Energy Innovation in the FY 2021 Budget: Congress Should Lead

BY COLIN CUNLIFF | MARCH 2020

Congress should make energy innovation a national imperative, and at least double U.S. investment in clean energy RD&D by 2025.

As it has in the past three budget cycles, the Trump administration has once again proposed massive cuts to energy research, development, and demonstration (RD&D), placing the administration's budget request in tension with bipartisan congressional efforts to reinvigorate the national energy innovation system.[1] Fortunately, Congress has soundly rejected the administration's previous budget proposals in this area, instead putting forward a positive vision for American innovation that invests in a future of clean, reliable, low-cost energy. Congress has also produced a strong slate of bipartisan, bicameral authorizing bills that would accelerate innovation if backed by significant new funding commensurate with the challenge.[2] Congress should keep up the momentum of the past three fiscal years and continue to elevate clean energy innovation as a national priority.

The administration's latest budget request would slash federal investments in the Department of Energy's (DOE) applied energy programs—including energy efficiency, renewable energy, sustainable transportation, fossil energy, nuclear energy, and grid modernization—by more than 44 percent, from $5.4 billion in FY 2020 to $3.0 billion in FY 2021. Popular and effective initiatives including the Advanced Research Projects Agency-Energy (ARPA-E), Title XVII loan guarantee program, and advanced vehicles manufacturing loan program would be eliminated. Even the basic energy-related research within the DOE Office of Science (SC)—which includes programs in fusion, bioenergy, and basic energy sciences, and falls squarely within the definition of "early stage research" the administration claims to support—would receive an 18 percent cut, from $3 billion in FY 2020 to $2.5 billion.[3] If enacted, this budget would impose the largest single-year cut to energy RD&D investments in the history of the department, bringing federal energy RD&D down to its lowest level since 2007.

Even more troubling, the proposed cuts come amid signs of a struggling domestic clean energy industry that is at risk of falling behind international competitors. China has ramped up investments in energy RD&D and now invests far more than the United States in key technologies, including solar energy, lithium-ion batteries, advanced nuclear, carbon capture, and electric vehicles. Europe is outstripping the United States in offshore wind. And U.S. companies account for a declining share of new cleantech patents, indicating the United States is falling behind in innovation.[4]

Congress has wisely taken note of these developments, providing significant boosts to federal clean energy RD&D investment in each of the last three budget cycles and using its authorizing powers to address key innovation challenges.[5] Support for more aggressive federal investments spans the political spectrum from conservative House Republicans, who have begun to tout innovation to address climate change, to progressive Democrats, who acknowledge that innovation will be needed to fully eliminate carbon emissions.[6]

The Trump administration has recognized the need to invest in innovation in order to maintain international leadership in certain emerging technologies. Its Industries of the Future initiative proposes to double federal investment in artificial intelligence, quantum information sciences (QIS), and other areas.[7] However, the administration's failure to include clean energy technologies on this list—in concert with its determination to double down on its support of unabated fossil fuels—represents a huge missed opportunity that would radically diminish America's role in the coming global transition.

Congress should reject the president's budget request and continue to elevate innovation in clean energy as a national priority in 2021. The Information Technology and Innovation Foundation (ITIF) recommends that Congress:

- Provide robust investment in clean energy innovation during the FY 2021 appropriation cycle, while laying the groundwork for an aggressive multiyear increase, similar to the five-year doubling for medical research at the National Institutes of Health (NIH) in 1998–2003;[8]
- Grow the ARPA-E budget to $1 billion by 2025;[9]
- Initiate new programs that address innovation gaps, particularly for manufacturing and harder-to-abate sources of carbon emissions in the industrial and transportation sectors, as well as for technologies to remove carbon directly from the air;[10] and
- Build a robust, diverse portfolio of large-scale energy technology demonstration projects.[11]

This report first describes the key role of the federal government in the U.S. energy innovation system. It then provides a high-level overview of DOE's current energy RD&D portfolio, what is at risk in the administration's FY 2021 budget request, and next steps in the appropriations process. Companion to this report is a series of short, 4-page briefs on the 19 science and technology program offices that make up DOE's energy innovation portfolio, detailing what would be put at risk by the administration's proposed cuts, and opportunities that might be realized through expansion.

THE KEY ROLE OF THE FEDERAL GOVERNMENT IN THE U.S. ENERGY INNOVATION SYSTEM

Both public and private investment play complementary roles in the commercialization of new energy technologies. The private sector is very good at improving mature technologies and developing nearly mature ones into marketable products. It does so in response to considerations such as competitive advantage, time to market, return on investment, and other economic incentives. Industry is the primary innovator in the United States, accounting for nearly 70 percent of total research and development (R&D) spending across all industries.[12] However, industrial innovation is by nature incremental and focused on relatively short-term payoffs.[13]

The energy industry invests a very small share of its revenues, just 0.5 percent, in R&D.[14] That is far less than the 14.2 percent R&D-to-revenue ratio found in pharmaceuticals, 11.3 percent in computers and electronics, 7.5 percent in aerospace and defense, and even 3.2 percent in autos.[15] The American Energy Innovation Council (AEIC), a group of the nation's most prominent corporate leaders, has made a detailed analysis of the challenges that limit private-sector innovation in the energy sector. These include high capital-intensity and long payback periods for investments.[16] Even venture capital funding, which tends to be less risk averse than other sources of private capital, favors payback times and returns on investments that make it a poor match for the cleantech industry.[17]

