information with respect to weather and climate results primarily from scientific observations, modeling, and research. Weather and climate services help apply that information for societal benefit.

Weather and climate services typically include weather forecasts and warnings, flood and drought prediction and monitoring, natural hazard preparedness and response, public health monitoring, disease prevention and control, assessment and management of fire risk, and decision support for water resources, agriculture, transportation, and other key economic sectors. In some instances, funding for services versus research is difficult to distinguish.

Weather and climate research spans multiple disciplines including atmospheric science, oceanography, hydrology, biology, and cryology. Understanding the societal impacts of weather and climate events also requires input from social sciences, including (but not limited to) economics, sociology, history, and political science. Policy choices must also consider ethical concerns, value judgments, philosophical views, and uneven distributional consequences.

Given this level of interdisciplinary complexity, accurately and comprehensively describing the weather and climate-related R&D in the federal budget is challenging and requires at least some subjective judgments.

President Obama's FY 2017 request for non-defense discretionary (NDD) spending was consistent with the level agreed to in the Bipartisan Budget Agreement of 2015 (BBA), a law that eased sequestration cuts for FY 2016 and FY 2017. This amount remains considerably below pre-

sequestration (FY 2010) levels in real terms (assuming a rate of inflation of 1.7 percent per year).

The President's request also included additional funding through new mandatory spending. This mandatory spending would provide a significant boost to weather and climate R&D at several agencies. However, Congressional Republicans have shown little interest in this additional spending, viewing it as a non-starter or gimmick. Indeed, many House Republicans sought to reduce overall discretionary spending $30 million below the BBA level earlier this year.

These efforts illustrate an ongoing disagreement between the President and Congressional Republicans on the appropriate level of federal spending, including on weather and climate research.

In addition to disagreements over spending levels for weather and climate research, several high-profile policy issues revolve around or involve weather and climate.

For example, efforts by the Obama Administration to free up radio frequency spectrum for commercial users offers opportunities for improved telecommunication services and significant proceeds from auctions. However, such efforts also create non-trivial risks to Earth observing capabilities of the weather and climate community through reductions in availability of spectrum for scientific uses or increased interference. The frequency spectrum is used to observe the Earth, to transmit satellite data to surface ground stations, and to distribute data from ground stations to users including emergency managers and academic researchers.

The increasing costs of satellite missions for weather observations have led some in Congress to push for alternative acquisition strategies, such as purchasing data from private sector companies rather than federally owned satellites. This approach has potential to reduce the costs of data acquisition but with potential risks to data quality and public availability of data. The latter is a concern because restrictions on agencies' ability to disseminate data could limit the availability of observations to the research community or could degrade efforts to promote international data sharing.

The rapid increase in data availability and the growing capabilities of data analytics evident in many fields are also occurring within the

weather and climate community. Recent efforts to increase public availability of data from Earth observations through efforts like NOAA's Big Data Project, which involves a partnership with five cloud computing companies, has the potential to transform weather and climate services.

Climate change risk management remains contentious and poses ongoing challenges to the scientific community. The Paris agreement, reached in December of 2015, is a non-binding treaty through which nations pledge reductions in their greenhouse gas emissions. The agreement established a goal of keeping human caused climate warming to below 2°C and possibly below 1.5°C. The Obama Administration helped create the agreement in a way that would allow US participation without Congressional approval, which appeared unlikely to be forthcoming. This work-around made US participation in the climate agreement possible but has angered some Congressional Republicans, thereby leading to further polarization of climate change.

Disagreement over climate change risk management increasingly influences policies affecting climate science. For example, House Science Committee Chairman Lamar Smith (R-TX) issued a subpoena for internal communications of NOAA scientists who worked on a recent climate study that refuted a widely-repeated argument used by those least concerned about climate change. This raised concerns within the scientific community over the potential intimidation of scientists and the risk to the free exchange of scientific ideas among agency and academic scientists.

Programs, Departments, and Agencies

National Oceanic and Atmospheric Administration (NOAA). Weather and climate observations, science, and related services occur in NOAA primarily through the Office of Oceanic and Atmospheric Research (OAR), the National Environmental Satellite, Data, and Information Service (NESDIS), the National Weather Service (NWS), and the National Ocean Service (NOS).

Funding levels for NOAA overall vary somewhat among the President's request (a 1.4 percent increase) and the House (a 3.2 percent decrease) and Senate (a 1.3 percent cut) appropriations. These relatively modest differences in top-line numbers belie some considerably larger disagreements in emphasis and priority.

There is notable and widespread agreement on the importance of observations, science, and services relating specifically to weather, as reflected in the President's request and the House and Senate appropriations. Indeed, funding differences for NWS among the House, Senate, and President are small.

However, funding levels for OAR and NOS are considerably different. In the President's budget, OAR would receive $519.8 million (a 7.8 percent increase). In contrast, the House would fund OAR at $462 million, a 4.1 percent cut and the Senate would fund OAR at $480 million, a 0.4 percent cut. Within the three OAR budgets there is sharp disagreement over funding for Climate Research. The President would increase Climate Research to $190 million, up 20.2 percent. The House would decrease it to $128 million, down 19.0 percent and the Senate would hold it constant at $158 million. The House would increase Weather and Air Chemistry Research to $118 million, a 14.5 percent increase.

The President's request for NOS is $532 million, a 5.6 percent increase. The House would cut NOS to $478 million, a 5.1 percent decrease and the Senate would increase NOS to $526 million, a 4.4 percent increase.

NESDIS is at the center of the discussions about commercial data purchases of satellite information, described above. A potentially interesting issue to watch for will be the extent that commercial data purchases supplement or replace federally owned satellites.

National Aeronautics and Space Administration (NASA). NASA Earth Science funds weather and climate-related research through Earth Science Research (ESR) and Applied Sciences (AS), and satellite observations through Earth Systematic Missions (ESM) and Earth System Science Pathfinder (ESSP).

The President's discretionary request for NASA Earth Science (a 2.7 percent increase) and the Senate appropriation (a 3.3 percent increase) are in close agreement (funding in the President's request increases by 5.8 percent if the new mandatory spending is included). Notably, the House appropriation is much lower (a 12 percent cut) than the Senate and Administration levels. This generally reflects a greater emphasis in the House for Planetary Science (e.g., the study of other planets and the search for extraterrestrial life) relative to Earth Science.

This debate is also discussed in the Geosciences and NASA chapters of this report.

National Science Foundation (NSF). NSF's Geosciences Directorate supports weather and climate research through its divisions on Atmospheric and Geospace Sciences, Earth Sciences, Ocean Sciences, and Polar Programs.

The President requested a 6.7 percent increase in funding for NSF overall with 1.3 percent of the increase coming through the NDD request. The House (a 0.8 percent reduction) and Senate (a 0.6 percent increase) appropriations are fairly similar to the President's NDD request. Though the President's NDD request for the Geoscience Directorate request is essentially flat (0.1% increase), inclusion of the new mandatory spending category would lead to an increase of 6.1 percent for the Geoscience Directorate.

Both appropriations leave the breakdown of funding among directorates to NSF, which is notable because in recent years Congress and the President have diverged on the importance of the geosciences to innovation and societal advancement.

Department of Energy (DOE). DOE's Office of Science supports basic research in atmospheric sciences, terrestrial ecosystems and climate modeling through the Office of Biological and Environmental Research (BER).

The President's FY 2017 request for BER was $662 million (an 8.7 percent increase). The Senate appropriation would fund BER at $637 million (a 4.6 percent increase). In contrast, the House appropriation would fund BER at $595 million (a 2.3 percent decrease). See the Department of Energy chapter of this report for a more thorough discussion of the relevant issues under debate.

Geoscience Funding

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Introduction

Geoscience has been attracting more attention from Congress. This attention is due in large part to discussions surrounding climate change policy, and has changed how members of Congress have chosen to fund geoscience research and development (R&D). How these changes have manifested, however, differs between the House and Senate.

Most notably, funding levels between the two chambers have significantly diverged over geoscience R&D within the National Aeronautics and Space Administration (NASA) and the National Science Foundation (NSF). Funding for the U.S. Geological Survey (USGS), however, remains flat in both the House and Senate, as it has for the past several years.

Background

Geoscience research helps farmers increase crop yields, businesses anticipate severe weather, and individuals build homes out of harm's way. It provides essential materials for our high-tech lives, and it fuels our planes, trains, and cars. From the big — supporting local economies and saving lives and property — to the not-so-big — creating cooler phones — geoscience research helps people understand and leverage Earth's complex systems.

For the past several years, federal funding for geoscience research has remained relatively flat. Funding for the USGS has grown by less than 2 percent per year since 2012; and although overall spending at NASA and NSF has increased, funding for geoscience research within them has been cut or remained basically flat.

This year, there have been continued attempts to cut geoscience funding within NASA's Earth Science Division and NSF's Geosciences Directorate, while funding at USGS has stayed constant.

Geoscience at NASA

NASA's Earth Science Division collects and disseminates publically available data on global soil moisture, land-use change, ice coverage, and more. To accomplish this, NASA maintains a fleet of Earth-observing satellites, including the Global Precipitation Measurement (GPM), Soil Moisture Active Passive (SMAP), Landsat, and ICESat satellites.

Many in the House have sought to cut funding for the Earth Science Division because of its perceived connections to climate change policy; the Senate, however, is not proposing cuts. The FY 2017 House Commerce, Justice, Science (CJS) appropriations bill cuts the division by 12 percent compared to FY 2016 levels. This cut reflects a growing sentiment in the House that funding for Earth and Planetary Science within NASA should be more "balanced," with greater emphasis on planetary exploration. As such, the House bill provides a 13 percent increase for the Planetary Science Division in FY 2017.

The broad cuts proposed by the House CJS Subcommittee and reinforced in proposed authorizing legislation by Science Committee Chairman Lamar Smith (R-TX) would affect almost every Earth-observing satellite within NASA's jurisdiction. The only exceptions would be for the NASA-ISRO Synthetic Aperture Radar satellite, which is set to launch in 2020 to help monitor natural hazards and ecosystem disturbances, and Landsat 9, which is set to launch in 2023 to ensure a continuous dataset for the Landsat series. Overall, top-level decreases in funding for NASA's Earth Sciences Division would limit the ability of farmers, city planners, and the military to plan crops, organize cities, and chart courses through the Arctic, among other things.

While the House bill proposes cuts, the Senate CJS bill provides a 3 percent increase to NASA Earth Science funding in FY 2017. The Senate's increase primarily goes toward ensuring an on-time launch for Landsat 9 — again, to ensure the continuity of its dataset. The proposed increase comes in spite of hearings led by Sen. Ted Cruz (R-TX), Chairman of NASA's authorizing subcommittee, which called into question the balance of funding between NASA's Earth and Planetary Science Divisions. The increases are largely due to Sen. Barbara Mikulski's (D-MD) position as Ranking

Member on the Senate CJS Appropriations Subcommittee; Sen. Mikulski is a long-standing champion of the Goddard Space Flight Center, a primary NASA Earth Science center, which is in her state. The Senate CJS bill instead proposes cutting Planetary Science by almost 17 percent compared to FY 2016 levels.

Although both bills have passed out of their respective appropriations committees, neither chamber has taken up its bill on the floor, and there is no indication when a final compromise between the two might be reached.

For more information on NASA's budget, please see the NASA chapter of this volume.

Geoscience at NSF

The NSF Geosciences Directorate (GEO) funds basic research to answer fundamental questions about our planet. With GEO's support, geoscientists around the country study how the atmosphere and oceans influence climate, how Earth's internal processes trigger natural hazards, and how soils clean our water. Since 2014, there have been attempts by both authorizing and appropriating committees in the House to decrease funding for geoscience research at NSF due largely to its perceived influence on climate change policy. The Senate has taken a more measured approach.

This year, authorizers in the Senate led by Sen. Cory Gardner (R-CO) and Sen. Gary Peters (D-MI) undertook a broad effort to revamp the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act (also known as the America COMPETES Act), which sets policy and top-level funding for NSF and other science agencies. After a series of stakeholder working groups that incorporated feedback from the science community, Gardner and Peters introduced their American Innovation and Competitiveness Act (S. 3084), which successfully passed out of committee on June 29. Gardner and Peter's bill authorizes growing top-line funding levels for NSF and omits directorate-level funding. This is in stark contrast to the House's update of the America COMPETES Act (H.R. 1806), which parses out authorized spending down to the directorate level and prioritizes funding for engineering and physical, computational, mathematical sciences over geoscience and the social, behavioral, and economic sciences.

Neither the House nor Senate FY 2017 appropriations bills contain language cutting geoscience research at NSF. However, advocates are concerned that some members of Congress may seek to cut GEO funding by proposing an amendment during debate on the chamber floor.

Overall, the House appropriations bill proposes cutting funding for NSF by 0.9 percent, but increasing the budget for Research and Related Activities, which includes GEO, by 0.8 percent; the Senate bill proposes increasing funding for NSF by 0.6 percent, but keeps the budget for Research and Related Activities flat. The House version of the bill proposes a more than 50 percent cut in funding for the NSF Major Research Equipment and Facilities Construction (MREFC) account, whereas the Senate would increase facilities funding by 23 percent. Current geoscience facilities, including the Seismological Facilities for the Advancement of Geosciences and EarthScope (SAGE) and the Geodetic Facilities for the Advancement of Geosciences and EarthScope (GAGE) are fully operational and funded by GEO, and thus do not rely on the MREFC account.

For more information on NSF facilities funding, please visit the NSF chapter of this volume.

Geoscience at USGS

The USGS explores, maps, inventories, and disseminates free and publically available information on natural hazards, ecosystems, and energy, water, and mineral resources. Compared to the other science agencies, USGS's budget is relatively small: only $1.1 billion. However, USGS information is widely used by emergency managers, land-use planners, energy and mineral producers, manufacturers, the defense and security sectors, and more.

The House and Senate FY 2017 appropriations bills prioritize funding for earthquake and volcano early warning systems, Landsat 9, and funding for the new 3D Elevation Program (3DEP) over other programs within USGS. Congressional support for the Landsat program helped the Climate and Land Use Change (CLU) mission area avoid cuts in funding for FY 2017. In fact, CLU received a 4.3 percent increase from the House and a 0.4 percent increase from the Senate in their FY 2017 appropriations bills. The entirety of these increases went to support land remote sensing, which includes Landsat.

