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Senate Appropriations: Where the Rubber Meets the Road for Energy Innovation

COLIN CUNLIFF I SEPTEMBER 2019

This briefing provides an update on energy research, development, and demonstration (RD&D) in the fiscal year (FY) 2020 appropriations process and identifies what to look for as negotiations over the budget resume this month.

KEY TAKEAWAYS

- The Senate appropriations process will test the growing bipartisan support for an innovation-based climate agenda. The Energy & Water subcommittee, which invests in DOE's clean energy RD&D programs, could hold a markup in early September.
- The budget agreement reached in July provides a 4 percent increase in non-defense discretionary spending. Next, the Senate will parcel out the budget across 12 appropriations bills, including the bill that funds the Department of Energy.
- Senators on both sides of the aisle have proposed new or expanded federal energy RD&D programs to address climate change and competitiveness challenges. And Sen. Alexander has proposed doubling federal investment in clean energy RD&D.
- Ambitious new programs, such as Senator Alexander's "New Manhattan Project for Clean Energy," could, in principle, be accommodated within the budget agreement because federal energy RD&D is just 1.2 percent of the non-defense discretionary budget.
- However, appropriators' ability to increase clean energy RD&D is limited by the amount that Senate leaders allocate to the Energy & Water subcommittee.

SUMMARY

This briefing provides an update on energy research, development, and demonstration (RD&D) in the federal fiscal year (FY) 2020 appropriations process, building on ITIF's summary of the administration's budget request. It compares the House Energy & Water appropriations bill with the request, and identifies what to look for, particularly in the Senate, as negotiations over the budget resume after Congress returns from recess.

SETTING THE STAGE: ENERGY INNOVATION POLICY IN THE SENATE

Energy innovation has emerged as a major focus of the 116th Congress, particularly in the Senate.

The Senate Energy and Natural Resources Committee (SENR)—the authorizing committee for the Department of Energy's (DOE) energy RD&D programs—has held three hearings with the word "Innovation" within their titles. These hearings focused on the health of the U.S. innovation system as well as the role of energy innovation in addressing climate change and supporting regional economic development.[1] Under the leadership of Chair Lisa Murkowski (R-AK) and Ranking Member Joe Manchin (D-WV), the committee has also held targeted hearings on key technologies for deep decarbonization, including advanced nuclear energy; advanced renewables and energy efficiency; carbon capture, utilization, and storage (CCUS); and energy storage for the electricity grid.[2]

Many senators on both sides of the aisle have proposed new or expanded federal energy RD&D programs to address innovation challenges. SENR has already favorably reported bipartisan nuclear energy and CCUS bills (S.903, S. 1201, and S. 1685), and is reportedly working on a bipartisan bill for energy storage.[3]

Energy innovation has even percolated into the upper echelons of senate leadership. Earlier this year, Senate Majority Leader Mitch McConnell (R-KY) acknowledged human-caused climate change, noting, "The question is how you address it.... The way to do this consistent with American values and American capitalism is through technology and innovation."[4] Republican Conference Chairman John Barrasso (R-WY) has also voiced his support for an innovation-based climate agenda, focusing particular attention on carbon utilization and direct air capture.[5] Sen. John Cornyn (R-TX), the former senate majority whip, is a sponsor of the LEADING Act, which would establish a new research and development (R&D) program aimed at developing carbon capture technologies for natural gas power plants.[6]