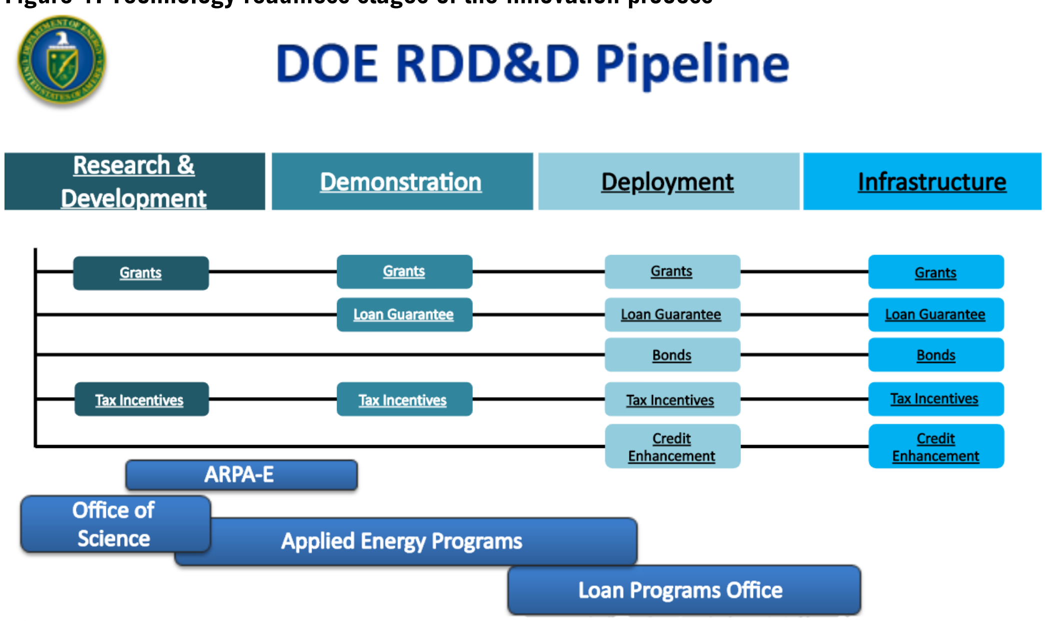
In addition, because energy is valued as a commodity—i.e., there is no tangible difference in the electricity that comes from a coal plant versus a wind farm—emerging energy technologies frequently cannot distinguish themselves from incumbent technologies and must therefore compete on price and performance from the moment they enter the market.[18] Electric utilities are often legally mandated to keep prices low, and are prohibited from investing in new technologies.[19]

The federal government is uniquely suited to address these barriers, making high-risk, long-term investments the private sector is simply unwilling to fund. The shale-gas revolution provides a case in point: Federal support for the development of advanced drill bits, directional drilling, and shale resource characterization in the late 1970s ultimately led to the shale-gas revolution in the mid-2000s, driving down energy costs for millions of Americans and enabling the United States to become a net exporter of natural gas.

But the path from discovery of domestic shale resources to widespread shale-gas production entailed more risk than any single company could bear, and required a range of policies working in concert to bring shale gas to market. The federal government funded fundamental research, countenanced and funded industry-wide collaboration in applied R&D that might otherwise have drawn antitrust scrutiny, and subsidized industry-led demonstrations of the first horizontal wells in West Virginia and Texas. This technology push overlapped with a time-limited production tax credit that provided a complementary pull. By 2002, when federal support tapered off, shale gas had grown to account for 2 percent of domestic gas production and was able to compete in the market on its own. Since then, shale gas production has grown dramatically, to more than 70 percent of domestic gas production.[20]

As the shale-gas example illustrates, accelerating energy innovation requires a range of policies acting together across the innovation spectrum (see figure 1). For technologies that are far from commercialized, basic and applied research and technology development are necessary to improve the performance and drive down the cost of emerging technologies to the point entrepreneurs and corporate R&D units jump in. As technologies mature, successful demonstration at commercial scale is required to establish cost, reliability, and performance characteristics, and provide confidence to more risk-averse investors and the public that the technology works as intended at a manageable cost. Additional tools such as loan guarantees for first-of-a-kind commercial projects and "market pull" policies such as tax incentives and clean energy standards bring technologies further down the cost curve. Public investment as a share of the total spent on each technology generally declines as it matures, from full public support for basic research to significant levels of private-sector cost sharing in the development and demonstration stages.

Figure 1: Technology readiness stages of the innovation process[21]



DOE's key role in bringing shale-gas technology to maturity is just one example in an impressive list of accomplishments. Federal investments by DOE's predecessor agencies were responsible for launching the private nuclear industry, which now contributes 20 percent of U.S. electricity. DOE helped develop low-cost flue-gas desulfurization scrubbers for power plants, which made the United States into a global leader in pollution control technologies, while also lowering energy costs and improving air quality for all Americans. And new methods for producing quantum dots—which have applications in high-efficiency TV screens, solid-state lighting, and quantum computing—were first developed in DOE laboratories. In each of these cases, the road from discovery to deployment took decades, required government investment to develop and "de-risk" the inventions, and entailed public and private partners working together to bring them to market.

AEIC summed things up in its 2020 report "Energy Innovation: Supporting the Full Innovation Lifecycle":[22]

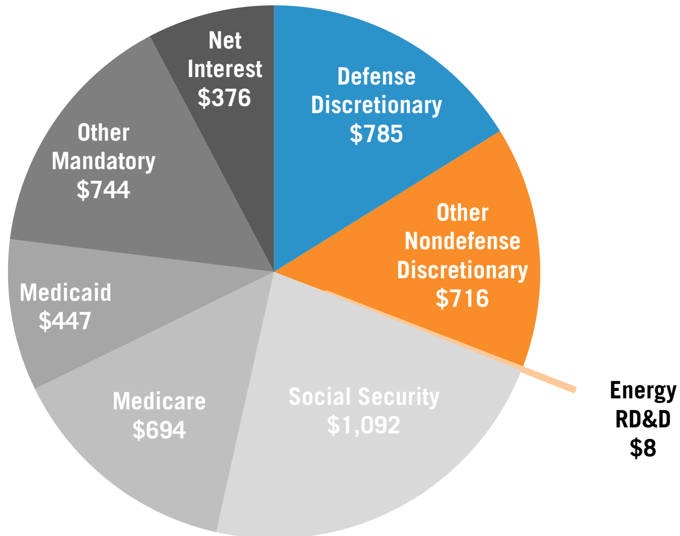
> [T]he U.S. government has long been a driving force in generating scientific breakthroughs, as well as a key partner to industry in funding technologies that have become central to modern life and the productive functioning of an advanced economy. This isn't to diminish the importance of industry research, but rather to acknowledge innovative technologies often emerge from the cross-pollination of ideas supported by both government and industry. … the public and private sector have unique strengths and differences in risk tolerance, and each plays a crucial and interdependent role across the innovation cycle.