While the House appropriations bill provides slight increases for all mission areas, the Senate appropriations bill decreases funding for the Ecosystems and Water Resources mission areas. The proposed decreases in the Senate reflect a growing sentiment among members of the Energy and Natural Resources Committee, especially Chairman Lisa Murkowski (R-AK), that USGS is experiencing "mission creep" into the more ecosystems- and biology-oriented sciences. Sen. Murkowski and others have stated they would like USGS to focus on what they believe to be USGS's core mission: geologic mapping and energy and mineral resources research.

For more information on USGS funding, please see the USGS chapter of this volume.

What a CR could mean for the geosciences

The geosciences rely on large, long-term, continuous, and consistent datasets, and several—including Landsat, streamgages, and other programs — need new investments to ensure continuity. Under a continuing resolution, programs would be stuck at FY 2016 levels and be prohibited from beginning new initiatives.

Biological and Ecological Sciences

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Introduction

Fiscal year 2017 is shaping up to be a year of haves and have-nots for biological and ecological research programs.

Several research programs would receive funding increases if legislation moving through Congress were enacted. Both chambers are considering proposals to increase funding for the Agriculture and Food Research Initiative, the Advanced Research Projects Agency-Energy, and the National Institutes of Health (NIH; Table 1).

Among the research programs that could experience budget cuts are those at the Agricultural Research Service, the National Oceanic and Atmospheric Administration, and the Environmental Protection Agency.

The Biological and Environmental Research program within the Department of Energy, the Ecosystems mission at U.S. Geological Survey (USGS), and the Forest and Rangeland Research Program at the U.S. Forest Service could end up with increased, flat, or declining funding depending on the outcomes of congressional negotiations. For these programs, one chamber proposed an increase while the other chamber proposed a cut. Climate variability research programs within the USGS would be flat funded under the House bill or face a cut from the Senate bill.

Future funding for the National Science Foundation (NSF) Directorate for Biological Sciences (BIO) is less clear, as Congress does not appropriate funds to the directorate level within NSF. Overall, research funding for NSF could remain at the FY 2016 level if Senate legislation is enacted or could increase by $45.8 million if lawmakers agree to the House funding level. BIO supports two-thirds of fundamental, non-medical research at universities and non-profit research institutions.

Table 1. Biological and Ecological Research Funding by Program
All changes are relative to the FY 2016 enacted level.

Agency	FY 2016 Enacted	FY 2017 President's Budget Request*	FY 2017 House Bill	FY 2017 Senate Bill
Advanced Research Projects Agency-Energy	$291.0 million	+$59.0 million	+$14.9 million	+$34.0 million
Agricultural Research Service	$1.4 billion	-$100.1 million	-$104.5 million	-$113.7 million
Agriculture and Food Research Initiative	$350.0 million	+$25.0 million	+$25.0 million	+$25.0 million
Department of Energy, Biological and Environmental Research	$609.0 million	+$52.9 million	-$14.0 million	+$28.0 million
Environmental Protection Agency, Science and Technology	$734.6 million	+$19.5 million	-$14.6 million	-$38.7 million
National Institutes of Health	$31.3 billion	-$1.1 billion	+$1.2 billion	+$1.6 billion
National Oceanic and Atmospheric Administration, Ocean, Coastal, and Great Lakes Research	$189.9 million	-$10.5 million	-$10.6 million	-$8.6 million
National Science Foundation, Directorate for Biological Research	$744.2 million	+$1.6 million	-- (Research directorates would collectively increase by $45.8 million)	-- (Research directorates would collectively remain at the FY 2016 level)
Smithsonian Institution	$840.2 million	+$82.0 million	+$23.1 million	+$20.0 million

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U.S. Forest Service, Forest and Rangeland Research	$291.0 million	+$1.0 million	+$11.0 million	-$11.0 million
U.S. Geological Survey, Ecosystems	$158.0 million	+$15.9 million	+$2.7 million	-$0.5 million

Source: agency budget documents and appropriations bills and reports.
**Only discretionary funding is included. For many research programs, President Obama also proposed new mandatory spending. See chapter on political context in this volume.*

Biological and Ecological Research Funding

The federal government supports a wide array of biology research, from agricultural research to ecology to zoology. This year, certain fields of study have garnered special attention. From emerging diseases to microbes to genomes, the White House, federal agencies, Congress, and others are giving a closer look to the microscopic aspects of biology.

Much public attention has been given to the emergence of Zika virus. Congress did not reach a compromise to fund prevention and response efforts before recessing for the summer. Yet Zika is not the only emerging disease that government agencies are addressing. The USGS and Department of Agriculture both support research programs on emerging diseases and are seeking additional research funding in FY 2017.

Antimicrobial resistance in pathogens is another growing concern. Several federal agencies are working on the issue, including the Centers for Disease Control and Prevention, NIH, Department of Agriculture, and even the Smithsonian Institution. Such efforts complement the Obama Administration's National Microbiome Initiative, which was launched in May 2016 to understand the communities of microbes in different ecosystems, including the human body. The initiative will support interdisciplinary research, develop new technologies, and expand the microbiome workforce. The federal government currently supports about $300 million a year for microbiome research; the Initiative pledges an additional $121 million, most of which is subject to appropriation by Congress. An extra $400 million was pledged by universities, non-profits, and businesses.

The rules that govern how an organism's genetic material and environment result in physical and biochemical traits and behaviors, called phenotype, have long been a mystery. The NSF has proposed a new research initiative — Rules of Life — to further our understanding of the rules that govern phenotypes. This research has implications for synthetic biology and microbiomes. The agency requested $13 million in new funding in the President's budget request.

Climate Research Funding

Climate change research encompasses many scientific disciplines, including the biological and ecological sciences. It is a cross-cutting theme throughout the federal budget housed in all twelve agency appropriation bills—from mitigation to adaptation and resilience planning within the Department of Interior (DOI) and other agency budgets.

Increasingly, appropriation bills are becoming vehicles for debate of contentious policy issues, such as blocking action to address climate change. While most scientists and scientific societies agree that climate change caused by human activity is occurring, some lawmakers are trying to introduce uncertainty into the science of climate change. Over the past year, the House Science, Space, and Technology Committee held several oversight hearings questioning the validity of climate science research. Although the House Science Committee does not appropriate funding, it can influence and set the tone for the House Appropriations Committee.

Conversely, the Obama Administration is going full steam ahead on building climate resilience and adaption strategies. The President's FY 2017 budget request invests in programs to increase the resilience of communities — and the ecosystems upon which they depend — along with programs that advance scientific understanding of climate science.

Much of this work occurs in the USGS's Climate and Land Use Change (CLU) Research and Development Program. For more additional information on climate science research funding, go to the Weather and Climate chapter in this volume.

Interior's CLU Program supports research to understand processes controlling Earth system responses to global change and models impacts of climate and land-cover change on natural resources. The

Administration's FY 2017 budget request for CLU is $171.4 million, a net change of +$31.5 million from the 2016 enacted level (Table 2). The CLU program supports the U.S. Global Change Research Program and other government-wide strategies such as the National Fish, Wildlife, and Plants Climate Adaptation Strategy.

Table 2. DOI's Climate and Land Use program

All changes are relative to the FY 2016 enacted level.

Climate and Land Use Change	FY 2016 Enacted	FY 2017 President's Budget Request	FY 2017 House Bill	FY 2017 Senate Bill*
Climate Variability:				
Climate Science Center	$26.4 million	$30.9 million	--	-$4.5 million
Climate Research and Development	$21.4 million	$22.7 million	--	-$2.5 million
Carbon Sequestration	$9.3 million	$9.3 million	--	-$400 thousand
Subtotal:	**$57.2 million**	**$63 million**	**--**	**-$7.4 million**
Land Use Change:				
Land Remote Sensing	$72.2 million	$96.5 million	+$6.0 million	+$9.4 million
Land change science	$10.5 million	$11.9 million	--	-$1.5 million
Subtotal:	**$82.7 million**	**$108.4 million**	**+$6.0 million**	**+$7.9 million**
Total Climate and Land Use Change	**$139.9 million**	**$171.4 million**	**+$6.0 million**	**+500 thousand**

** No Interior appropriations bill has been considered by the Senate as of August 8, 2016.*

Both Congress and the Administration slate the lion's share of CLU funding to the Land Remote Sensing programs (the Landsat satellite mission and the National Land Cover Database). The data collected by these programs is used to assess changes in land use, land cover, ecosystems, and water resources resulting from the interactions between human activities and natural systems.

Despite the sizeable funding boost sought by President Obama for the program, Congress is backing more modest increases. The House Interior and Related Agencies appropriations bill supports existing Landsat operations and the accelerated launch schedule for Landsat-9 and recommends $6.0 million above the fiscal year 2016 enacted level for the land remote sensing account; otherwise funding is lackluster with flat funding (Table 2).

The Senate bill provides $140.5 million for the CLU program, an increase of $500,000 for Arctic research. Program cuts to the CLU sub-activities have allowed for an increase of $15.4 million for the Landsat system (Table 2).

Within the Administration's CLU budget request, the National Climate Change and Wildlife Centers would receive $30.9 million, a net change of +$4.5 million. Most of the Administration's increase is slated for a new Great Lakes Climate Science Center in addition to the eight regional existing Climate Centers. Its establishment may be in jeopardy given the flat or reduced program funding included in appropriations bills.

Research Infrastructure

Construction of large research facilities has attracted scrutiny from Congress in recent years. In June 2016, the House of Representatives passed H.R. 5049, the "NSF Major Research Facility Reform Act of 2016." If enacted, the legislation would require the agency to provide better oversight and auditing of major multi-user research facilities. The topic was even interjected into the appropriations process, as the committee reports accompanying the House and Senate legislation to fund NSF and other agencies in FY 2017 call for an independent review of all programs funded within NSF's Major Research Equipment and Facilities Construction (MREFC) account.

The issue first drew attention in late 2014 over concerns about the management of the National Ecological Observatory Network (NEON), which is funded by NSF. After it came to light that construction of the monitoring network was a year behind schedule and projected to be $80 million over budget, NSF scaled back the project and hired a new management company in March 2016.

Although construction of NEON was funded within MREFC, its ongoing operating expenses represent a growing portion of the budget for the Directorate for Biological Sciences (BIO). FY 2017 will be the first year that BIO will assume full funding responsibility for NEON. NSF has proposed a $65 million annual operating budget; although this would represent a $21 million increase, the agency plans to cap NEON's operating and maintenance budget at this level until FY 2022. Given that the President's budget request proposed only a 0.2 percent increase for BIO, NEON operational expenses may squeeze other biological and ecological research programs, especially if the flat or modest increases for NSF research proposed by the Senate and House are enacted. This would worsen an already troubling trend — funding rates are in the single digits for some BIO research programs.

Lawmakers have also been debating NSF's future needs for research ships. The Obama Administration had requested funding to construct two regional class research vessels that would support research on marine biodiversity and oceanography. Senate appropriators identified a need for three new ships, whereas the House committee rejected the funding request altogether. A 2015 report by the National Academies of Sciences, Engineering, and Medicine supports the acquisition of two vessels.

Chemistry Funding in the FY 2017 Budget

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Overview

A major question stands at the heart of the longstanding debate over research and development (R&D) funding: How does the United States fund science and technology (S&T) year to year while maintaining and expanding our robust R&D infrastructure and without hindering future innovations? The complexities of balancing short-term appropriations with long-term investments grow increasingly cumbersome, and the Administration and Congress often struggle to find areas of agreement. The proposal contained within the President's FY 2017 Budget Request (PBR) to direct mandatory funding to S&T accounts points to the Obama Administration's prioritization of long-term investment in R&D.[1] Congress, however, shows no desire to relinquish control over annual spending, and instead has different priorities.

Chemistry is a fundamental science that underpins advances in areas as diverse as understanding disease pathways and designing new drugs, finding new materials and chemical processes to develop next-generation energy systems, and improving standards and measurement technologies to enhance American competitiveness. R&D in the chemical sciences is found throughout the federal departments and agencies, including the Department of Defense (DOD), the Department of Energy (DOE), the Environmental Protection Agency (EPA), the National Institute of Standards and Technology (NIST), the National Institutes of Health (NIH), and the National Science Foundation (NSF). Table 1 outlines the appropriations for fiscal year (FY) 2016, the FY 2017 PBR, and the FY 2017 appropriated level at the time of this writing for the above agencies.[2]

Table 1. Funding for Select R&D Agencies
(Dollars in billions)

Agency	FY 2016 Enacted	FY 2017 PBR*	FY 2017 House Bill		FY 2017 Senate Bill	
			Dollars	Change from FY16	Dollars	Change from FY16
DOD Science & Technology	13.0	12.5	13.0	-0.1%	13.4	2.5%
DOE R&D (est.)	14.4	16.6	15.7	9.0%	15.8	9.5%
EPA Science & Technology	0.7	0.8	0.7	-2.0%	0.7	-5.3%
NIST	1.0	1.0	0.9	-10.3%	1.0	1.0%
NIH	32.3	31.3	33.6	3.9%	34.3	6.2%
NSF	7.5	7.6	7.4	-0.8%	7.5	0.6%

*Excludes mandatory proposals for FY 2017.
Source: Agency budget documents and appropriations bills and reports.

Chemistry plays a role in several of the President's FY 2017 initiatives, including the Brain Research through Advancing Innovative Neurotechnologies (BRAIN), Cancer Moonshot, and Mission Innovation for clean energy initiatives.[3] Though the Administration requests base spending in compliance with the Bipartisan Budget Act of 2015, there are also significant proposed increases in mandatory spending across the federal agencies.[4] The mandatory funding proposals have been largely ignored by Congress. As of this writing, the House has passed appropriations bills funding S&T at the DOD[5] and EPA,[6] while the Senate has passed appropriations for the DOE.[7] Neither chamber has passed appropriations funding the NSF,[8] NIST,[6] or NIH.[9]

[1] https://www.aaas.org/news/guide-presidents-budget-research-and-development-fy-2017
[2] Discussion of authorizations and appropriations that have not yet passed the chamber is centered on recommendations from the appropriate authorizing and appropriations committees. Much of the information presented is also found within the committees' report language, rather than the legislation itself.
[3] https://www.whitehouse.gov/administration/eop/ostp/rdbudgets
[4] http://www.aaas.org/news/two-year-budget-deal-means-room-rd-growth
[5] H.R. 5293, H. Rept. 114-577
[6] H.R. 5538, H. Rept. 114-632
[7] S. 2804, S. Rept. 114-236
[8] H.R. 5393, H. Rept. 114-605, S. 2837, S. Rept. 114-239. NIST and NSF receive appropriations from the same legislation.
[9] H.R. 5926, H. Rept. 114-699, S. 3040, S. Rept. 114-274

Highlights of a few synergies and points of contrast for chemical R&D funding for FY 2017 are outlined below within two main themes--clean energy and sustainability and biomedical research.