ENERGY RD&D APPROPRIATIONS: CONGRESS CHARTS ITS OWN PATH

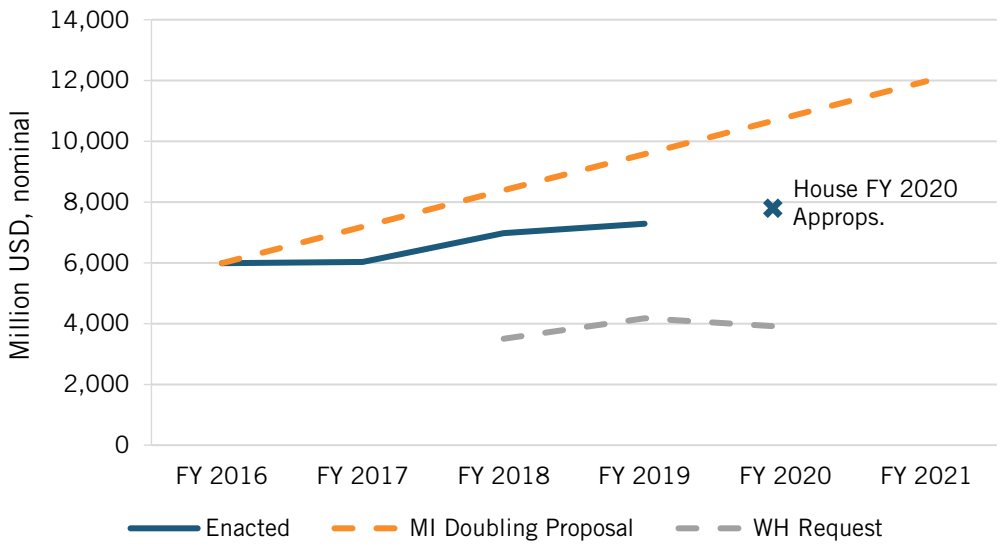
It is one thing to consider questions of "what" and "how" in the authorizing committees and quite another to answer "how much?" That is the central question addressed in the appropriations process.

The FY 2020 appropriations process began in March, when the White House released its budget request, which called for gutting federal investment in energy RD&D. The proposed 48-percent cut, from $7.3 billion to $3.9 billion, would have been the largest in a single year in the history of DOE.[7]

But congressional opposition to this kind of request has solidified. Similar proposals in the prior two budget cycles were rejected by both parties and both chambers. Rather than adopting the administration's proposals, the Republican-controlled 115th Congress instead boosted energy RD&D programs by 14 percent in FY 2018, and 5 percent in FY 2019.[8]

The 116th Congress seems poised to continue the trend of modest year-over-year growth. The House Energy & Water (E&W) appropriations bill for FY 2020, which funds DOE and was passed in June, provides a 6-percent boost for energy RD&D to $7.7 billion.[9] While welcome, the House mark still leaves the United States well below the doubling pathway envisioned when the international Mission Innovation initiative was launched by the United States and other nations at the time of the Paris Climate Agreement in 2015 (figure 1).[10]

Figure 1: Enacted funding levels for energy RD&D at DOE, compared with the Mission Innovation doubling pathway and the Trump administration's proposed budgets for FY 2018 through FY 2020[11]



SEPTEMBER: A TIME FOR ACTION

The House bill was passed before the White House and congressional leaders reached an overall budget agreement in late July. The agreement provides a 4-percent increase in non-defense discretionary spending in FY 2020—below the 6 percent assumed by the House—as well as a 1-percent increase in FY 2021. The Senate appropriations process, therefore, is where the rubber will meet the road, posing a major test for bipartisan cooperation on energy innovation.

When the Senate returns from recess in September, the process will begin in earnest, with the E&W bill likely to be first up.[12] The E&W appropriations subcommittee could hold a markup of its spending bill as early as September 10, with a full committee markup following on September 12.

Senator Lamar Alexander (R-TN), who chairs E&W, laid down a marker in April, when he called for a "New Manhattan Project for Clean Energy" that would double funding for energy RD&D over five years. The subcommittee's ranking member, Dianne Feinstein (D-CA), also supports increased investment in energy RD&D. The doubling goals of Alexander's "New Manhattan

Project" and Mission Innovation could, in principle, be accommodated within the budget agreement, because federal energy RD&D spending accounts for just 1.2 percent of the non-defense discretionary budget. Double-digit increases in this small slice of the budget could be offset elsewhere without breaching the overall spending cap.

In practice, however, E&W's ability to act on Senator Alexander's agenda will be limited by the chamber's leadership, which will determine how much money will be allocated to its bill and the 11 others that comprise the budget.

U.S. Competitiveness in Clean Energy at Risk

In 2007, the National Academies released its groundbreaking report *Rising Above the Gathering Storm*, which examined U.S. leadership and competitiveness in science and technology. The report concluded that without increased RD&D investments, the United States risked falling behind other nations—particularly in clean energy innovation. And in 2008, Sen. Lamar Alexander (R-TN) first proposed a "New Manhattan Project for Clean Energy" that entailed a doubling of funding at DOE's applied energy technology RD&D programs. The doubling goal was adopted when the United States joined Mission Innovation in 2015 and committed to doubling its clean energy RD&D by 2021. However, actual appropriations have not matched these funding targets, and the United States remains far short of its doubling goal.