FEDERAL ENERGY RD&D: GENERATING HUGE RETURNS ON A MODEST INVESTMENT

Out of a total budget of nearly $4.8 trillion, the federal government funded DOE at $38.6 billion in FY 2020. But only $8 billion—about 21 percent of DOE's budget and less than 0.2 percent of the federal budget (see figure 2)—supports energy innovation, with defense, environmental cleanup, and non-energy-related basic science research accounting for the rest. Federal investment in energy RD&D is an even smaller share of the U.S. economy, only about 0.04 percent of U.S. gross domestic product (GDP).

DOE was created in the late 1970s—a time when energy demand was increasing rapidly, energy prices were high and rising, and the Organization of the Petroleum Exporting Countries (OPEC) was flexing its muscles in global oil markets. Energy innovation and the development of domestic clean energy resources were viewed as matters of economic and national security. In 1978, Congress invested more than $10.5 billion (in 2020 dollars) in energy RD&D, or 0.14 percent of GDP. Had federal investment kept pace with growth in the economy, DOE's RD&D budget today would be $32 billion, on par with other national priorities such as health research.[23]

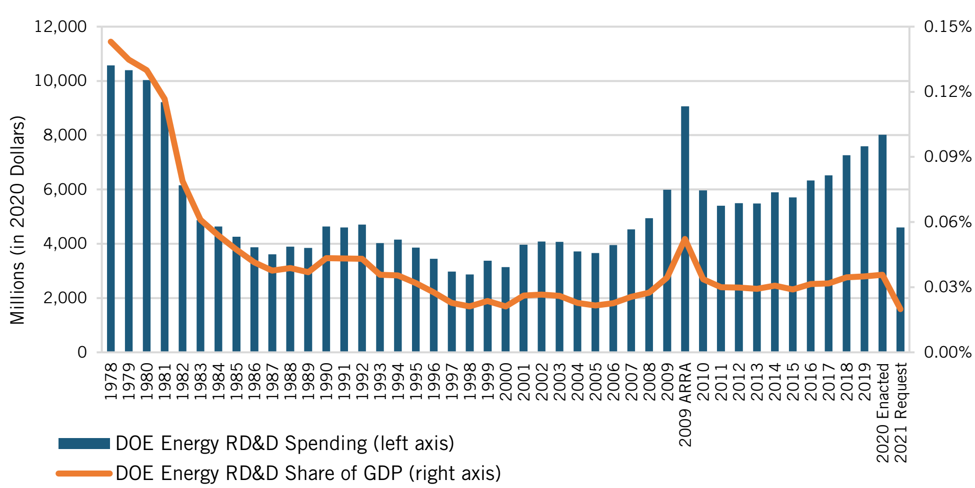
Figure 2: Federal energy research as a share of total outlays in FY 2020 (in billions)[24]



> *U.S. investment in energy research has declined from 0.14 percent of GDP in 1978 to 0.04 percent in 2019. Had investment kept pace with the economy, DOE's RD&D budget today would be $32 billion.*

The threat posed by climate change is more severe than the energy shortage crises of the late 1970s, but the government is investing far less in energy innovation to meet this challenge. As energy prices fell in the 1980s, energy innovation receded as a national priority, with funding levels hovering below $4 billion for most of the mid-1980s through the early 2000s. During the George W. Bush administration, Congress began increasing funding in response to higher energy prices and reports that the United States risked falling behind other nations in clean energy.[25] And as part of Mission Innovation—an international agreement launched in tandem with the Paris Climate Agreement to accelerate clean energy innovation—the United States committed to doubling clean energy RD&D by 2021, providing additional impetus for congressional appropriators.[26] Congress has increased budgets for DOE's energy programs for 11 of the last 15 years, but annual appropriations have consistently fallen short of doubling targets, and funding has not yet returned to its 1978 level (see figure 3).

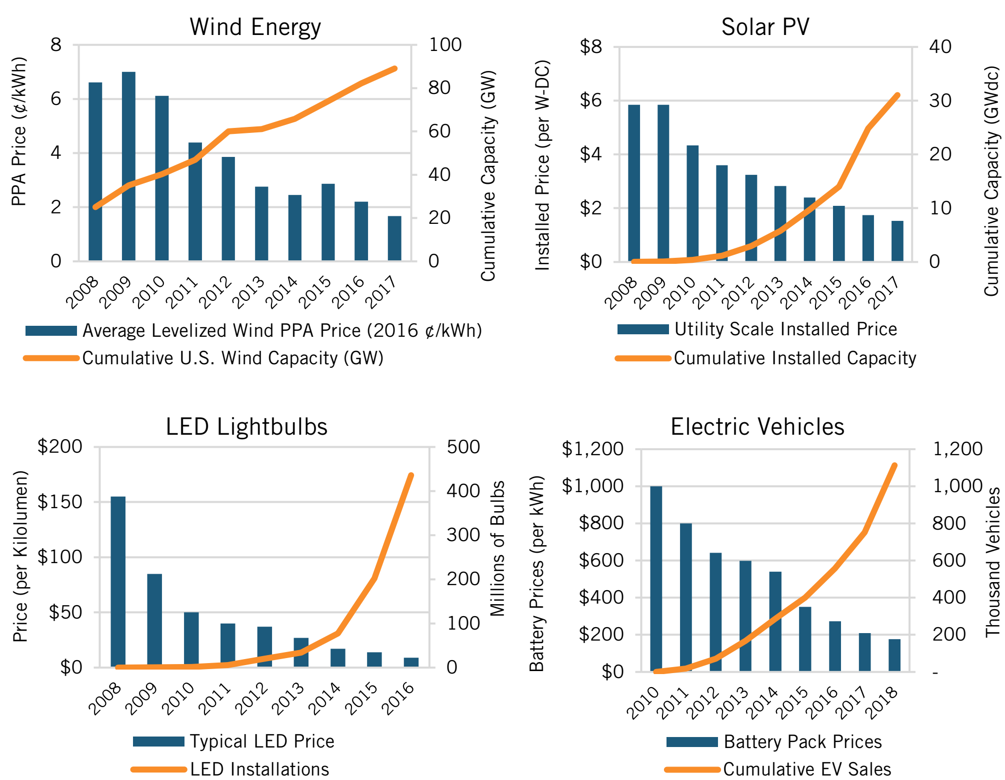
Figure 3: U.S. DOE RD&D spending, FY 1978 through FY 2021 request[27]