Clean Energy and Sustainability

One of the primary thrusts of the Obama Administration has been advancing technologies that reduce the United States' dependence on fossil fuels. This includes R&D in both renewable energy and energy efficiency. In November 2015, President Obama joined twenty other world leaders in launching Mission Innovation, in which participating countries committed to double clean energy R&D by 2021.[11] Areas of focus included renewable fuels, better battery and energy storage, and lighter and more robust materials. The chemical sciences are major contributors in all of these areas.

DOE would be the primary driver of Mission Innovation within the United States, according to the President's request. For FY 2017, the President called for increased investment in the Biological and Environmental Research (BER) program, as well as for the Materials Science and Engineering (MSE) and Chemical Sciences, Geosciences, and Biosciences divisions within the Basic Energy Science (BES) program. Increased funding for fundamental, game-changing research through the Advanced Research Projects Agency-Energy (ARPA-E) was also part of the request. Though the House and Senate would increase funding for BES for FY 2017, the House report strongly cautioned DOE against "assuming an ever-increasing budget when planning the balance among facility runtime, construction, and research funding."

The House was disquieted by the Administration's continued focus on renewable energy, stating, "A budget request that fails to provide adequate funding for all energy sources within the nation's energy portfolio does not represent a fair 'all of the above' approach." This language points to a possible rationale for drastically decreasing funding for the Office of Energy Efficiency and Renewable Energy (EERE). In contrast, the Senate expressed its broad support of Mission Innovation's goals and provided significant increases to BES, BER, ARPA-E, and a small increase to EERE. Seeing the potential for bioenergy, the Senate also allocated $35 million, as requested, for a Synthetic Biology

Foundry, "to enable the biotechnology industry to achieve substantial improvements in conversion efficiencies and the scale-up of biological processes."

The PBR includes increases to NSF programs in the Mission Innovation initiative. Within the chemistry division (CHE) in the Mathematical and Physical Sciences (MPS) directorate, clean energy research would receive a funding boost of $21.3 million.[12] This includes research in hydrogen, fuel cells, biomass, solar energy, hydrocarbon conversion, carbon dioxide capture and use, and energy storage.

Other FY 2017 CHE priorities include continued support of the Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS) and the Centers for Chemical Innovation, which support research focused on major, long-term chemical research challenges, such as catalysis, solar fuels, sustainable materials, nanotechnology, and polymers.[13] However, Congress has decided to essentially flat-fund Research and Related Activities (R&RA) for NSF, and the House would require abstracts of funded research explain how the research is in the "national interest."

Congress has expressed its support for sustainable chemistry research. For example, in the Senate's appropriations report language, the committee recognized the FY 2017 sunset of the Sustainable Chemistry, Engineering, and Materials (SusChEM) program but encouraged NSF to continue sustainable chemistry research within its existing programs and to "pursue a long-term vision for sustainable chemistry."[14] Further, the authorizing bill for NSF and NIST, the American Innovation and Competitiveness Act (recently approved by the Senate Commerce, Science, and Transportation Committee) includes language boosting federal investment and coordination of sustainable chemistry research.[15]

[12] https://nsf.gov/about/budget/fy2017/pdf/21_fy2017.pdf
[13] https://www.nsf.gov/about/budget/fy2017/pdf/37_fy2017.pdf; http://www.nsf-cci.com/
[14] https://www.congress.gov/114/crpt/srpt239/CRPT-114srpt239.pdf; https://www.nsf.gov/pubs/2014/nsf14077/nsf14077.jsp
[15] https://www.congress.gov/bill/114th-congress/senate-bill/3084; https://www.commerce.senate.gov/public/_cache/files/8d9746db-88d1-4464-b28e-57f7aac30e53/71FC44AF6FA9B451AF4DAA815C9DABA1.s.3084-udall-1-modified-.pdf

The EPA also plays a key role in the Administration's sustainability efforts. EPA conducts its own S&T research on risk assessment, as well as the impacts of chemicals and other substances on human health and the environment, in order to provide the sound science needed to make regulatory decisions. S&T research at EPA is housed within the Office of the Research Director (ORD), with the bulk of chemical R&D falling under the Chemical Safety for Sustainability (CSS) research program. The work supported by CSS provides EPA with the tools and knowledge necessary to evaluate and predict the impacts of manufactured chemicals throughout their lifecycle.

In addition, EPA oversees implementation of the Toxic Substances Control Act (TSCA), which aims to ensure a safe and sustainable environment and was re-authorized in June 2016 for the first time in forty years.[16] With the exception of agricultural and pharmaceutical chemicals, TSCA regulates the chemicals in day-to-day commerce. The legislation passed in a rare instance of bipartisanship and agreement across the legislative and executive branches, as well as industry and non-profit organizations. Additional chemical reviews and risk assessments will necessitate the development of scientific tools and methodologies funded by ORD. However, without sufficient appropriated funds to cover increased costs of review and risk assessments, EPA may have to re-allocate resources from other areas to meet the new law's requirements.

Biomedical Research

Biomedical research appears to be enjoying a period of broad support from Congress, which boosted the NIH's budget by $2 billion for FY 2016 and is poised to provide further increases this year. In contrast, the FY 2017 request would decrease the NIH's base budget by $1 billion and would rely on mandatory funding to avoid budget decreases.[17] That mandatory funding would largely go to fund the BRAIN, Cancer Moonshot, and Precision Medicine Initiative.

Both the House and Senate Appropriations Committees have rejected the Administration's reliance on mandatory funding for FY 2017, instead increasing overall NIH base spending, including the institutes and centers (ICs) responsible for the majority of health-related chemical R&D. These ICs include the National Institute of General Medical

[16] https://www.congress.gov/bill/114th-congress/house-bill/2576

Sciences (NIGMS), the National Cancer Institute (NCI), the National Institute of Biomedical Imaging and Bioengineering (NIBIB), and the National Center for Advancing Translational Sciences (NCATS).

Supporting cutting edge biomedical research and researchers at sustainable levels has been a challenge for stakeholders and policymakers since funding toward doubling the NIH's budget concluded in 2003. To remedy this, the House Appropriations Committee proposed a 3.9 percent funding increase while stipulating that the additional funds be used to support a grant proposal success rate of at least 20 percent, equal to roughly 11,000 new research project grants. The report language also urges NIH to restore extramural research support to 90 percent of all NIH funding, with basic research support not falling below 55 percent of the portfolio. The committee also indicated that the NIH should continue focusing on lowering the average age of NIH-supported new investigators. Finally, House appropriators stated that they expect NIH to increase stipend levels consistent with any 2017 federal employee pay raise.

Further, in an effort to ensure a sustainable and predictable funding stream for the NIH, the House's authorization bill, the 21st Century Cures Act, passed in summer 2015, called for the establishment of an Innovation Fund.[18] This fund would provide $1.75 billion in mandatory federal dollars for each fiscal year from 2016 to 2020. The bill authorized base funding for FY 2016-2018 and would require ICs to set aside a specific percentage of funding for high-risk, high-reward research. The Senate has not passed its own authorization, taking a piecemeal approach, but progress has stalled due to disagreements over the potential mandatory funding.

[18] https://www.congress.gov/bill/114th-congress/house-bill/6

Some Good News in FY 2017 Appropriations for the Behavioral and Social Sciences

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Key Takeaway: The 2017 appropriations bills do not contain directives for cuts or harsher oversight for the behavioral and social sciences as in the recent past.

National Science Foundation

As noted in the National Science Foundation (NSF) chapter elsewhere in this report, the agency is facing probable flat funding at around $7.5 billion in the final FY 2017 appropriations bill. Under such a scenario, NSF's seven directorates, including the Social, Behavioral and Economic Sciences (SBE) Directorate and the Education and Human Resources (EHR) Directorate, would likely be held flat. Although SBE is the smallest of the research directorates, representing less than 5 percent of the total NSF budget, it remains a critical source of funding for basic social and behavioral science research at universities across the country. In addition, EHR provides the research foundation for the teaching and learning of a STEM-literate population.

More notable than the funding levels proposed in the House and Senate bills is the absence of any directives aimed at cutting social science funding at NSF, as we saw in House appropriations and authorization bills last year. Both chambers' bills steer clear of picking winners and losers among the scientific disciplines supported by NSF.

Still, both bills include report language worth monitoring. For example, the report accompanying the Senate bill calls on NSF to include criteria in its merit review process evaluating "how a proposal will advance our Nation's national security and economic interests, as

well as promote the progress of science and innovation in the United States." While not specific to social and behavioral science, this language is reminiscent of — though potentially much less damaging than — language in the final FY 2013 appropriations bill that limited NSF's Political Science Program by requiring that all funded projects "promote the national security or the economic interests of the United States." It is unclear how this language would be interpreted by NSF should a version of it stick in the final FY 2017 appropriations bill.

Similarly, the House bill includes language directing NSF to ensure that award abstracts explain how funded projects address U.S. economic competitiveness, advance public health, foster a STEM workforce, support the national defense, and other interests. The language is taken from the Scientific Research in the National Interest Act (H.R. 3293), a House-passed bill that seeks to set a definition of "national interest" for projects eligible for NSF support, with an implied emphasis on rooting out "wasteful" social science projects. The language in the House bill is viewed as largely benign.

National Institutes of Health

The behavioral and social sciences are represented in the portfolios of almost all the institutes and centers of the National Institutes of Health (NIH), reflecting the importance of those factors in health and disease. Following the $2 billion increase for NIH in FY 2016, Congress appears likely to provide another substantial funding increase. The House and Senate bills provide allocations to specific Administration or congressional priorities, including the Precision Medicine Initiative (PMI) cohort program, Alzheimer's disease research, the Brain Research through Application of Innovative Neurotechnologies (BRAIN) initiative, and programs targeted at opioid abuse. The behavioral and social sciences are well represented in the Alzheimer's initiative (e.g. with research on memory, cognitive enhancement, exercise, caregiving) and are playing a leadership role in the PMI plan to use mobile health (mHealth) technologies to correlate activity, physiological measures and environmental exposures with health outcomes. In addition, strong congressional support continues for the Environmental Influences on Child Health Outcomes (ECHO)/ National Children's Study Follow-on, which focuses on understanding the effects of environmental exposures on child health and development.

In response to House Appropriations language in FY 2016, NIH adopted an overall strategic plan in December. The FY 2017 House Appropriations report says, "The Committee expects NIH to prioritize Federal funds for medical research on discovery over outreach and education. NIH is expected to use the scientific strategic plan to prioritize funding. The Committee requests a report in the fiscal year 2018 budget request on how the NIH-wide strategic plan was reviewed and used to allocate resources for the fiscal year 2018 budget request and used during fiscal year 2017 to better focus resources to diseases with the significant opportunity to improve the current or future health of the American population." The behavioral and social sciences are represented in the NIH strategic plan, and advocates are hopeful that the plan will forestall attacks against specific research projects that are assumed by some members of Congress not to reflect NIH priorities.

Department of Education: Institute of Education Sciences

The Institute of Education Sciences (IES) is the principal federal agency for conducting research on education, with the critical role of expanding fundamental knowledge and understanding of education from early childhood to postsecondary study. IES-funded research seeks to identify practical solutions to education challenges.

During the Obama Administration, proposed increases have reflected strong support for rigorous research and evidence-based education policies and practice. The President included $694 million for IES in FY 2017. Despite reliable requests for increases since 2009, the IES budget in FY 2016 ($618 million) was barely above the FY 2009 budget ($617 million).

The Senate Appropriations Committee trimmed the IES allocation to $612 million in its version of the FY 2017 budget. The House, on the other hand, chopped it to $536 million, a number that would prevent IES from awarding any new grants. While significant, the cut is only half the size of what was passed by this committee last year.

These suggested cuts come at a time when the reliance on IES data and the demand for rigorous education research is increasing. President Obama signed the Every Student Succeeds Act (ESSA) on December 10, 2015. ESSA replaced the term scientifically based research, which had defined narrowly what was considered reliable research, with the broader term evidence-based research, which included three tiers:

- Strong evidence includes at least one well-designed and implemented experimental study, meaning a randomized controlled trial.
- Moderate evidence includes at least one well-designed and implemented quasi-experimental study, such as a regression discontinuity analysis.
- Promising evidence includes at least one well-designed and implemented correlational study that controls for selection bias.

Legislation to reauthorize IES, The Strengthening Education through Research Act (SETRA), remains frozen in the House. Members opposing the legislation have expressed concern about the adequacy of student data privacy provisions in a separate piece of legislation, the Family Educational Rights and Privacy Act, because it is referenced in SETRA.

Department of Defense

Within the $70 billion Research & Development account, DoD's fundamental and applied research portfolio (the Science and Technology or S&T line) has a mission to "invest in and develop capabilities that advance the technical superiority of the U.S. military to counter new and emerging threats." This includes support for behavioral, cognitive and social science, the majority of which is funded through intramural and extramural programs within the Army Research Institute (ARI) and Army Research Laboratory (ARL); the Office of Naval Research (ONR); the Air Force Office of Scientific Research (AFOSR) and the Air Force Research Laboratory (AFRL). These military service laboratories conduct and sponsor fundamental (6.1), applied/exploratory development (6.2), and advanced development (6.3) research in the human systems area. All of the services fund research in the broad categories of personnel, training and leader development; warfighter protection, sustainment and physical performance; and system interfaces and cognitive processing. There also are human systems research programs funded through the Office of the Secretary of Defense, the Defense Advanced Research Projects Agency (DARPA), and a variety of other smaller DoD entities.

Both the House and Senate Appropriations Subcommittees for Defense have restored and increased funding to the S&T line in their bills, the House bringing its total support up to $13.0 billion, and the Senate to $13.4 billion. In both House and Senate bills, however, basic 6.1 level research would drop from its current FY 2016 level of

$2.3 billion by up to 8 percent. DARPA is slated for an agency-wide increase from $2.9 billion in FY 2016 to an FY 2017 level of between $2.9 and $3.0 billion in proposals from the President and both congressional subcommittees.