As a result, U.S. competitiveness in the global clean energy industry may be at risk. Eleven other countries—including China—invest more in energy RD&D as a share of their economy than the United States. As other countries have stepped up their investments in clean energy, the share of cleantech patents granted by the U.S. Patent and Trade Office to U.S. companies has declined, from roughly 50 percent in 2001 to less than 40 percent in 2016.

For these reasons, many prominent government and industry leaders have recommended doubling or even tripling federal funding for energy RD&D. In 2018, the American Energy Innovation Council called for a federal energy RD&D budget of $16 billion annually to bring the energy sector closer to other advanced technology sectors.

ENERGY RD&D IN SENATE APPROPRIATIONS: WHAT WE'RE WATCHING

Once E&W's allocation (known as 302(b)) is fixed, the subcommittee will have to decide how much to invest in each of DOE's energy RD&D programs as well as other programs and agencies within its jurisdiction, such as the Department of Interior and Army Corps of Engineers. The FY 2019 E&W 302(b) allocation was $44.6 billion, of which $35.7 billion went to DOE. But only about 20 percent of DOE's budget, about $7.3 billion, supports energy innovation, with defense, environmental cleanup, and non-energy-related basic science research accounting for the rest.

In addition to the topline numbers, we are also tracking individual **program funding levels** for each of the applied energy technology and energy science programs within DOE. Table 1 displays the final FY 2019 budget, the FY 2020 administration request, and the FY 2020 House-approved appropriations bill, broken down by major function.

Table 1: DOE FY 2020 spending proposals by function, in millions ($)[13]

	FY 2018 Enacted	FY 2019 Enacted	FY 2020 WH Request	FY 2020 House
DOE Total Budget	34,520	35,685	31,502	37,087
Defense	15,509	16,089	17,520	16,796
Environmental Management	7,126	7,175	6,559	7,175
Basic Science Research	3,548	3,755	3,185	3,939
Other	769	749	736	762
DOE Energy RD&D Programs*	7,568	7,917	4,142	8,416
ARPA-E	353	366	-287	428
Electricity Delivery/CESER	248	276	339	350
Cybersecurity for Energy Systems	-	90	75	95
Transmission & Distribution R&D	125	132	156	173
Energy Efficiency & Renewable Energy	2,322	2,379	343	2,652
Sustainable Transportation				
Vehicle Technologies	338	344	73	370
Bioenergy Technologies	222	226	40	256
Hydrogen & Fuel Cell Tech	115	120	44	144
Renewable Energy				
Solar Energy	242	247	67	270
Wind Energy	92	92	24	104
Water Power	105	105	45	125
Geothermal Technology	81	84	28	90
Energy Efficiency				
Advanced Manufacturing	305	320	81	360
Building Technologies	221	226	57	248
Fossil Energy R&D	727	740	562	740
CCUS and Advanced Power Systems	481	486	387	504
Natural Gas Technologies	50	51	11	48
Unconventional Oil Technologies	40	46	19	30
Other R&D	51	51	41	51
Nuclear Energy	1,205	1,326	824	1,318
Reactor Concepts RD&D	237	324	215	325
Nuclear Energy Enabling Tech	159	153	98	125
Fuel Cycle R&D	260	264	90	319
Other R&D	13	13	0	13
Science	6,260	6,585	5,546	6,870
Basic Energy Sciences	2,090	2,166	1,858	2,143
Fusion Energy Sciences	532	564	403	688
BER Bioenergy Research Centers	90	100	100	100

* Energy RD&D program office funding levels include some non-RD&D functions (e.g., the Weatherization Assistance Program in EERE). Therefore we estimated total energy RD&D to be slightly less than the sum of funding for all energy RD&D program offices. See endnote 11 for details.

We are also tracking **congressional direction to DOE** in the committee reports that accompany the appropriations bills in both chambers. These reports provide additional guidance to ensure that DOE investments match congressional priorities. Typically, both the House and Senate committee reports are binding except when they are superseded by a final joint explanatory report from the House-Senate conference committee.

Advanced Research Projects Agency–Energy

Funding for Advanced Research Projects Agency – Energy (ARPA-E) had never approached the $1 billion recommended by the National Academies when it proposed creating the agency as a way to advance high-potential, high-impact energy technologies that are too risky for private-sector investment.