Despite a comparatively small investment, federal energy RD&D has delivered big returns for the American public. Decades of federal investment in solar and wind power, lithium-ion batteries, and efficient LED lightbulbs, for instance, have led to cost reductions ranging from 55 to 94 percent since 2008, leading to impressive growth in adoption, and generating huge benefits for taxpayers (see figure 4).[28] An external review of energy efficiency and renewable energy RD&D at DOE found that a total taxpayer investment of $12 billion between 1975 and 2015 yielded more than $388 billion in net economic benefits, a remarkable return of over $32 for every federal dollar invested.[29]

Similarly, a review of the Building Technologies Office (BTO)—which accounts for just 4 percent of DOE's applied energy budget—found that federal investments between 2010 and 2015 culminated in the successful commercialization of 27 products, including energy-efficient water heaters, solid-state lighting, and energy-saving windows.[30] A retrospective assessment of BTO investments between 1976 and 2015 across three technology areas—heating, ventilation, and air conditioning (HVAC); water heating; and appliances—found that BTO investments have yielded a benefit-to-cost ratio of more than 20 to 1.[31]

Figure 4: Cost reductions and capacity buildouts in four key clean technologies[32]



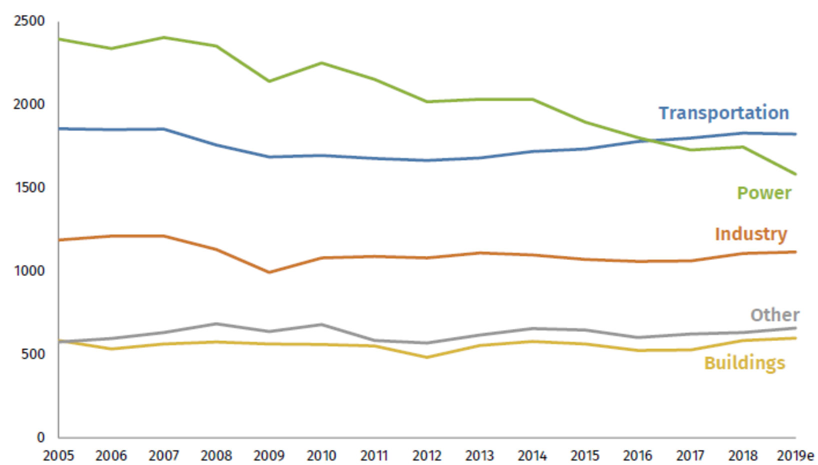
DOE research has also helped reduce the environmental impacts of fossil fuel consumption. DOE partnerships with major engine manufacturers to develop more-efficient diesel engines saved the U.S. trucking industry 17.6 billion gallons of diesel fuel over the 12 years between 1995 and 2007, which translated into $34.5 billion in reduced fuel expenditures and $35.7 billion in health and environmental benefits from lower pollution.[33] DOE leadership in carbon capture technologies led to successful first-of-a-kind demonstrations of carbon capture at a fertilizer production facility (Port Arthur, in 2013), a corn ethanol refinery (ADM, in 2017), and a coal power plant (Petra Nova, in 2017).[34] And DOE has issued a conditional loan guarantee of up to $2 billion to build the world's first clean methanol facility with carbon capture in Lake Charles, Louisiana, with construction slated to begin in mid-2020.[35]

DOE is now preparing to launch new programs to address new challenges. The Office of Fossil Energy (FE) is beginning to research technologies that can remove carbon dioxide directly from the atmosphere. The Geothermal Technologies Office is building a field laboratory in Milford, Utah, to research systems that may ultimately provide clean baseload power.[36] The Nuclear Energy (NE) office is planning a versatile test reactor user facility in Idaho to jump-start innovation in advanced non-light-water nuclear reactors.[37] The Solar Energy program just released a new funding opportunity announcement that aims to demonstrate concentrating solar power with a supercritical Brayton cycle, improve efficiencies of solar photovoltaics (PVs), and develop innovative solar PV manufacturing technologies and processes.[38] Such initiatives are promising, but are just the beginning of what should be long-term, multiyear investments. Many of them would receive reduced funding or be eliminated under the administration's proposal.

Every $1 invested in energy efficiency and renewable energy RD&D between 1975 and 2015 returned an average of $32 in economic benefits to the American taxpayer.