Within these overall S&T accounts it is unclear how human-centered, behavioral research programs specifically would fare in each of the military laboratories, defense-wide agencies and medical research programs. In the current budget environment, behavioral research accounts in the S&T line can expect to see level or decreased funding.

National Science Foundation Support for the Mathematical Sciences in the FY 2017 Budget Request

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Over 60 percent of all U.S. federal support for basic research in the mathematical sciences comes from the National Science Foundation (NSF), and it is the only agency that supports mathematics research broadly across all fields. In fact, the Division of Mathematical Sciences (DMS), housed in the NSF Directorate of Mathematical and Physical Sciences (MPS), supports research at the frontiers of fundamental, applied, and computational mathematics and statistics. Research in the mathematical sciences not only extends the frontiers of mathematics but aids discovery in fields of science and engineering. The combination of mathematical, science, and engineering discovery is important for modern day technological development Discoveries in science and engineering stimulate the development of more complex mathematical and statistical theories.

Within the NSF budget, DMS has two modes of support: (1) research and education grants, and (2) institutes. Grants include individual-investigator awards; awards to groups of researchers, including multi-disciplinary; and educational and training awards. Approximately 52 percent of the DMS budget is available for new research grants and the remaining 48 percent is used primarily to fund continuing grants.

The FY 2017 budget request for DMS is $249.17 million, of which $235.05 million is discretionary and $14.12 million is new mandatory funding. It is not likely that this mandatory funding will be considered by Congress (see NSF chapter elsewhere in this volume). The $235.05 million discretionary is $1 million over the FY 2016 budget estimate of $234.05 million and $0.38 million less than the FY 2015 actual budget. The DMS FY 2017 discretionary budget request for research is $227.56 million, $1 million over the FY 2016 budget estimate and$4.29 million over the FY 2015 actual budget. These budgets reflect the fact

that the total NSF budget has had very little growth over the last several years. DMS received a 6.5 percent increase in the budget request. This percentage is in line with what other MPS divisions received in the request.

The Division supports disciplinary research programs in algebra and number theory; analysis; applied mathematics; computational mathematics; geometry and topology; mathematical biology; probability; foundations; and various areas within statistics.

In FY 2017 DMS plans to increase its investment in CAREER grants by $200,000 over the FY 2016 estimate to a total of $9.85 million. Support for early-career researchers is not only a Division priority but an MPS priority as well. This increase will enable DMS to support larger CAREER awards which will ensure that top young mathematicians will be funded at an adequate level. Disciplinary and Interdisciplinary Research will increase by $14.30 million over the FY 2016 estimate to a total of $226.51 million. Support for fundamental research is a major focus and the requested increase would provide additional funding for research awards with emphasis on the following activities: Cyber-Enabled Materials Manufacturing and Smart Systems (CEMMSS) (increase of $3.50 million above FY 2016 estimate for total of $5.60 million); Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21) (increase of $1.60 million for total of $4.90 million); Optics and Photonics (increase of $2.0 million for total of $3.50 million); Understanding the Brain (UtB) (increase of $425,000 for total of $5.30 million); Research at the Interface of the Biological, Mathematical, and Physical Sciences (BIOMaPs) (level at $3.26 million); Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS) (level at $400,000); Risk and Resilience (level at $500,000); Secure and Trustworthy Cyberspace (SaTC) (level at 2.0 million).

FY 2017 DMS funding for Mathematical Sciences Research Institutes is reduced by $2.0 million from the FY 2016 estimate to a total of $25.20 million. The number of NSF supported institutes is reduced from eight to seven. Report language for the Senate FY 2017 Commerce, Justice, Science, and Related Agencies bill recognizes the importance of the NSF Mathematical Sciences Institutes across the country, which provides important basic research in multiple fields.

Funding for Research Experiences for Undergraduates (REU) is level at $3.39 million and funding for Mathematical Sciences Postdoctoral Research Fellowships is level at $4.10 million.

Two newer programs in DMS are Mathematical Sciences Innovation Incubator (MSII) and Enriched Doctoral Training (EDT). MSII activity encourages and supports new research collaborations among mathematical scientists and other scientists and engineers working in NSF-supported research areas of high national priority by facilitating DMS co-review and co-funding of multi-disciplinary research collaborations involving mathematical scientists; providing leverage for investments on non-DMS NSF programs in projects that include mathematical scientists; and providing a uniform mechanism through which collaborative research teams involving mathematical scientists can request DMS co-review.

The MSII activity emphasizes scientific research areas of high national priority that would benefit from innovative developments in mathematics and statistics. For example, modern communication, transportation, medicine, manufacturing, security, and finance all depend on the mathematical sciences. Success in meeting crucial challenges currently facing the nation in these areas will rest on advances in mathematical sciences research. The increasingly important challenges of deriving knowledge from huge amounts of data, whether numerical or experimental, of simulating complex phenomena accurately, and of dealing with uncertainty effectively are some of the areas where the mathematical sciences will play a central role. Other promising areas where mathematical scientists could play larger roles include research on the power grid, the brain, and optics and photonics. Collaborative research projects involving mathematical scientists have the potential to transform the nation's ability to respond to these and many other challenges.

The long-range goal of the Enriched Doctoral Training in the Mathematical Sciences (EDT) program is to strengthen the nation's scientific competitiveness by increasing the number of well-prepared U.S. citizens, nationals, and permanent residents who pursue careers in the mathematical sciences and in other professions in which expertise in the mathematical sciences plays an increasingly important role. The EDT program supports efforts to enrich research training in the mathematical sciences at the doctoral level by preparing Ph.D. students to recognize and find solutions to mathematical challenges arising in

other fields and in areas outside today's academic setting. Graduate research training activities supported by EDT prepares participants for a broader range of mathematical opportunities and career paths than has been traditional in U.S. mathematics doctoral training.

The information in this chapter is from the FY 2017 NSF Budget Request documents and from the DMS Website.[1]

[1] http://www.nsf.gov/about/budget/fy2017/pdf/21_fy2017.pdf; http://www.nsf.gov/div/index.jsp?div=dms

Computing Research in FY 2017

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Highlights

-- Funding for the Networking and Information Technology Research and Development (NITRD) program would grow by $49.1 million, or 1.1 percent, to $4.5 billion in the FY 2017 budget versus FY 2016.

-- DOE's advanced scientific computing research efforts including work on "exascale-class" computing systems would again see significant increases in both the President's budget and appropriations legislation.

-- Efforts in both the House and Senate to reauthorize the NITRD program, improve interagency coordination and require strategic planning among the NITRD agencies have seen advances in the current Congress.

Introduction and Background

As of FY 2017, the federal IT R&D effort is now a $4.5 billion multi-agency enterprise called the Networking and Information Technology Research and Development (NITRD) program, coordinated by the Interagency Working Group on Information Technology Research and Development within the National Science and Technology Council (NSTC). NITRD is the successor of the High Performance Computing and Communications Program established by Congress in 1991. NITRD agencies now coordinate research in ten Program Component Areas (PCAs), which have been updated and revised for FY 2017: Cyber Security and Information Assurance; Enabling-R&D for High-Capability Computing Systems*; Human Computer Interaction and Information Management; High-Capability Computing Systems Infrastructure and Applications*; High Confidence Software and Systems; Large-Scale Data Management and Analysis*; Large Scale Networking; Robotics and Intelligent Systems*; Software Design and Productivity; and Social, Economic, and Workforce Implications of IT.

NSF is the lead agency among 20 NITRD member agencies and 32 other participating agencies.

Current Policy Environment

Exascale computing continues to be a large driver in the growth of federal investments in computing research in FY 2017, particularly at the Department of Energy, where a new project line focused on this class of computing a hundred times faster than the current fastest machines contains nearly all the proposed growth in the Advanced Scientific Computing Research program in the Office of Science. Focus on these "leadership class" machines is probably not surprising given the growth in capability demonstrated by global competitors to the U.S., particularly China, which now claims the top spot in the TOP500 supercomputing ranking, as well as ownership of more computers in the TOP500 (167) than any other nation (the U.S. is second with 165).[1]

These developments may have also helped animate Congress to move a legislative reauthorization of the NITRD program towards passage, something it has failed to do since the last authorization of the program in 2007. Both the House and Senate have moved their own versions of a NITRD reauthorization bill this year. The House passed a stand-alone measure in June, the *Networking and Information Technology Research and Development Modernization Act of 2016* (H.R. 5312), that implements many of the recommendations of a 2015 review of the program by the President's Council of Advisors on Science and Technology (PCAST). The bill aims to make the NITRD program stronger by improving the planning and coordination of the National Coordinating Office (NCO) for NITRD, requiring that the NCO and NITRD agencies create a five-year strategic plan for the program, and requiring the periodic review and assessment of the program's contents and funding — all recommendations of PCAST in its most recent review of the program. The bill passed the full House on a 385-7 vote.

However, the House has passed versions of a NITRD reauthorization in each of the last four sessions of Congress, only to see the Senate fail to move on a bill or draft one of its own. This year, following passage

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* These four PCAs are new for FY 2017, based on recommendations of the President's Council of Advisors on Science and Technology issued in 2015.

[1] See "China's New Supercomputer Puts the US Even Further Behind": http://www.wired.com/2016/06/fastest-supercomputer-sunway-taihulight/

of H.R. 5312, the Senate Committee on Commerce, Science and Transportation included language in the *American Innovation and Competitiveness Act* (S. 3084), the Senate's version of an American COMPETES reauthorization that passed the House in May 2015, which would reauthorize the NITRD program. Title 1, Section 105 of the Act contains language similar in scope to the House's H.R. 5312, including a requirement for the NCO to engage in strategic planning and identification of some new areas of focus for the program, including research on the interplay of computing and people; research on cyber-physical systems; a greater understanding of the science, engineering, policy and privacy protection related to IT; and an understanding of the human facets of cyber security.

The fate of the Senate version of the NITRD reauthorization is therefore tied to the fate of S. 3084. The bill was marked up by the Senate Commerce, Science and Transportation committee with the NITRD section unchanged. Whether that bill clears the full Senate before the end of this Congress is unclear, as is how a NITRD reauthorization would fare in that bill in conference with the House.

Regardless of the progress, or lack thereof, on a NITRD policy bill in the current Congress, the NCO has taken many of the recommendations of PCAST and implemented them, even without congressional direction. Of particular note to those who rely on the NITRD budget crosscut to track federal investments across the IT research and development portfolio, the NCO has reviewed and reevaluated the Program Component Areas into which NITRD investments are classified and revised them significantly to reflect current areas of research (as noted above).[2]

FY 2017 Budget Request

The NITRD FY 2017 budget request totals $4.5 billion, an increase of $49 million or approximately 1.1 percent above the FY 2016 estimate (see table below).

[2] For much more detail on the makeup of the new PCAs and crosswalks to previous categories, see the NITRD Budget Supplement for FY 2017: https://www.nitrd.gov/pubs/2017supplement/FY2017NITRDSupplement.pdf

	FY15 Actual ($M)	FY16 Estimate ($M)	FY17 Request ($M)	Percent Change	Amount Change ($M)
NSF	1,205.3	1,195.9	1,198.0	0.2%	2.1
DOD	942.9	923.1	888.7	-3.7%	-34.4
DARPA	395.8	425.5	440.4	3.5%	14.9
DOE	644.9	720.5	759.1	5.4%	38.6
DOE/ NNSA	20.9	22.2	33.5	50.9%	11.3
NIH	729.7	754.7	754.7	0.0%	0
NIST	138.3	146.9	160.5	9.3%	13.6
NASA	167.5	161.9	157.0	-3.0%	-4.9
DHS	64.3	71.9	73.8	2.6%	1.9
NOAA	30.2	36.9	43.2	17.1%	6.3
AHRQ	28.2	21.5	22.9	6.5%	1.4
EPA	5.9	6.5	6.8	4.6%	0.3
NIJ	4.7	5.5	3.5	-36.4%	-2.0
NARA	0.2	0.2	0.2	0.0%	0
Total	**4,378.6**	**4,493.3**	**4,542.4**	**1.1%**	**49.1**

Source: NITRD FY 2017 Budget Supplement.

National Science Foundation (NSF)

The National Science Foundation continues to be the lead agency in the NITRD program. The hub of NSF's NITRD activity is the Foundation's CISE directorate, which would account for $938 million of NSF's NITRD-related funding in FY 2017, an increase of $2.6 million or 0.28 percent over FY 2016 estimated levels.

Evidence of the centrality of computing research to much of the Foundation's priorities, CISE leads or takes part in a number of the agency's crosscutting initiatives, including those outlined in the following table.

	FY16 Estimate ($M)	FY17 Request ($M)	Amount Change ($M)	Percent Change
CEMMSS[3]	90.98	92.50	1.52	1.7%
NSCI[4]	--	19.70	--	--
D4SDA[5]	--	19.60	--	--
S&CC[6]	3.50	16.50	13.0	371.4%
CIF21[7]	84.21	50.0	-34.21	-40.6%
SaTC[8]	70.50	70.50	0.0	0.0%
UtB[9]*	29.72	23.58	-6.14	-20.7%
INFEWS[10]*	9.0	6.0	-3.0	-33.3%
Clean Energy Technology	22.57	45.90	23.33	103.4%
INCLUDES[11]	1.87	1.78	-0.09	-4.8%

Department of Defense & DARPA

NITRD investments would see a decrease of $34.4 million at the Department of Defense (DOD), which includes the individual service research offices and labs, in addition to other defense programs. This is due to decreases of $48 million in high capability computing systems and $12 million in Human-Computer Interaction R&D.

[3] Cyber-Enabled Materials, Manufacturing, and Smart Systems
[4] National Strategic Computing Initiative
[5] Data for Scientific Discovery and Action
[6] Smart and Connected Communities
[7] Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education
[8] Secure and Trustworthy Cyberspace
[9] Understanding the Brain
[10] Innovations at the Nexus of Food, Energy, and Water Systems
[11] NSF Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science
* - UtB and INFEWS are partnerships among all NSF directorates.

DARPA, while under DOD, is independent of the research organizations of the individual services. Within DARPA, there is a planned increase of $27.6 million for Large Scale Networking for Advanced RF Mapping and Spectrum Efficiency and Access programs, partially offset by a decrease of $17.8 million in high capability computing systems due to the completion of the Unconventional Processing of Signals for Intelligent Data Exploitation program.