But support for ARPA-E has been building, potentially setting it up for a large boost in FY 2020. The agency received modest increases in the each of the last 6 years, reaching its current high of $366 million in FY 2019. The last two increases came in a Republican-controlled Congress that rejected repeated attempts by the Trump administration to eliminate ARPA-E. Both parties in the House have expressed their support for the agency through reauthorization bills. The bills differ mainly over how quickly to increase funding. The Republican bill would increase funding gradually to $500 million by 2024, whereas the Democrats' opts for a steeper ramp to the $1 billion in the same period.[14]

The House appropriations bill would fund ARPA-E at $428 million for FY 2020.[15]

Clean Energy Manufacturing Institutes

Manufacturing plays an outsize role in the health of the U.S. economy because of its impact on trade and innovation, and its large multiplier effect on other sectors. The Clean Energy Manufacturing Institutes (CEMIs) sponsored by DOE support U.S. manufacturers in their efforts to accelerate innovation.

DOE has adopted a five-year window for the CEMIs to transition to other funding sources. All program participants recognize that a full transition within five years will be extremely challenging. Indeed, comparable programs in other countries, such as Germany's Fraunhofer Institutes, receive core institutional funding from the government on a permanent basis. The five CEMIs, including PowerAmerica and the Advanced Composites Manufacturing Innovation, which are nearing the end of their initial federal funding, could be cut off from federal support without completing their task of rebuilding U.S. manufacturing. Congress could continue to support these institutes—possibly at a reduced level of funding—without running afoul of authorizing language. Such funding would offer flexibility to institute managers and provide confidence to industry members, while also sustaining vital programs for workforce development and engagement with small and medium-sized manufacturers that might otherwise be put at risk.[16]

Harder-to-Decarbonize Sectors and Key Technologies

The energy innovation agenda of the last 10 years has focused, with considerable success, on reducing the cost and expanding the use of wind and solar resources for electricity generation. It is time now to expand the agenda beyond this "low-hanging fruit." Reducing carbon pollution to zero will require a broader set of technologies that cover all sectors of the economy in order to

provide clean energy that is as cheap and reliable as that from fossil fuels. The effort should tackle air travel, shipping, long-distance trucking, heavy industry (cement, steel, chemicals, etc.), and other end uses for which there are currently no good zero-carbon options. ITIF has identified several key science and technology missions for the federal government to address these harder-to-decarbonize sectors.[17]

Advanced Nuclear Energy

Recent action in Congress and by the administration aims to jump-start RD&D in advanced nuclear technologies. In the last budget cycle, the administration proposed a new R&D subprogram focused on advanced (non-light-water) small modular reactors (SMRs), to which Congress appropriated $100 million in FY 2019. The administration's FY 2020 budget would cut funding of the advanced SMR subprogram to $10 million, but the House appropriations bill maintains the investment at $100 million.

Many advanced reactor designs are fast reactors that do not use a moderator to slow down neutrons. Development of these reactor concepts will require testing of materials and fuel designs in a fast-neutron environment, but the United States currently has no fast-neutron research facilities. In FY 2019, Congress appropriated $65 million toward the design of a Versatile Advanced Test Reactor to fill this gap. The House FY 2020 bill maintains flat funding at $65 million "to pursue conceptual design and other activities necessary to achieve Critical Decision-1 (CD-1), Alternative Selection and Cost Range." The House also directs DOE "to identify ways to reduce the cost and address the timeline of the Versatile Advanced Test Reactor, including the potential for international collaboration and cost-sharing."[18]

Carbon Capture for Natural Gas Power Plants and Industrial Sources

For years, federal investment in carbon capture technologies RD&D has focused almost exclusively on coal-fired power plants. Indeed, DOE's carbon capture program is located in the "Coal CCS and Power Systems" program office. But carbon capture technologies are applicable to a range of other sources that have been neglected by DOE, including natural gas power plants and industrial facilities. While past appropriations bills have encouraged the department to fund RD&D that benefits both natural gas and coal power plants, such pronouncements have come with the condition that funding for coal projects remain undiminished. For the first time, the House FY 2020 bill includes $7 million for natural gas systems, and $4 million for industrial facilities.