But even at current funding levels, DOE's energy programs fall far short of accelerating the pace of innovation sufficiently to meet the climate challenge. While emissions in the electricity sector have declined due to cheap natural gas and subsidized renewables, emissions from the industrial sector have barely budged in recent years, and emissions from transportation and buildings sectors are increasing (see figure 3). RD&D programs that would tackle emissions in these large and growing hard-to-decarbonize sectors comprise a disproportionately small portion of DOE's portfolio. For example, the industrial sector accounts for 22 percent of direct greenhouse gas (GHG) emissions but only 6 percent of DOE's overall energy RD&D budget.[39]

Figure 5: Net U.S. GHG emissions by sector[40]



Source: Rhodium Climate Service

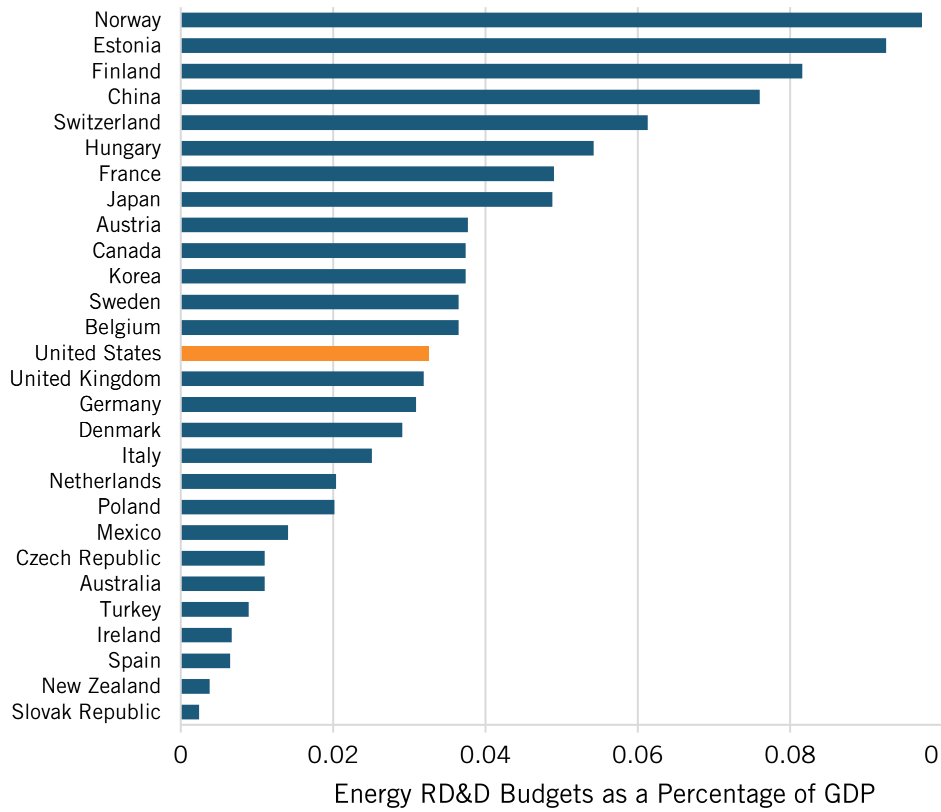
Lack of federal investment is putting U.S. competitiveness in the growing global clean energy industry at risk. While the United States is the world's top funder of energy innovation on an absolute basis, China is rapidly scaling up its energy RD&D investments, and will soon surpass the United States. [41] And 13 other countries invest more in energy RD&D as a share of their economies than the United States (see figure 6).[42] As other countries have stepped up their investments in clean energy, the share of cleantech patents granted to U.S. companies by the U.S. Patent and Trade Office has declined, from roughly 50 percent in 2001 to less than 40 percent in 2016, indicating U.S. leadership in innovation is on the decline.[43]

In 2019, ITIF released a comparative analysis of national energy innovation systems, finding that U.S. leadership in energy innovation is being challenged along multiple fronts, and the U.S. energy innovation system is comparatively weak when it comes to scaling up and commercializing emerging clean technologies. The report evaluates 22 nations and the European Union across 3 essential functions of an innovation system: the ability to generate new clean energy options (option generation); the ability to refine and scale up options into marketable products (scale up); and the extent to which a nation's political, legal, and regulatory institutions provide the social "license to operate" needed for innovations to scale up (social legitimation). The United States ranks third in its ability to generate new clean energy options, owing to its robust support for basic energy-related science research, and its ability to generate new inventions. But the United States comes in 8th in its ability to scale up new energy technologies, and 15th on the social legitimation index. Though the United States has enormous strengths and capacity to innovate, its position as a global leader in clean energy innovation is being challenged by other nations.

For these reasons, many prominent government and industry leaders have recommended doubling or even tripling federal funding for energy RD&D. In 2020, the corporate leaders comprising AEIC reiterated their call for a federal energy RD&D budget of $16 billion annually to bring this sector closer to other advanced technology sectors.[44] In its *Getting to Zero* report, the Center for Climate and Energy Solutions (C2ES) recommended increasing climate-related R&D to $20 billion annually by 2030, and investing $50–100 billion over the next decade for high-impact demonstration projects.[45]

Many congressional leaders have also called for renewed commitment to energy innovation, along with significant increases in federal RD&D. In April 2019, Senator Lamar Alexander (R-TN), who chairs the Energy & Water Appropriations Subcommittee, renewed his call for a "New Manhattan Project for Clean Energy" that would double funding for applied energy RD&D over five years.[46] The subcommittee's ranking member Dianne Feinstein (D-CA) also supports increased investment in energy RD&D. And in January 2020, House Republicans unveiled their plan to address climate change and competitiveness through innovation, which includes doubling funding for basic energy-related science research over five years.[47]

Figure 6: Government energy RD&D investment as a percentage of GDP, 2017[48]



Such an increase is not unprecedented. Congress doubled investment in biomedical research at NIH over a five-year span, from 1998 to 2003. Doing the same for climate- and energy-related research would elevate energy innovation as a national priority and bring funding for clean energy RD&D closer to other national priorities.

THE TRUMP BUDGET: A DRAG ON INNOVATION

The administration's FY 2021 budget fails to meet the moment. Far from putting energy RD&D on a doubling track, it would result in the largest single-year decrease in DOE's history. It is based on three flawed rationales: first, that the private sector will pick up the slack if the federal government withdraws from mid- and late-stage energy technology RD&D; second, that the success of certain technologies that have seen dramatic price reductions in recent years—such as wind power, solar power, and electric vehicles—means federal action to spur further energy innovation is no longer needed; and third, that the government cannot invest in innovation when it is running a budget deficit.