DARPA's computing research mainly focuses on three programs in the 6.1 basic account and one program in the 6.2 applied account (see table below).

Basic (6.1) Accounts	FY16 Estimate ($M)	FY17 Request ($M)	Amount Change ($M)	Percent Change
Mathematics & Computer Science	144.3	149.1	4.8	3.3%
Cyber Sciences	50.4	45.0	-5.4	-10.7%
Transformative Sciences	38.4	53.1	14.7	38.3%
Applied (6.2) Account				
Information & Communications Tech	341.4	353.6	12.2	3.6%

Department of Energy (DOE)

The FY 2017 budget would establish a new program within DOE's Advanced Scientific Computing Research (ASCR) Office focused on exascale computing efforts, in response to the Administration's recently established National Strategic Computing Initiative.[12] As a result, funding is shifted from the Mathematical, Computational, and Computer Sciences Research programs within ASCR to the new Exascale program (see table below). Though DOE's budget justification describes the shift as a reclassification, there remains concern within the computing

[12] https://www.whitehouse.gov/the-press-office/2015/07/29/executive-order-creating-national-strategic-computing-initiative

research community that the reprogramming may change the character of the work from research to more development-oriented work. The bottom-line: it appears Exascale gets almost all of the increase in ASCR's proposed budget, and the rest of the program is flat funded.

Congressional appropriators have signaled their support for Exascale. As of August 1st, both House and Senate Energy & Water Appropriations bill reports have included funding at or near the President's request (Senate at $154 million and the House at $151 million).

ASCR Budget	FY16 Estimate ($M)	FY17 Request ($M)	Amount Change ($M)	Percent Change
Adv Sci Computing Res (ASCR)	621.0	663.2	42.2	6.8%
Math and Computer Sci Research	*179.2*	*150.9*	*-28.3*	*-15.8%*
High Perf Comp and Net	*441.8*	*358.3*	*-83.5*	*-18.9%*
Exascale Computing	*--*	*154.0*	*--*	*--*

National Nanotechnology Investment in the FY 2017 Budget

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Introduction

The emerging fields of nanoscale science, engineering, and technology — which investigate how to measure and restructure matter at the atomic, molecular, and supramolecular levels to create materials, devices, and systems with fundamentally new properties and functions — are leading to unprecedented understanding and control over the basic building blocks and properties of all natural and man-made things. The fiscal year (FY) 2017 funding request for nanoscale science, engineering, and technology (in brief, *nanotechnology*) research and development (R&D) is **$1.44 billion** (see funding table) across 20 participating federal departments, independent agencies and commissions (called in brief participating "agencies"; see Table 1 for names and acronyms), reflecting nanotechnology potential. Known as the National Nanotechnology Initiative (NNI), this investment began in FY 2001, inspired by a long-term vision,[2] and with a budget of $464 million.[3] The 2014 NNI Strategic Plan and 2011 NNI Environmental, Health and Safety Research Strategy are implementation guiding documents.[3]

The NNI vision is a future in which understanding and control of matter at the nanoscale will lead to a revolution in technology and industry that benefits society. The four goals of the NNI are to: advance a world-class nanotechnology research and development program; foster the transfer of new technologies into products for commercial and public

[1] The author is Senior Advisor to the National Science Foundation (NSF) and key architect of the National Nanotechnology Initiative. Opinions expressed in this material do not necessarily reflect the views of the NSF or NSTC.

[2] "Nanotechnology Research Directions" (M.C. Roco, S. Williams, P. Alivisatos, eds.), Springer 1999, adopted as an official document of NSTC in 2000; "Nanotechnology Research Directions for Societal Needs in 2020" (M.C. Roco, C. Mirkin, M. Hersam, eds.), Springer, 2011; http://www.wtec.org/nano2/

[3] See the NNI website at http://www.nano.gov/2014StrategicPlan and .../node/681 (an update is estimated to be published by the end of 2016)

benefit; develop and sustain educational resources, a skilled workforce, and the supporting infrastructure and tools to advance nanotechnology; and support responsible development of nanotechnology. Because of the NNI, federal agencies have engaged in strategic planning and collaboration and have initiated major new nanotechnology R&D activities under a common vision that supports national goals and agency missions. These agencies have established an extensive infrastructure of nanotechnology research and education centers, and they are working together to maximize the effectiveness of their individual and collective investments for societal impacts.

The 21st Century Nanotechnology R&D Act (Public Law 108-153) (http://www.gpo.gov/fdsys/pkg/PLAW-108publ153/content-detail.html) was signed into law in December 2003 and authorized long-term funding levels for five agencies (NSF, DOE, NASA, NIST, and EPA). In its biennial assessment of the NNI in 2014, the President's Council of Advisors on Science and Technology (PCAST) provided suggestions on effecting the transition to NNI 2.0 and emphasized the need for greater focus on commercialization activities and broader engagement of the nanotechnology community in setting the future goals and directions of the Initiative. The Nanotechnology-Inspired Grand Challenge for future computing was announced by OSTP on October 20, 2015 ("create a computer that can proactively interpret and learn from data, solve unfamiliar problems using what it has learned, and process information with the efficiency of the human brain." see www.nano.gov/grandchallenges). Spin-off areas of nanotechnology (such as metamaterials, plasmonics, and synthetic biology) and new areas at the intersection between nanotechnology and other technology platforms (such as nanobiomedicine, nanoinformatics, and nano-neuroscience) expand the use of nanoscale science and engineering beyond the initial definition in almost all sectors of national economy, medicine and defense.

Summary of FY 2017 Budget Request for NNI

The President's FY 2017 request of $1.44 billion for federal investment in nanotechnology (see funding table, and "NNI: Supplement to the President's Budget for FY 2017" on http://www.nano.gov/node/1573) is about 4 percent lower than the actual FY 2015 budget of $1.5 billion and about the same with the estimated FY 2016 budget of $1.43 billion. Approximately two-thirds of total NNI funding supports academic research and one-third supports

R&D at government laboratories and industry. Additionally, about 7.4percent of the NNI budget is estimated for the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs (actual budget in FY 2014 was $96.6 million).

NNI-sponsored R&D is reported in **five Program Component Areas** (PCAs) in the FY 2017 request:

(1) Nanotechnology Signature Initiatives (NSIs), $158.3 million, representing about 11 percent of the budget;
(2) Foundational Research, $601.0 million, about 42 percent;
(3) Nanoscale-Enabled Applications, Devices, and Systems, $349.5 million, about 24 percent;
(4) Research Infrastructure and Instrumentation, $234.6 million; about 16 percent;
(5) Environment, Health, and Safety, $100.1 million, about 7 percent.

About 35 percent of the FY 2017 request is for R&D for the **Nanotechnology Signature Initiatives (NSIs[4])** and **R&D for nanotechnology-enabled applications, devices, and systems** — both areas that aim to accelerate this transition. NSIs are multiagency initiatives designed to provide an increased emphasis and focus on technology areas of national importance that may be more rapidly advanced through enhanced interagency coordination and collaboration. Each of the five NSIs underwent internal reviews in 2015 to assess their impact and progress and to identify changes, if necessary, to keep the goals and objectives current. For example, updates to the white papers that discuss the goals and objectives of the Nanomanufacturing and Nanoelectronics NSIs are being made in 2016. The NSI on **Nanotechnology for Solar Energy Collection and Conversion** completed its role in FY 2016, and a new NSI on water was added. A brief description of the five NSIs are as follows:

(1a) **Sustainable Nanomanufacturing: Creating the Industries of the Future**, $37.4 million, with participation from DOD, DOE, IC/DNI, NASA, NIOSH, NIST, NSF, OSHA, and USDA/FS. It has two areas of focus: design of scalable and sustainable nanomaterials, components, devices, and processes; and nanomanufacturing measurement technologies.

[4] http://www.nano.gov/signatureinitiatives

(1b) Nanoelectronics for 2020 and Beyond, $69.8 million, with participation from DOD, DOE, IC/DNI, NASA, NIST and NSF. The initiative aims to explore new or alternative "state variables" for computing; increase processor speed, reduce energy consumption, merge nanophotonics with nanoelectronics; explore carbon-based nanoelectronics; exploit nanoscale processes and phenomena for quantum information science; and augment the national nanoelectronics research and manufacturing infrastructure network.

(1c) **Nanotechnology Knowledge Infrastructure: Enabling National Leadership in Sustainable Design**, $22.1 million, with participation from CPSC, DOD, EPA, FDA, NASA, NIH, NIOSH, NIST, NSF, and OSHA. The initiative aims to create a community-based, solutions-oriented knowledge infrastructure, including informatics and modeling and simulations, to accelerate nanotechnology discovery and innovation.

(1d) **Nanotechnology for Sensors and Sensors for Nanotechnology: Improving and Protecting Health, Safety, and the Environment**, $29.0 million, with participation from CPSC, DOD/DTRA, EPA, FDA, NASA, NIH, NIOSH, NIST, NSF, and USDA/NIFA. The initiative aims to provide new solutions in physical, chemical, and biological sensing that enable increased detection sensitivity, specificity, and multifunction in portable devices for a variety of health, safety, and environmental assessments.

(1e) **Water Sustainability through Nanotechnology: Nanoscale Solutions for a Global-Scale Challenge**, was launched to address the pressing technical challenges of ensuring water quality and supply, including increasing water availability, improving the efficiency of water delivery and use, and enabling the next generation of water monitoring systems.

Agencies

The five agencies with the largest FY 2017 NNI investments are described below: NSF, HHS/NIH, DOE, DOD and DOC/NIST (see funding table).

The National Science Foundation (NSF) (www.nsf.gov/nano/) would continue to support research and education in all disciplines of nanoscale science and engineering with an NNI budget of $414.9 million in FY 2017. NSF would support about 5,000 active awards with full or partial contents on nanoscale science and engineering, and about 10,000 students and teachers will be educated and trained. A new user National Nanotechnology Coordinated Infrastructure

(NNCI) network was awarded at the end of FY 2015 with a total budget of about $160 million until 2024.

The Department of Health and Human Services (HHS) would support nanotechnology R&D at $404.4 million in FY 2017, which is essentially flat from last year's enacted level and a slight increase over FY 2015. This funding is distributed between the National Institutes of Health (NIH: $382.0 million), the Food and Drug Administration (FDA: $11.4 million) and the National Institute for Occupational Safety and Health (NIOSH: $11.0 million). NIH addresses nanotechnology-based biomedical research at the intersection of the life and physical sciences.

The Administration's focus on energy is reflected in the **Department of Energy (DOE)** request of $361.7 million for FY 2017 NNI activities, a $31 million or 9.5 percent increase over FY 2016 enacted. The Department of Energy includes the Office of Science, the Advanced Research Project Agency-Energy (ARPA-E), and the Office of Energy Efficiency and Renewable Energy (EERE). DOE's Office of Science will continue to support full operation of the five DOE Nanoscale Science Research Center (NSRC) user facilities and the Energy Frontier Research Centers.

The Department of Defense (DOD) funding request for NNI is $131.3 million for FY 2017, which is $2.5 million or 1.9 percent below the FY 2016 estimated level of $133.8 million. The nanotechnology investment will continue with approximately 50 percent for fundamental research, 40 percent applied research, and 10 percent advanced technology development. DOD's focus is on nanoscale science and engineering research advancing defense and dual-use capabilities.

The National Institute of Standards and Technology (NIST) requests $81.8 million for NNI investments in FY 2017, a slight increase of $2.3 million or 2.9 percent above last year. The Center for Nanoscale Science and Technology (CNST) user facility maintains the capabilities needed to effectively support industrial innovation.

Proposed NNI investments in **research facilities and infrastructure** in FY 2017 total $235 million, a 7 percent increase over actual 2015 levels. These facilities include five DOE NSRCs, NIST's CNST, NSF's NNCI, NSF's Network for Computational Nanotechnology, and two state-of-the-art nanomaterial characterization laboratories established by the Food and Drug Administration. The FY 2017 request includes

funding for the Consumer Product Safety Commission (CPSC) for a new nanotechnology center at NIH's National Institute of Environmental Health Sciences (NIEHS) to conduct research in exposure and risk assessment of engineered nanomaterials in consumer products.

Many of the NNI participating agencies and programs are also actively contributing to complementary and synergistic U.S. R&D priorities, including the National Strategic Computing Initiative (NSCI), Networking and Information Technology Research and Development (NITRD) Program, the United States Global Change Research Program (USGCRP), the Materials Genome Initiative, Advanced Manufacturing, and the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative.

National Nanotechnology Initiative (NNI) Funding in FY 2017 Budget
(budget authority in millions of dollars)

	FY 2015 Actual	FY 2016 Estimate	**FY 2017 Budget**	Change FY 16-17 Amount	Change FY 16-17 Percent
Energy 1/	313	330	**362**	31	9.5%
HHS - NIH, NIOSH, FDA	386	405	**404**	-1	-0.1%
Natl Science Foundation	490	415	**415**	0	0.0%
Defense	143	134	**131**	-3	-1.9%
Commerce - NIST	84	80	**82**	2	2.9%
Environ Protection Agency	15	14	**15**	1	10.1%
NASA	14	11	**6**	-5	-44.5%
USDA - Forest Serv, NIFA	21	22	**21**	-1	-2.3%
Homeland Security	28	21	**2**	-20	-92.9%
All Other	3	4	**6**	2	57.1%
Total NNI	**1,496**	**1,435**	**1,444**	**9**	**0.6%**

1/ Includes the combined budgets of the Office of Science, the Office of Energy Efficiency and Renewable Energy (EERE), the Office of Fossil Energy, and the Advanced Research Projects Agency-Energy (ARPA-E).

Baesd on OSTP FY 2017 R&D documents and budget supplements.