Direct Air Capture of Carbon Dioxide

Direct air capture (DAC) is a family of technologies that separates carbon dioxide from the air for the purposes of using it or sequestering it to reduce the gas's atmospheric concentration. DAC differs from conventional climate mitigation technologies, which either prevent the creation of carbon dioxide in the first place or remove it from a facility's waste stream, where its concentration is much higher than in the atmosphere. DAC is one of a set of carbon dioxide removal technologies that the National Academies recommended for further federal RD&D in a landmark report in 2018.[19] The House bill includes $10 million for DAC and directs the Office of Fossil Energy to collaborate with the Bioenergy Technologies Office on this program.

Long-Duration Energy Storage for the Grid

Advances in energy storage technologies have the potential to transform the U.S. electricity system by bolstering grid reliability, reducing electricity market prices, and improving the integration of a diverse clean energy generation mix.[20] To date, DOE's research in low-cost grid-scale storage has focused primarily on short-duration (hourly) storage and has been scattered among different programs and offices throughout DOE. The House bill directs DOE "to establish a crosscutting program to lower the cost of long duration grid-scale energy storage" that "leverage[s] the energy storage work being conducted within the Offices of Science, Energy Efficiency and Renewable Energy, Nuclear Energy, and Fossil Energy," along with the Office of Electricity's (OE) Energy Storage program. The House bill boosts OE's storage funding to $57 million, and also provides $5 million to establish a grid storage launch pad for development, testing, and evaluation of battery systems, as the administration proposed. The House also directs DOE to provide a report that sets cost and performance targets, identifies emerging energy-storage applications, and outlines a strategy for coordinating and aligning RD&D across the DOE programs.[21]

Carbon-Neutral Fuels: A New "Fuels From Sunlight" Hub

Fuels such as hydrogen, ammonia, and synthetic hydrocarbons that are made using energy from renewables or other low-carbon energy sources can address multiple decarbonization challenges. Support for carbon-neutral fuels is scattered throughout DOE. The Fuels From Sunlight Hub housed in the Basic Energy Sciences (SC-BES) program aims to generate fuels directly from sunlight, water, and carbon dioxide—a form of artificial photosynthesis. The hub—managed jointly by Caltech and Lawrence Berkeley National Laboratory—will complete its second five-year term in FY 2019. In FY 2020, DOE will hold an open competition to solicit proposals for a new hub, and the administration has requested $20 million for that purpose, a $5 million increase over FY 2019. The House bill provides flat funding at $15 million.[22]

The House bill provides $21 million for an integrated nuclear energy/hydrogen production demonstration project, to be cost-shared between the Office of Nuclear Energy and the Hydrogen and Fuel Cells Technologies Office. The House bill also provides $30 million within the Office of Fossil Energy's Solid Oxide Fuel Cells program to focus on hydrogen production and storage.[23]

Long-Distance Trucking

Heavy-duty, long-haul trucking is an especially challenging transportation subsector to decarbonize. The Li-ion batteries that could enable electrification of light-duty cars and trucks are unlikely to become good enough to electrify long-distance trucking. DOE's SuperTruck II program aims to improve the freight-hauling efficiency of heavy-duty Class 8 long-haul trucks. Achieving the SuperTruck II technology cost and performance targets would save truck operators nearly $20 billion in fuel expenditures, while also reducing carbon dioxide emissions by 128 million metric tons.[24] The Trump budget request would eliminate SuperTruck II, whereas the House bill provides $20 million to continue the program.

Industrial Decarbonization Roadmaps

Many industrial sectors—including cement, steel, and chemicals—are challenging to decarbonize, either because they emit carbon dioxide as a result of chemical reactions that have

nothing to do with energy consumption or because they require high-temperature heat that is hard to produce without fossil fuel combustion. Industrial decarbonization has begun to receive greater attention from policymakers in both chambers of Congress. For example, the Clean Industrial Technology Act, led by Sens. Whitehouse (D-RI), Capito (R-WV), Braun (R-IN), and Machin (D-WV), and Reps. Casten (D-IL), McKinley (R-WV), Johnson (D-TX), and Radewagen (R-AS), would establish a new crosscutting RD&D program.

While appropriators are generally hesitant to establish new RD&D programs in advance of authorizing legislation, they sometimes complement authorizers' efforts by directing studies of key issues. House appropriators have chosen this approach for industrial decarbonization, directing DOE to develop roadmaps to guide future RD&D efforts. The new roadmaps would build on prior DOE energy efficiency studies and focus on industrial process electrification and carbon capture.