The Office of Management and Budget (OMB) has directed agencies to focus RD&D spending on early-stage research, and has issued guidance that "federally funded energy R&D should continue to reflect an increased reliance on the private sector to fund later-stage research, development, and commercialization of energy technologies."[49] The proposed cuts therefore fall most heavily on the applied research, development, and demonstration programs that help technologies scale up (see figure 7).

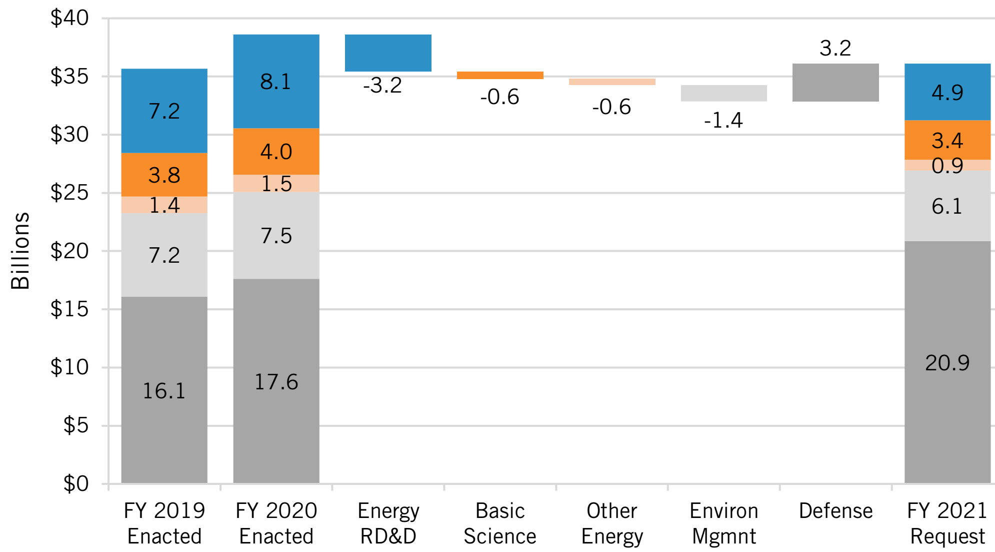
But public support for emerging energy technologies is needed across the innovation spectrum in order to help emerging energy technologies reach full maturity. The administration itself implicitly recognizes the importance of later-stage technology commercialization and tech-transfer programs. In 2018, then-Secretary Rick Perry established DOE's first-ever Chief Commercialization Officer to oversee the department's tech-to-market programs and coordinate tech-transfer activities in order to expand the commercial impact of DOE's RD&D investments.[50] It issued a public request for information to solicit input on ways to "enhance the commercial impact of DOE's portfolio of Research, Development, Demonstration, and Deployment activities."[51] And in early 2020, ARPA-E launched its new Seeding Critical Advances for Leading Energy technologies with Untapped Potential (SCALE-UP) program to help promising technologies that have already passed the proof-of-concept stage receive follow-on support to enable a path to market.[52] OMB's guidance and the administration's budget place DOE in the impossible position of being held responsible for accelerating innovation without being given the tools to do so.

In the last two years, DOE has sought to improve its technology transfer and commercialization activities. But such steps are inconsistent with efforts to slash funding for later-stage applied RD&D.

Energy Secretary Dan Brouillette and other senior DOE officials have also pointed to the relative maturity of the wind and solar industries as justification for budget cuts.[53] Given the complementary roles of the public and private sectors in energy innovation, it makes sense to shift the nature and scale of public support for technologies as they mature. But such shifts should be taken as opportunities to expand investments in less-mature technologies, rather than to cut the budget. Opportunities abound: Offshore wind, concentrating solar power, marine and hydrokinetic power, enhanced geothermal power, algal biofuels, advanced small modular reactors, and many other clean technologies remain far from matching the reliability and low costs of conventional technologies. Yet these are the technologies that are targeted for the most severe cuts.

Moreover, the administration does not consistently apply the principle of shifting support as technologies mature. It continues to prioritize investments in unabated coal combustion technologies, despite coal combustion having provided the majority of U.S. electricity generation for most of the 20th century—and has a much longer history than renewables or nuclear.

Figure 7: Proposed changes in DOE's budget, by major function



A third rationale for cutting the energy innovation budget, which was recently offered by Acting Office of Management and Budget Director Russ Vought, is that the government cannot afford to invest more in innovation when it is already running at a budget deficit.[54] However, history has shown that federal investments in energy RD&D have paid for themselves many times over in the form of lower energy costs for consumers, fewer energy imports, avoided pollution, expanded entrepreneurship, and improved competitiveness of U.S. businesses. Senator Alexander noted as such during the FY 2019 appropriations process, when he remarked that "science, research and innovation is what made America first, and I recommend that [President Trump] add science, research and innovation to his 'America First' agenda."[55]

WHAT'S AT RISK

The energy RD&D portfolio supports 20 science and technology exploration programs that tackle a diverse set of challenges: mature domains that need to be reenergized, such as building technologies; sectors that are growing rapidly, such as solar power; cross-cutting programs that support energy systems, such as storage; and innovations yet to be commercialized, such as fusion. These science and technology programs are spread across eight program areas.