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

Table 1. NNI members (20 federal agencies)

Federal departments and independent agencies and commissions with budgets dedicated to nanotechnology research and development (11)
Consumer Product Safety Commission (CPSC)*
Department of Commerce (DOC)
National Institute of Standards and Technology (NIST)
Department of Defense (DOD)
Department of Energy (DOE)
Department of Health and Human Services (DHHS)
Food and Drug Administration (FDA)
National Institute for Occupational Safety and Health (NIOSH)
National Institutes of Health (NIH)
Department of Homeland Security (DHS)
Department of Transportation (DOT)
Federal Highway Administration (FHWA)
Environmental Protection Agency (EPA)
National Aeronautics and Space Administration (NASA)
National Science Foundation (NSF)
U.S. Department of Agriculture (USDA)
Agricultural Research Service (ARS)
Forest Service (FS)
National Institute of Food and Agriculture (NIFA)
Other participating departments and independent agencies and commissions (9)
Department of Education (DOEd)
Department of the Interior (DOI)
U.S. Geological Survey (USGS)
Department of Justice (DOJ)
National Institute of Justice (NIJ)
Department of Labor (DOL)
Occupational Safety and Health Administration (OSHA)
Department of State (DOS)
Department of the Treasury (DOTreas)
Intelligence Community (IC)
Office of the Director of National Intelligence (ODNI)
National Reconnaissance Office (NRO)
Nuclear Regulatory Commission (NRC)
U.S. International Trade Commission (USITC)
Also participating from the Department of Commerce, listed above: Bureau of Industry and Security (BIS); Economic Development Administration (EDA); U.S. Patent and Trademark Office (USPTO)

(*) Denotes an independent commissions that is represented on NSET but is non-voting

Mechanical Engineering in FY 2017

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HIGHLIGHTS

-- The Department of Energy (DOE) would focus on advancing the development and commercialization of clean energy and carbon mitigating technologies, as well as advanced manufacturing research through the Advanced Manufacturing Office.

-- The Department of Defense (DOD) basic research efforts are directed towards DARPA project funding in the cyber, bio, and aerospace domains and establishing two new DOD-led advanced manufacturing institutes in addition to the six already in place.

-- The National Institute of Standards and Technology (NIST) remains focused on building out the National Network for Manufacturing Innovation (NNMI), despite entrenched opposition in Congress.

-- The National Science Foundation (NSF) budget focuses on supporting early-career investigators, advancing engineering research through effective use of data and cyberinfrastructure, and investing in post-Moore's Law computing systems.

-- Mechanical engineering research and development is a multidisciplinary field involving physics, mathematics, materials science, electronics, and many other scientific disciplines. As such, it is spread across a wide range of agencies for an even broader range of applications. This report will focus on the agencies and activities with primary influence on federally funded mechanical engineering R&D. The funding requests discussed in this chapter represent potential — not dedicated — sources of funding for mechanical engineers. Recent trends in federally-supported mechanical engineering-related R&D include:

-- Emphasis on advanced manufacturing and energy; and

-- Increased focus on industrial partnerships and technology commercialization.

DEPARTMENT OF ENERGY (DOE)

The Department's budget for FY 2017 focuses on advancing the development and commercialization of clean energy and carbon mitigating technologies, improving the resiliency of energy infrastructure assets, and supporting facilities for cutting-edge research. Continuing the thematic of connecting scientific research to commercialization efforts, there is also significant focus on advanced manufacturing research and creating new collaborative research opportunities. Mechanical engineering-related R&D lies primarily in five DOE offices: Office of Science, Office of Energy Efficiency and Renewable Energy (EERE), Office of Electricity Delivery and Energy Reliability (OE), Office of Nuclear Energy, and Office of Fossil Energy. Relative to FY 2016, the budget request reflects significant increases for the Office of Science, EERE, and OE.

The EERE budget request of $2.9 billion represents a 40.0 percent increase over the FY 2016 appropriated amount and includes a strong focus on clean energy technology development. Most of the key EERE programs with mechanical engineering components, including Bioenergy, Solar, Wind, Geothermal, Building Technologies, Vehicle Technologies, and Advanced Manufacturing technologies, receive substantial proposed funding increases to support the growth of renewable energy and energy efficiency technologies. A significant portion of the increase for EERE comes through the Advanced Manufacturing Office (AMO), which aims to improve the energy efficiency and productivity of the U.S. manufacturing sector by bringing together industry and research institutions to tackle cross-cutting sectoral challenges. Within AMO, the President's request includes $84 million for six DOE-led National Network for Manufacturing Innovation (NNMI) institutes, which includes $70 million for the five existing DOE manufacturing institutes and $14 million for a new Clean Energy Manufacturing Innovation Institute (CEMI). The FY 2017 House Energy & Water bill includes the requested funding for the additional CEMI institute, while the Senate version does not.

The Office of Electricity Delivery and Energy Reliability (OE) proposed budget focuses on Smart Grid R&D and State Reliability and Assurance Grants to shore up grid reliability and energy assurance. OE's budget seeks additional support for Energy Storage and the Infrastructure Security and Energy Restoration program areas, as well as funding for advances in technologies related to grid security, resilience, and a suite of smart grid technologies. The request includes $14 million in funding for a Grid Clean Energy Manufacturing Innovation Institute, which would become part of the larger multi-agency NNMI network. Appropriators in neither chamber provided funding for the Administration's proposed grid technology manufacturing institute.

The Office of Nuclear Energy's Small Modular Reactors (SMR) Licensing and Technical Support program received strong backing in the request, but programs like Reactor Concepts and Fuel Cycle R&D have been slated for cuts. Reactor Concepts is a particularly critical program as the commercial nuclear reactor fleet faces challenges as plants approach the end of their operational license. Congress has been concerned that lack of funding in this category may adversely impact the ability of the current US reactor fleet to continue to operate past its 60 year life, and House appropriators in particular have pushed for strong funding for Light Water Reactor Sustainability to continue R&D on the technical basis for license renewal.

The Office of Fossil Energy proposes significant structural changes in the request through combining coal and natural gas carbon capture technologies into one budget category and reducing the number of line items in the program. The Carbon Capture and Storage (CCS) and Advanced Power Systems program area (formerly the CCS and Power Systems area) are flat-funded at the FY 2016 level. The Administration further recommended that $240 million in previously appropriated funds for CCS demonstration projects be reprogrammed to support core R&D programs, raising questions as to the Administration's commitment to developing CCS demonstration projects. Both House and Senate appropriators soundly rejected these notions, and have proposed small increases for Fossil Energy R&D overall.

The $350 million discretionary budget request for ARPA-E, a $59 million or 20.3 percent increase over FY 2016, is representative of the Administration's commitment to energy technology innovation. House appropriators provided a 5.1 percent increase for ARPA-E in FY 2017, while their Senate counterparts offered an 11.7 percent funding boost.

The last major funding element at DOE, the Office of Science (SC), supports mechanical engineering-related R&D within its Basic Energy Sciences (BES), Advanced Scientific Computing Research (ASCR), and Fusion Energy Sciences (FES) programs. The FY 2017 discretionary budget proposal of $5.6 billion for SC is an increase of $225 million or 4.2 percent from FY 2016 estimated levels. Both House and Senate appropriators have proposed only $5.4 billion for SC's overall budget, but this figure includes fairly significant disagreements within almost every area of SC's budget. One item of particular contention is the U.S. contribution to the International Thermonuclear Experimental Reactor (ITER) project; the Senate recommended no funding for the program, while House appropriators offered up $125 million to match the President's request. Other line items include smaller differences, demonstrating appropriators' recognition of the importance of DOE's basic science research efforts.

Department of Defense (DOD)

Mechanical engineering is spread across the DOD's Research, Development, Test, and Evaluation (RDT&E) account, which is budgeted at $71.4 billion in the FY 2017 request, a slight increase relative to FY 2016. However, the S&T portfolio would be funded at $12.5 billion, representing a decrease of 4.1 percent.

The President's request provides resources to launch new manufacturing institutes and sustain those underway, including $137 million for six DOD-led NNMIs, which includes funding for two new institutes; appropriators granted the proposed increases for DOD advanced manufacturing programs, which are administered through the Office of the Secretary of Defense.

Elsewhere, appropriators provided increases for Advanced Technology Development, but basic research would see a decline in Senate legislation, and even steeper reductions in the House and request. DARPA sees a large plus-up in the President's budget, up 3.7 percent from last year, while the House and Senate provide modest increases of 2.1 percent and 1.4 percent, respectively.

National Institute of Standards and Technology (NIST)

The President's FY 2017 budget would provide $189 million to the NIST Industrial Technology Services (ITS) account, which funds the

Manufacturing Extension Partnership (MEP) and NNMI programs. Both the NNMI and MEP are important to ensuring manufacturing readiness, supporting U.S. national security readiness and ensuring the nation's economic prosperity. The Senate appropriation of $155 million for ITS includes $130 million for MEP and $25 million for NNMI, both flat from the previous year. The House committee also flat funds MEP and provides only $5 million or $42 million less than requested for NNMI activities, a major concern for the manufacturing research community given the growing interest in manufacturing research and competitiveness globally.

National Science Foundation (NSF)

The FY 2017 request of $7.5 billion for NSF represents a significant portion of the federal funding devoted to the physical sciences and approximately a quarter of the research conducted at U.S. colleges and universities. The request for NSF's Engineering Directorate (ENG) focuses on supporting early-career investigators, advancing engineering research through effective use of data and cyberinfrastructure, and investing in disruptive technologies to enable post-Moore's Law computing systems. Core ENG research activities include areas such as advanced materials and manufacturing, systems science and engineering, engineering biology, food-energy-water nexus research, and next-generation electronic devices, circuits, and systems. Major ENG cross-cutting programs include the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative, the Advanced Manufacturing Partnership (AMP), the National Robotics Initiative (NRI), the National Strategic Computing Initiative (NSCI), and the Strategy for American Innovation. Senate appropriators flat-funded NSF's research accounts, while the House committee provided a small 0.8 percent increase to match the President's requested level.

Materials Research in the FY 2017 Budget: National Science Foundation (DMR), Department of Energy (MSE), and Other Agencies

Damon A. Dozier
Materials Research Society

Introduction

Materials science is a broad interdisciplinary field supported by funding from a number of federal departments and agencies, particularly the National Science Foundation, the Department of Energy Office of Science, the National Institute of Standards and Technology, and Department of Defense. The discipline includes elements of physics, chemistry, engineering, biology, and medicine, as well as research in emerging fields such as nanoscience and nanotechnology. Materials research is conducted in universities, government laboratories, and industry. Materials scientists and engineers conduct research that results in fundamental breakthroughs in electronics, energy systems, aerospace, biomedical devices, nanotechnology, transportation, and advanced computation and communication technologies. Federal materials research programs support scientific research, state-of-the-art facilities, and analytical techniques, as well as programs that advance innovation and train the next generation of materials scientists and engineers.

National Science Foundation: Division of Materials Research

National Science Foundation's Division of Material Research (DMR) is located within the Mathematical and Physical Sciences (MPS) Directorate. Historically, Congress has not elected to fund the agency's separate research directorates directly; instead, each group (and their respective subgroups) has been funded separately by the Administrator. However, in recent years, there have been efforts, mainly initiated by the House Committee on Science, Space and Technology, to limit authorized funding levels for certain directorates (specifically, Geosciences and Social and Behavioral Sciences) and increase funding for others (such as

MPS). Thus far, these efforts have been largely unsuccessful, and there has been no effort to date to duplicate these efforts with the Senate Committee on Commerce Science and Transportation on the other side of the Capitol. For the most part, the scientific research community — composed of individual researchers, scholarly and technical societies, and industry — has voiced their concerns about the House's efforts.

Among NSF's divisions, DMR is charged with supporting research that centers on advancing materials discovery, design, synthesis, and characterization. Over the past five years since FY 2012, DMR has been funded at roughly $300 million, with funding reaching a high of $315.8 million in FY 2016. This represents an increase of $8.8 million (or 2.9 percent) above FY 2015 levels.

NSF also funds cross-agency initiatives that draw their funding from multiple directorates. Among these, the Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS) initiative is particularly important for materials research. The latest budget increases CEMMSS funding by 0.3 percent to reach a total of $257 million, with a specific focus on the Designing Materials to Revolutionize and Engineer our Future (DMREF) program. The purpose of DMREF is to design and synthesize materials by integrating theory, computation, experimentation, and data mining. These programs are a direct response to the Administration's Materials Genome Initiative (MGI). NSF intends to continue several existing programs under the CEMMS umbrella, including DMREF, Cyber Physical Systems (CPS), the NSF National Robotics Initiative, and programs related to advanced manufacturing.

Materials Centers funding in the proposed FY 2017 budget for DMR is equivalent to FY 2016 funding at $56.0 million. This level would support 21 MRSECs.

The budget request includes other agency focus areas including the Sustainable Chemistry, Engineering, and Materials (SusChEM) effort, under the NSF-wide Science, Engineering, and Education for Sustainability (SEES) program area; this effort includes critical minerals and materials. SEES investments would drop to $52 million for FY 2017, a reduction of 29.8 percent, as the program heads towards sunset.

Programs impacting materials research are also found in two other divisions of MPS — Chemistry (increase of 6.4 percent),

Physics (increase of 6 percent) — and in NSF's Engineering Directorate (ENG). Both of these programs enjoy bipartisan and bicameral support, and have not been targeted for any budget cuts. On the House side, there have been some efforts to increase the budget for ENG, with the Social, Behavioral, and Economic Science Division targeted for cuts in its version of the COMPETES authorization bill. These efforts are opposed by the S&T community.

Department of Energy: Materials Science and Engineering

The Materials Science and Engineering (MSE) Division of the Department of Energy (DOE) Office of Science (SC) is located within the Basic Energy Sciences (BES) group. Overall, DOE supports fundamental and applied materials research that seeks to achieve discoveries in a wide range of global energy and national security challenge areas. The DOE budget emphasizes the importance and priority of materials, chemistry, and biology by design. The Office of Science is the largest federal sponsor of basic research in the physical sciences, and BES is the largest of the office's program areas, due mainly to stewardship of national user facilities. The BES budget is projected to grow by 4.7 percent or $87.7 million for a total of just over $1.9 billion, per the President's budget. Within non-facility-based research programs of BES, the MSE Division includes materials discovery, design, and synthesis; condensed-matter and materials physics; and scattering and instrumentation sciences. Again, this program enjoys bi-partisan and bi-cameral support. In FY 2017, funding for Materials Science and Engineering (MSE) would rise to $395.8 million, an increase of over $26 million above FY 2016.

DOE oversees 17 national laboratories through SC and the National Nuclear Security Administration (NNSA). The BES program operates the Scientific User Facilities (SUF) Division, with large national user research facilities that provide researcher access to expensive and rare instrumentation, including synchrotron and neutron sources, nanoscience centers, and smaller user facilities for materials preparation and electron microscopy. BES also operates five Nanoscale Science Research Centers within SUF at national laboratories and, through their user programs, supports a wide range of individual programs on nanoscience.