Support for a Complete Innovation Agenda

Both chambers have firmly rejected the administration's focus on early-stage research, acknowledging that federally supported mid- and late-stage RD&D is necessary to integrate early-stage research into the nation's energy system. Variations of "research, development, demonstration, and deployment" (RDD&D) have appeared throughout the House and Senate guidance to DOE in previous years. In its FY 2020 bill, the House affirmed that DOE should continue to support all stages of innovation:[25]

> While early-stage research and development has an appropriate place in a balanced research portfolio, the Committee strongly believes that a focus on only early-stage activities will forego the nation's scientific capabilities in medium- and later-stage research and development and will not fully realize the technological advancements that can and should happen as a result of the Department's applied energy activities. The Committee provides robust funding to support a comprehensive, balanced approach that also includes medium- and later-stage research, development, deployment, and demonstration activities.

Congress has firmly rejected the administration's focus on early-stage research, and directs DOE to support all stages of innovation, including mid- and late-stage RDD&D.

This support for a complete innovation agenda is likely to be echoed in the FY 2020 Senate bill. However, DOE program managers and other administration officials have wide latitude in how they design and implement their RD&D programs, leaving considerable wiggle room for DOE's interpretation of congressional direction. In recent years, Congress has been incorporating more explicit and granular direction in its committee reports—often down to the subprogram and research activity level, and in some cases specifying that funding is to be used for pilot- and demonstration-scale projects—to ensure that DOE invests in a complete energy innovation agenda.

Crosscutting Initiatives

Crosscutting initiatives are important mechanisms for breaking out of the technology silos of DOE's science and energy technology offices to draw on expertise and perspectives from across

the department. Crosscutting initiatives do not have a separate control point in appropriations bills, and in the past have been largely driven by the executive branch with limited congressional input.

In the FY 2019 cycle, however, Congress included express directions regarding several crosscutting initiatives. For example, both House and Senate appropriators indicated their support for DOE's Grid Modernization Initiative (GMI). The Senate directed DOE to provide a plan to Congress to extend GMI "to include priorities for field validation of the most successful research outcomes… to accelerate adoption of the key Department results." Other crosscutting initiatives receiving congressional attention included the Energy-Water Nexus, the Beyond Batteries Initiative, and the Materials Working Group.

The House was largely silent on crosscutting initiatives in its FY 2020 bill, and it will be interesting to see whether the Senate picks up the slack.

APPROPRIATIONS OUTLOOK: FY 2021 AND BEYOND

The outlook for FY 2021 is similar to FY 2020. The budget agreement makes space for modest increases in energy RD&D, but the double-digit increases envisioned in Senator Alexander's Manhattan Project and Mission Innovation are unlikely without sustained and growing support for innovation investments from congressional leadership. Nonetheless, the agreement ends the threat of sequestration imposed by the Budget Control Act of 2011, and provides Congress with a window to set priorities for federal investment in energy RD&D.

This priority-setting process will need to take place in both appropriations and authorizing committees. The House Science, Space, and Technology Committee, which has jurisdiction over DOE's energy RD&D programs, has already approved legislation authorizing a ramp-up in funding for the solar, wind, and fossil energy programs, and will hold more hearings in the fall. The Senate Energy and Natural Resources Committee has been more reluctant to authorize new spending. Both chambers should broaden support for federal investment in energy RD&D, so that the United States can meet its myriad clean energy innovation challenges.

About The Author

Colin Cunliff is a senior policy analyst with the Information Technology and Innovation Foundation, where he focuses on clean energy innovation. He previously worked at the U.S. Department of Energy (DOE) in the Office of Energy Policy and Systems Analysis as a AAAS Science & Technology Policy Fellow, with a portfolio including energy sector resilience and environmental mitigation. He holds a Ph.D. in physics from the University of California, Davis, and bachelor's degrees in physics and mathematics from the University of Texas in Austin.

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ENDNOTES

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total energy RD&D number is less than the sum of all energy RD&D program offices, because some offices include non-RD&D activities. See endnote 11.

10. Colin Cunliff, "Mission Innovation: Despite Trump, America Is Still In" (Information Technology and Innovation Foundation, 2018), https://itif.org/publications/2018/05/22/mission-innovation-despite-trump-america-still.
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