Figure 8: DOE's RD&D funding by program area, FY 2020

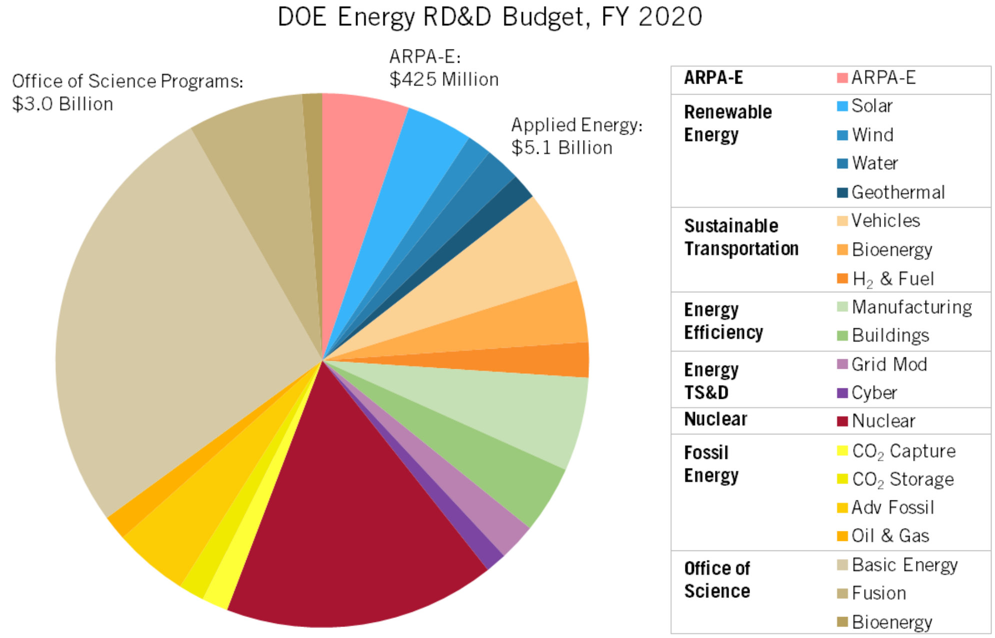


Figure 8 displays the distribution of funds across this portfolio in the current budget (FY 2020), with programs aggregated into groups according to the DOE office that manages them. The bulk of the funding lies in DOE's applied energy offices: Energy Efficiency and Renewable Energy (EERE), which houses the programs in renewable energy, sustainable transportation, and energy efficiency; Electricity (OE); Cybersecurity, Energy Security, and Emergency Response (CESER); FE; and NE. Within SC, Basic Energy Sciences (BES), Fusion Energy Sciences (FES), and a small portion of Biological and Environmental Research (BER) that supports the bioenergy research centers are also included in DOE's energy RD&D portfolio. ARPA-E is a stand-alone, semiautonomous agency that advances cross-cutting research in high-potential, high-impact energy technologies that are too early for private-sector investment.

The proposed cuts would hit the most important energy RD&D programs hardest (figure 9). ARPA-E would be completely eliminated, and $311 million in previously appropriated funding would be rescinded. But ARPA-E has proven to be a remarkably versatile catalyst for U.S. energy innovation, funding a wide range of innovative projects outside the technology-specific silos of other program offices. Projects funded by ARPA-E are five times more likely to produce a patent and scientific publication than projects funded by other research programs—one reason why Congress has continued boosting its budget every year since 2013.[56] The Senate Energy and Natural Resources committee and the House Science, Space and Technology committee have both advanced legislation reauthorizing ARPA-E and increasing its budget to $750 million by 2024, nearing the $1 billion level that ITIF and many others have called for.[57]

Within the applied energy programs, the largest cuts are reserved for the Energy Efficiency, Renewable Power, and Sustainable Transportation programs within EERE. Proposed cuts to these programs range from 70 percent for water-power technologies to 83 percent for bioenergy technologies. The State Energy Program, which provides funding and technical assistance for state energy offices, would be eliminated. And the total budget for EERE would be cut by an astounding 74 percent, from $2.8 billion to $720 million.

Nuclear energy also fares badly, notwithstanding recent congressional efforts to jump-start RD&D in advanced nuclear technologies, receiving a 21 percent cut. One bright spot is the inclusion of $295 million to build a versatile test reactor—a user facility that would enable testing of materials and fuel designs in a fast-neutron environment.[58] However, this significant boost comes at the expense of other advanced nuclear innovation priorities. In particular, the Advanced Reactor Demonstrations program, which was just added this year, would be cut from $230 million to $20 million.

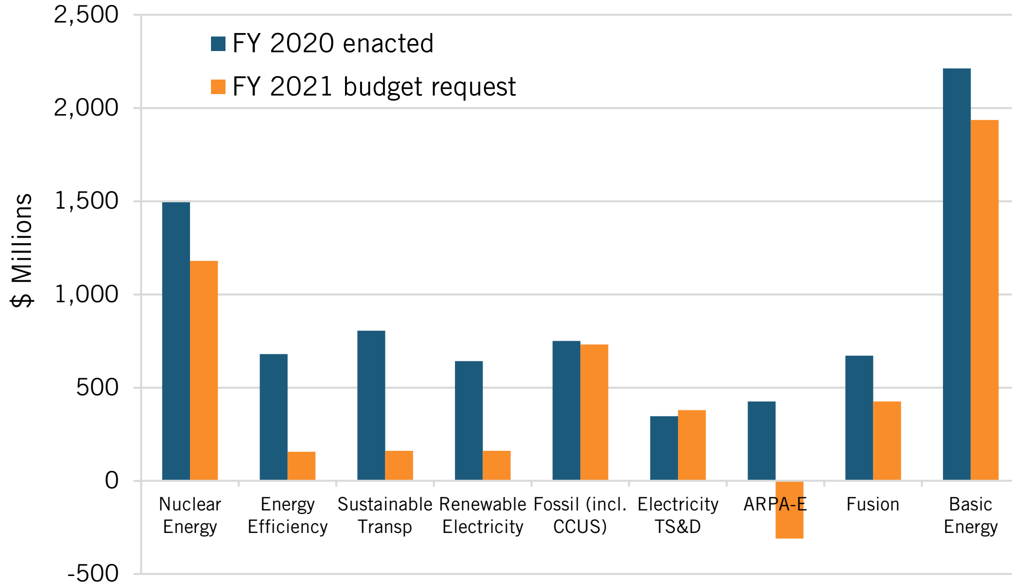
Bright spots in the budget include $40 million for construction of a new Energy Storage Launchpad, and $295 million to build the Versatile Test Reactor.