BES also manages the Energy Frontier Research Centers (EFRCs), which are multi-investigator and multidisciplinary centers that pursue projects of high priority to energy research. The scientific directions for

these centers cut across materials science and engineering, chemical sciences, geosciences, and biosciences.

DOE supports applied materials research for energy technologies through a number of programs in the Office of Energy Efficiency and Renewable Energy (EERE), with a proposed budget of $2.9 billion, and directed materials research for national security through the National Nuclear Security Administration's Weapons Activities account, within the Science and Engineering programs. The Advanced Manufacturing Office in EERE focuses on materials technologies and production techniques that have broad applications for energy-intensive manufacturing methods. The Advanced Research Projects Agency-Energy (ARPA-E), which would see a 20.3 percent increase in FY 2017, is a source of funding for high-risk, high-payoff materials research projects. In addition, DOE has continued to manage Energy Innovation Hubs, including the Critical Materials Hub at Ames Laboratory and a multi-team Batteries and Energy Storage Hub led by Argonne National Laboratory.

National Institute of Standards and Technology (NIST)

NIST's Scientific and Technical Research and Services budget is proposed to increase by 5.9 percent in the FY 2017 request. The agency's budget contains an expansion of the National Network for Manufacturing Innovation (NNMI) by 2025, which would be carried out through $1.9 billion in mandatory funding in FY 2017. NIST develops measurements, standards, and data needed to advance the development of metals, ceramics, polymers, nanomaterials, biomaterials, electronics, and semiconductor materials that are critical to national needs related to commerce. The budget emphasizes manufacturing technologies, network infrastructure, and support for the MGI program.

National Institutes of Health (NIH)

Within NIH, the National Institute of Biomedical Imaging and Bioengineering (NIBIB) is an important funding agency for materials research with an emphasis on health-related science and applications. For fiscal year 2017, the National Institute of Biomedical Imaging and Bioengineering (NIBIB) would receive $342.5 million, essentially the same level of funding from the previous year.

The National Institute of General Medical Sciences (NIGMS) would be flat-funded as well at $2.5 billion, while research project grants that support investigator-initiated research would increase by 3.6 percent across the institute. Funding for the Division of Biomedical Technology, Bioinformatics, and Computational Biology (BBCB) would stay virtually flat, decreasing by only $60,000 from the FY 2016 enacted level. The budget request highlights new and continuing NIH initiatives, including $69.1 million to the Big Data to Knowledge (BD2K) program through the Common Fund to stimulate broad use of biomedical big data by supporting the development of big data software, reference datasets, data analysis, and dissemination methods. This would be a $6.2 million (9.8 percent) increase over FY 2016 to make big data software innovations more user-friendly and support innovative approaches using crowdsourcing and interactive digital media, as well as create a comprehensive data commons for NIH data resources.

Food Security Funding in FY 2017

Lowell Randel
Federation of Animal Science Societies

The term "food security" can apply to both domestic and global food needs and has been recognized as a high priority on the global level by the G20, as well as the U.S. federal government. Food security has also been the subject of recent legislation designed to strengthen the nation's programs, including research in this area. On July 20th, President Obama signed into law bipartisan legislation entitled "The Global Food Security Act of 2016," which requires the development of a government-wide strategy to address food security. Research across multiple agencies will play an important role in meeting the challenge of food security.

The U.S. Department of Agriculture (USDA) strategic plan emphasizes food security, and includes the goal to "Help America promote agricultural production and biotechnology exports as America works to increase food security." The primary USDA agencies supporting food security research are the National Institute of Food and Agriculture (NIFA) and the Agricultural Research Service (ARS). Research on food security is also supported by the National Science Foundation (NSF) and the U.S. Agency for International Development (USAID).

NIFA programs that address food security include the Agriculture and Food Research Initiative (AFRI) competitive grants program and the Sustainable Agriculture Research and Education Program. Examples of NIFA research on food security include improving feed efficiency and extending knowledge to producers to enhance reproductive fertility in food animals and developing more sustainable, productive, and economically viable plant and production systems.

AFRI represents the largest NIFA program that supports research in food security. The president's budget requests $375 million in discretionary funding for AFRI, which is $25 million above FY 2016. The President's budget also recommends $325 million in mandatory funding to bring the AFRI program to its fully authorized level of $700 million. Within AFRI, the FY 2017 NIFA budget proposes the consolidation of the Food Security and Water for Agriculture Challenge Areas into the Challenge Area entitled Water for Food

Production Systems. The FY 2017 budget includes $70 million for this Challenge Area that supports efforts to improve food security. This is approximately the same level of funding in the enacted FY 2016 appropriations.

Both the House and Senate versions of the FY 2017 Agriculture Appropriations Bill provide $375 million for AFRI. Neither version of the bill includes any mandatory funding for AFRI, as requested in the President's budget.

The FY 2017 ARS budget includes $152.5 million to accomplish the agency's food security goal, up slightly from $152.1 million in FY 2016. The FY 2017 budget includes highlighted priorities such as: climate change, foreign animal disease, water resources and antimicrobial resistance. Each of these priority areas have an important impact on production capacity and efficiency and can support improvements in food security. Other major areas of ARS research that support food security include research on livestock and crop production and protection.

NSF also supports food security research through a number of its programs. The Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS) is an NSF-wide investment that aims to understand, design, and model the interconnected food, energy, and water system through an interdisciplinary research effort. The FY 2017 budget request includes $62.2 million for INFEWS, which is up from $48.7 million in FY 2016. The NSF Biological Sciences (BIO) Directorate's Division of Integrative Organismal Systems (IOS) also supports research and education related to food security including science aimed at understanding the diversity of plants, animals, and microorganisms as complex systems interacting with their environments. The FY 2017 budget includes $215.4 million, which is slightly over the FY 2016 level of $214.3 million. Among the IOS programs impacting food security are the Plant Genome Research Program (PGRP) and the Basic Research to Enable Agricultural Development (BREAD) Program.

The FY 2017 request for USAID includes $978 million for the Feed the Future initiative to fight chronic food insecurity. This is the same amount as FY 2016. The total amount designated for R&D under Feed the Future in FY 2017 has yet to be determined. An important research component within the Feed the Future initiative is the Feed the Future Innovation Labs program. The House version of the Department of

State/Foreign Operations Appropriations bill directs that no less than $60 million be provided for the labs, while the Senate version recommends at least $32 million. USAID also supports the *Consultative Group on International Agricultural Research* (CGIAR) program, an essential component of global long-term agricultural R&D, and the *Collaborative Research Support Programs* (CRSP). USAID does not provide budget details for these programs, and neither is specifically mentioned in the current versions of the House or Senate appropriations bills.

Research to support food and agriculture production to enhance food security remains a high priority across multiple federal agencies and is the subject of recently passed legislation. However, it appears that specific funding for food security related research will be relatively flat for USDA, NSF and USAID programs in FY 2017.

Agriculture R&D Outside of USDA

Bethany Johns
American Society of Agronomy
Crop Society of America
Soil Science Society of America

Food, energy, and water are all interconnected. The Food and Agriculture Organization of the United Nations (FAO) projects that feeding a world population of over 9 billion people in 2050 would require raising overall food production by some 60 percent between 2005 and 2050.Climate change may also adversely affect the prospect of achieving food security, as well as the increased integration between agriculture and the energy market fostered by the growing use of crops in biofuels production, which represents a potential disrupting element in the future (Alexandratos and Bruinsma, 2012).[1]

Water is another critical resource. Irrigation has been an important contributor to crop yield Growth, which underpinned much of the production increases over past decades. Water scarcity due to increases in competition for water from households and industry will continue to reduce the share available to agriculture. Thermoelectric power, irrigation, and public supply account for 90 percent of the total withdrawals (USGS, Nov 2014).[2] At the global level, irrigation water withdrawal is expected to grow by about 6 percent in 2050 (Alexandratos and Bruinsma, 2012).[3] As the FAO report states:

> "In general, the sustainability of the food production system is being questioned. Doubts are cast on the possibility to continue doing more of the same, that is, using high levels of external inputs in production, increasing the share of livestock in total output, expanding cultivated land and irrigation, and

[1] http://www.fao.org/docrep/016/ap106e/ap106e.pdf

[2] http://pubs.usgs.gov/fs/2014/3109/pdf/fs2014-3109.pdf; see figure on page 16 to see detail of how each U.S. state uses fresh water withdrawals

[3] http://www.fao.org/docrep/016/ap106e/ap106e.pdf

> transporting products over long distances. Many advocate the need for "sustainable intensification" of production."[4]

Given these challenges, agricultural research requires increased attention. And yet, while the Department of Energy (DOE) and the National Science Foundation (NSF) are among the top five agencies that fund the most federal R&D, the U.S. Department of Agriculture (USDA) does not receive similar funding from Congress for research. Therefore, DOE and NSF are potential major partners with USDA for agriculture-related R&D.

Department of Energy

Biological and Environmental Research

DOE funds agriculture-related research in the Biological Environmental Research (BER) program of the Office of Science. BER focuses on two main missions: Biological Systems Science, which supports fundamental research to understand complex biological systems such as genome science, and Climate and Environmental Science, which supports fundamental science associated with climate change.

The President proposed $662 million for BER in FY 2017 budget request, an increase of 8.7 percent from the FY 2016 enacted level of $609 million; this does not include any additional dollars BER may have received through the $100 million in mandatory funding the Administration proposed for the Office of Science on top of the discretionary increase, though Congress has not yet taken up this funding. The BER directorate is approximately 11 percent of the total DOE Office of Science budget each year.

The BER directorate has repeatedly come under scrutiny from the House Republican majority, likely because it funds climate change research. The House flipped to a Republican Party majority during the 2010 Congressional elections associated with the Tea Party movement. The FY 2011 appropriations process was mired in the election process. Therefore, seven continuing resolutions funded the government at FY 2010 levels until a final bill was signed on April 15, 2011 with $38.5 billion in cuts compared to FY 2010. FY 2012 appropriations were greatly affected by the Budget Control

[4] Ibid.

Act of 2011, passed in August 2011, which imposed caps on discretionary programs that reduced government funding by more than $1 trillion over the ten years from 2012 through 2021. With significant reductions in spending, Congress prioritized some science programs more than others. For example, the House selected climate research to be defunded, whereas the Senate, which was still in a Democratic majority, recognized the unique importance of BER's climate science research. The differing takes are noted in the dueling quotes below:

> "The Climate and Environmental Sciences program devotes the majority of its funding to areas not directly related to the core mandate of science and technology research leading to energy innovations. Further, climate research at the Department of Energy is closely related to activities carried out in other federal agencies and may be better carried out by those organizations." (House Report 112-118)[5]

> "The Committee recognizes the unique contributions of this program in advancing climate research." (Senate Rept. 112-75)[6]

Figure 1 shows how the House Republican majority, starting in 2011, has continually underfunded BER compared to the President's Budget Request (PBR), the Senate, and the final enacted budget.

Energy-Water Nexus (EWN)

Energy-Water Nexus (EWN) is a set of DOE cross-program collaborations to accelerate the nation's transition to more resilient energy and coupled energy-water systems. The water-energy nexus is integral to two DOE policy priorities: climate change and energy security. While several federal agencies have missions that touch on the water side of the energy-water nexus, DOE's focus on the energy side is

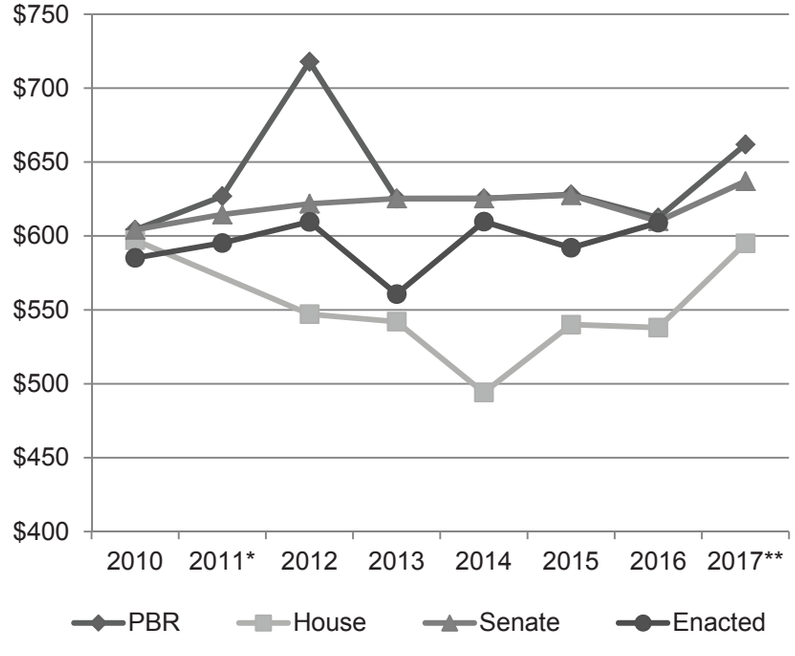
[5] https://www.congress.gov/congressional-report/112th-congress/house-report/118/1

[6] https://www.congress.gov/congressional-report/112th-congress/senate-report/75/1

essential if the nation is to realize meaningful solutions. DOE also recognizes agriculture's unique role in the EWN as the largest single consumer of water and how it competes directly with the energy sector for water resources. Agriculture also contributes indirectly to the energy sector via production of biofuels.

DOE's program offices have addressed the water-energy nexus for many years; however, this work has historically been organized on a program-by-program basis. In FY 2015, DOE managed EWN activities as separate, modest programmatic efforts with an incremental increase in coordination at a level of $15.6 million. In FY 2016, EWN activities began to be managed as a coordinated set of programmatic efforts included within the enacted budgets for six major programs: the offices of Energy Efficiency and Renewable Energy (EERE), Energy Policy and Systems Analysis (EPSA), Fossil Energy (FE), International Affairs

Fig. 1: Office of Science BER Funding Totals
(dollars in millions)



*No House figure in FY 2011.
**FY 2017 final appropriations have not yet been enacted.

(IA), Indian Energy (IE), and Science (SC). The FY 2016 budget for EWN about doubled to $34.3 million. Now, the FY 2017 requested funding has almost tripled to $96 million.

BER supports the Energy-Water Nexus (EWN) at $24.3 million proposed for FY 2017. BER will focus on advanced, integrated data, modeling, and analysis to improve understanding and inform decision-making.

Partner with USDA

BER tries to partner with USDA to fund related research. For example a recent Funding Opportunity Announcement (FOA) in FY 2016 titled, "Plant Feedstock Genomics for Bioenergy: A Joint Research Funding Opportunity Announcement USDA, DOE," (DE-FOA-0001444) funds genomics based research that will lead to the improved use of biomass and plant feedstocks for the production of fuels such as ethanol or renewable chemical feedstocks.

National Science Foundation

On May 2016, France Córdova, the director of the National Science Foundation (NSF), unveiled a research agenda intended to shape the agency's next few decades and win over the next U.S. president and Congress. Agriculture research was recognized in one of the initiatives which will focus on understanding the rules of life, i.e., predicting phenotypes from genotypes. This initiative is one of the priorities in the report, *Unleashing a Decade of Innovation in Plant Science: A Vision For 2015-2025*,[7] which was supported by over a dozen agriculture-related organizations and science societies. The mission of this decadal vision is to create crops that are flexible and adaptable to the challenges of environment and population.

The Director's vision for NSF should be reflected in the budget request for the 2018 fiscal year. However, since 2016 is an election year, the next president will ultimately decide how to align their FY 2018 budget with their platform, and may even have a say in NSF's 2017 budget if Congress can't complete its work before Inauguration Day.

[7] https://plantsummit.files.wordpress.com/2013/07/plantsciencedecadalvision10-18-13.pdf

Innovations at the Nexus of Food, Energy, and Water Systems

Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS) is an NSF-wide investment that aims to understand, design, and model the interconnected food, energy, and water system through an interdisciplinary research effort that incorporates all areas of science and engineering and addresses the natural, social, and human-built factors involved. INFEWS was first requested in FY 2016 for $75.0 million; however, only $48.7 million was enacted. The FY 2017 budget proposal includes $62.2 million, an increase of 27.7 percent.

Between June and December 2015, NSF funded a series of 17 FEW nexus workshops, to stimulate debate, discussion, visioning, and collaboration across research communities, and enable a higher appreciation, visualization, and understanding of food systems and their couplings to energy and water systems. The first INFEWS grant opportunity was an interagency partnership between NSF and USDA/NIFA[8] in March 22 with an anticipated funding amount of $50 million. NSF anticipates contributing approximately $45 million, and USDA/NIFA anticipates contributing approximately $5 million.

This activity enables interagency cooperation on one of the most pressing problems of the millennium — understanding interactions across the food, energy and water nexus — how it is likely to affect our world, and how we can proactively plan for its consequences. It allows the partner agencies — National Science Foundation (NSF) and the United States Department of Agriculture National Institute of Food and Agriculture (USDA/NIFA) and others — to combine resources to identify and fund the most meritorious and highest-impact projects that support their respective missions, while eliminating duplication of effort and fostering collaboration between agencies and the investigators they support.

Environmental Research and Education

Human uses of the environment for food, water, energy, and materials are causing global-scale changes in air, water, land, and climate. Yet connections among these social, biophysical, and built systems are poorly understood. A next step in advancing science for improved

[8] http://www.nsf.gov/pubs/2016/nsf16524/nsf16524.htm

environmental system design is transitioning from sustainability science to a "science of integration."

In 2000, the NSF established the Advisory Committee for Environmental Research and Education (AC-ERE), which provides advice, recommendations, and oversight concerning new and emerging environmental science, engineering, and education that affects multiple disciplines. Their recent report, "America's Future: Environmental Research and Education for a Thriving Century,"[9] released in September 2015, recommends that NSF build and sustain long-term cross-directorate activities to enhance the capacity of diverse environmental researchers grounded in systems science and motivated by societal issues with the aim of supporting science that can be used to design resilient landscapes, productive managed and natural ecosystems, sustainable urban spaces, and a healthy planet. Addressing complex socio-environmental problems requires understanding the interconnected nature of multiple environmental problems and challenges.

NSF is uniquely capable of addressing these challenges. See, for example, NSF's work on DNA sequencing of environmental samples. Modern microbiologists now regularly collect and sequence vast quantities of microbial environmental DNA (eDNA) from water, soil, and even the air — that field has come to be known as metagenomics. Most microbial species can't be detected any other way, because they are so small, similar, or difficult to grow in a lab. Metagenomics has a wide array of applications including: ecological monitoring and bioremediation, agriculture, biofuels, biotechnology, and bioengineering.

Connecting basic natural and social science with technical engineering approaches and demand management is necessary to optimize food and energy production while minimizing waste of water and other resources. Issues related to water and agriculture are of paramount concern now and will only grow in importance in the coming decades. Coupled biological, social, and engineered systems frame these concerns. Support for integrated and interdisciplinary research on these topics can directly support environmental planning that is based on sound science.

[9] http://www.nsf.gov/geo/ere/ereweb/ac-ere/ac-ere_thriving_century.pdf

Food Safety and Nutrition Research and Development in FY 2017

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American Society for Nutrition

Jaheon Koo
Institute of Food Technologists

Highlights

The President's 2017 budget request proposes to fully fund the U.S. Department of Agriculture (USDA)'s Agriculture and Food Research Initiative (AFRI), doubling the amount that was available in 2016, with a total of $700 million, though nearly half of this would be funded via new mandatory spending, rather than discretionary funds. AFRI is the nation's premier competitive, peer-reviewed research program for fundamental and applied agricultural sciences, targeting challenges of climate change, pollinator health, anti-microbial resistant bacteria, and bioenergy. During FY 2017 appropriations, the U.S. Senate and House both provided $2.5 billion to support all agricultural research conducted by USDA, including $375 million for AFRI, an increase of $25 million over FY 2016 enacted funding levels.

It is uncertain where the momentum behind the recent budget increases for USDA's competitive grants program is coming from, although coalitions of varied stakeholders representing numerous sectors within the agricultural research world are more frequently working together and attempting to have a stronger, unified message to reach mutual goals of increased federal investments in agricultural research. However, while extramural research funding is advancing, USDA's in-house scientific research agency, the Agricultural Research Service (ARS), is suffering from funding cuts.

Introduction

Food and nutrition research is crucial to providing a safe, nutritious, affordable, and sustainable food supply for the growing world population; to preserve the competitive position of U.S. agriculture, as

well as national security; and provide jobs and revenue to support the U.S. economy.

R&D funding for food safety primarily resides within the U.S. Department of Agriculture (USDA) and Department of Health and Human Services (HHS), specifically within the U.S. Food and Drug Administration (FDA). The largest portion of USDA's food safety R&D is found in ARS, and the National Institute of Food and Agriculture (NIFA), USDA's major extramural research agency.

The USDA and HHS, specifically the National Institutes of Health (NIH), fund more than 90 percent of nutrition-related research and training, although many other federal agencies contribute to nutrition research such as the Department of Defense; the National Aeronautics and Space Administration; the Veterans Administration; the National Science Foundation; and the U.S. Agency for International Development.

Food Safety

The President's budget request[i] would provide $30 million to enhance Animal Disease Response to outbreaks of swine enteric coronavirus disease and highly pathogenic avian influenza that have caused significant industry impacts. The budget includes a total of $61 million, an increase of about $35 million to address antimicrobial resistance in pathogens of humans and livestock, and to seek answers to key questions about the relationships among microbes and livestock, the environment, and human health. The budget provides $94.5 million to maintain the quality of ARS' scientific research, sustaining the capacity for conducting research on challenges to global food, agriculture, and natural resources systems. The budget provides $8.5 million for the Food Safety and Inspection Service (FSIS) to further modernize its science-based decision-making process by developing and deploying new tools to reduce the prevalence of foodborne illnesses.

With the increase of $25.3 million requested in the President's budget for FY 2017, FDA[ii] will build on work in two key areas. The National Integrated Food Safety System ($11.3 million) will collaborate with state, local and tribal governments. The system is a central element of FDA's strategy to achieve full, effective, and efficient implementation of the Food Safety Modernization Act (FSMA). New Import Safety Systems ($14.0 million) will be implementing the Foreign Supplier Verification Programs (FSVP) rule, which makes importers responsible

for ensuring that the foods they bring in from other countries are produced in a manner consistent with U.S. food safety standards.[iii]

Table 1. Food, Nutrition, Agriculture, and Natural Resources Sciences in the FY 2017 Budget

(budget authority in millions of dollars)

	FY2015 Actual	FY 2016 Enacted	FY 2017 Estimate	Change FY 16-17 Amount	Change FY 16-17 Percent
US Dept of Agriculture R&D					
NIFA 1/					
Food Safety	33	**31**	**35**	4	12.9%
Food Security	40	**46**	**46**	0	0.0%
Nutrition	125	**127**	**128**	1	0.8%
ARS					
Food Safety	112	**112**	**116**	4	3.6%
Food Security	150	**152**	**152**	0	0.0%
Nutrition	87	**87**	**85**	-2	-2.3%
ERS					
Food Safety	2	**2**	**2**	0	0.0%
Food Security	4	**4**	**4**	0	0.0%
Nutrition	20	**21**	**21**	0	0.0%
Dept of Health and Human Serv					
FDA					
Food Safety	1,229	**1,336**	**1,547**	212	15.8%
NIH					
Food Safety	105	**109**	**109**	0	0.0%
Nutrition	1,574	**1,631**	**1,631**	0	0.0%
Nutrition-Obesity	900	**931**	**931**	0	0.0%

Source: Agency budget justifications and other budget documents. All figures rounded to the nearest million. Changes calculated from unrounded figures.
1/ Includes portion of AFRI funding that supports Education and Extension.

FDA's FY 2017 budget provides $41.6 million for antimicrobial resistance activities, which includes Combating Antibiotic Resistant Bacteria (CARB), the same as the FY 2016 enacted level. The FY 2017 budget request provides an increase of $3.6 million over the FY 2016 enacted level for urgent facility investments that will improve the functioning of offices and labs across the country to ensure FDA can

execute its Food Safety and Medical Product Safety and Availability mission.

The FY 2017 budget will allow the Foods Program to continue its statutory mission of promoting and protecting public health by ensuring that the nation's food supply is safe, sanitary, and properly labeled, and that cosmetic products are safe and properly labeled. This mission becomes more challenging every year as globalization, advances in science and technology, and shifts in consumer expectations drive change throughout the human and animal food systems. In response to these increasing demands, the Foods Program conducts a variety of activities aimed at providing American consumers with food and cosmetics products that are safe and properly labeled.

Nutrition and Obesity

In FY 2017, the NIH estimates[iv] that it will award $1.6 billion in grants for nutrition-related research and $931 million in obesity-related research. These estimates are the same as FY 2016 enacted funding levels. The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), the National Heart, Lung and Blood Institute, and the National Cancer Institute are the lead investors in nutrition research at NIH. NIDDK would contribute approximately $481.2 million to Digestive Diseases and Nutrition extramural research in FY 2017,[v] $1.2 million less than was enacted in FY 2016. NIDDK will continue to support major ongoing studies to assess the health risks and benefits of weight-loss surgery in extremely obese adolescents and the impact of lifestyle interventions to reduce excessive weight gain in overweight and obese pregnant women. NIDDK will support research to define interactions between the host and the gut microbiota that regulate normal physiology and pathophysiology of diseases, as well as research on intestinal stem cells that can benefit a variety of digestive diseases.

During FY 2017 appropriations, the Senate Appropriations Subcommittee on Labor, Health and Human Services, and Education, and Related Agencies directed the Centers for Disease Control and Prevention (CDC) to update the Dietary Reference Intake (DRI) values for sodium prior to spending any funds on population-wide sodium reduction activities. The National Academy of Sciences, Engineering, and Medicine will be tasked with updating the DRIs for sodium and potassium. Congress has provided $49.9 million to the CDC for Nutrition, Physical Activity, and Obesity under Chronic Disease

Prevention and Health Promotion programs in FY 2017, with an additional $10 million going to High Obesity Rate Counties.

The USDA ARS budgets $85.2 million for the Human Nutrition Research Program in FY 2017, down $1.6 million from the FY 2016 enacted budget.[vi] The Senate Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Subcommittee directed ARS to spend no less than it did in FY 2016 on human nutrition research given their concern with the high rates of obesity in the United States, and to prioritize research efforts to explore the connection between nutrition, physical activity, and healthy and active aging. The subcommittee also recommends an appropriation of $1 million dollars to the USDA Nutrition Programs Administration for Phase II of dietary guidance from birth to 24 months.

The USDA NIFA will support ongoing nutrition-related research, education, and extension activities in FY 2017 with approximately $128 million, down slightly from FY2016.[vii] NIFA will continue to support the development of nutrition education and obesity prevention strategies and interventions. AFRI grants will be awarded to address global food security and hunger, childhood obesity, and other nutrition-related topics.

USDA's Economic Research Service (ERS) has set aside funds of $21 million for nutrition research in FY 2017, the same amount available in FY 2016.[viii] The ERS research program focuses on food access, food security, and child and adult obesity. An external review of ERS' Food Access, Food Choices, and Nutrition Research Program, commissioned by ERS as part of its five-year planned program review of all major ERS research topics, was completed in March 2015. The goal of the review was to obtain an objective, rigorous assessment of the research program for ERS that focuses on topics related to the actions of and interactions among consumers, the food industry, and government as they relate to food choices, the food supply, food assistance, and regulation. The review panel found that the program has developed an exemplary record in conducting research to provide timely, policy-relevant information on food choices, food access by low-income households and individuals, and diet-related quality.

[i] http://www.usda.gov/wps/portal/usda/usdahome?navid=BUDGET
[ii] http://www.fda.gov/AboutFDA/ReportsManualsForms/Reports/BudgetReports/ucm488357.htm
[iii] http://www.fda.gov/Food/GuidanceRegulation/FSMA/
[iv] ucm432576.htm https://report.nih.gov/categorical_spending.aspx https://
[v] www.niddk.nih.gov/about-niddk/budget-legislative-information/Documents/National-Institute-of-Diabetes-and-Digestive-and-Kidney-Diseases-Fiscal-Year-2017-Budget_%20508.pdf
[vi] http://www.obpa.usda.gov/18ars2017notes.pdf
[vii] http://www.obpa.usda.gov/19nifa2017notes.pdf
[viii] http://www.obpa.usda.gov/16ers2017notes.pdf

Appendix 1

AAAS Committee on Science, Engineering and Public Policy

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William D. Provine (2018)
DuPont

Anthony (Bud) Rock (2019)
Association of Science-Technology Centers

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* Terms expire on last day of Annual Meeting in year shown.

Appendix 2

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