The Office of Fossil Energy would receive only a 3 percent cut—but that comparatively generous treatment hides damaging priorities. The administration proposes combining the Carbon Capture and Carbon Storage subprograms into a single Carbon Capture, Utilization, and Storage (CCUS) subprogram, while cutting combined funding by 43 percent from $218 million in FY 2020 to $123 million in FY 2021. The Natural Gas Technologies program, which houses the methane emissions quantification and mitigation research activities, would see a 71 percent reduction in funding. Cuts in these emissions-reduction programs are offset by increased funding for the administration's Coal FIRST (Flexible, Innovative, Resilient, Small, Transformative) initiative, which seeks to increase coal exports.

OE and CESER are the only winners among the applied energy programs. OE would get a 3 percent increase, which would cover a 50 percent increase in the Energy Storage subprogram to $84 million, highlighted by a $40 million grid-storage launchpad at the Pacific Northwest National Laboratory.[59] However, the boost in energy storage funding comes at the expense of research in resilient electricity distribution systems, which would get a 60 percent cut. CESER, which includes RD&D in cybersecurity for energy delivery systems—essential for enabling grid modernization—would get a 19 percent boost.

Even basic science research at DOE faces cuts. SC would be slashed by 17 percent, from $7 billion to $5.8 billion. BES and FES—the energy-related programs in SC—would be cut by 13 percent and 37 percent, respectively.

Figure 9: Proposed changes in the DOE energy budget by program office



At the other end of the innovation spectrum, the administration's budget again proposes eliminating the Title 17 loan guarantee program that supports early commercial adoption of complex, capital-intensive technologies such as CCUS, as well as the Advanced Technology Vehicles Manufacturing loan program.[60] Congress's rejection of prior requests for the loan programs' elimination demonstrates its support for this important financial facility.

WHAT HAPPENS NEXT

Congress is unlikely to give this year's budget request any more credence than it has other years' since President Trump was elected. Similar proposals in the prior three budget cycles were soundly rejected by both parties and both chambers. Rather than adopting the administration's proposals, Congress boosted energy RD&D programs by 14 percent in FY 2018, 5 percent in FY 2019, and 11 percent in FY 2020. Senate Budget Committee Chairman Mike Enzi (R-WY) has already said he will not hold a hearing on the president's proposed budget, declaring, "Congress doesn't pay attention to the president's budget exercise."[61]

However, Congress will have to make more difficult choices this year than in the past three. Top-line spending is bound under the agreement reached between Congress and the White House last July that caps non-defense discretionary spending to a 1 percent increase—and congressional leaders have said they do not intend to revisit that agreement.[62]

The next step is for the House and Senate Appropriations committees to apportion the overall discretionary budget to their subcommittees, setting what are referred to as the "302(b) allocations" for each of the 12 bills that fund the government. DOE, along with the Army Corps of Engineers, Department of Interior, and other related agencies, is funded through the Energy and Water Development (E&W) appropriations bill.

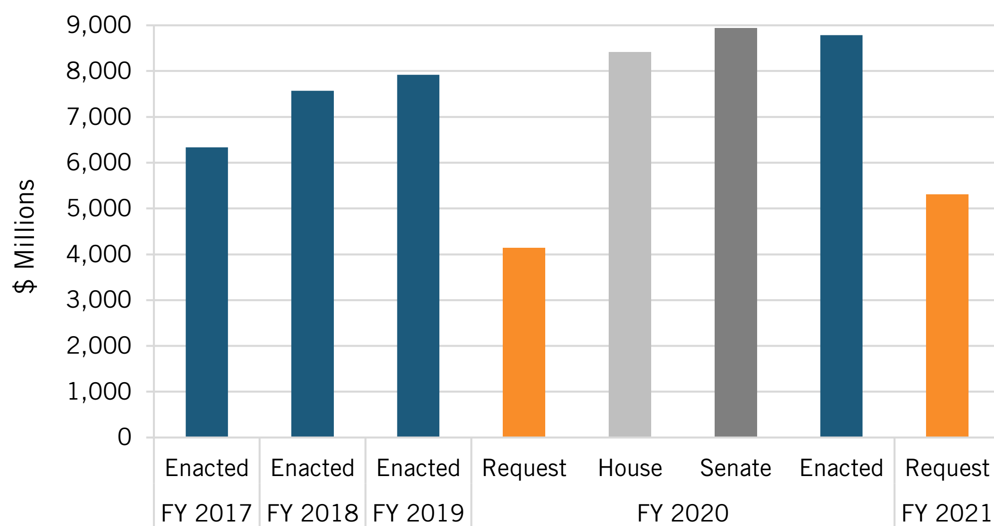
Large increases in federal investments in energy innovation could, in principle, be accommodated within the budget agreement. Because federal energy RD&D accounts for such a small share of the budget (see figure 2), double-digit increases could be offset elsewhere without breaching the cap.

In practice, however, appropriators' ability to increase funding will be limited by each chamber's leadership, which will determine how much money will be allocated to the E&W bill and the 11 others that comprise the budget. Funding levels for most of DOE's programs will likely remain flat or receive only modest increases. Expectations set by the E&W subcommittee chair, Senator Alexander—who called for a "New Manhattan Project for Clean Energy" last April—will undoubtedly not be met.

The House and Senate Appropriations committees have begun holding hearings on the budget, with each chamber producing its own Energy & Water bill as early as May of this year. Ultimately, an appropriations bill is supposed to pass both chambers of Congress and be signed by the president before the next fiscal year begins on October 1, although continuing resolutions that extend current fiscal-year spending levels into the next fiscal year have frequently been used in recent years.

Concurrent with the appropriations process, the House of Representatives may soon take up bipartisan legislation authorizing a diverse array of new RD&D programs and updating the authorizations for many existing programs. The Senate has deferred consideration of such legislation for the moment, but the debate may be reopened before the 116th Congress adjourns.[63] Although these bills may not impact the current appropriations cycle, their passage would open new opportunities to scale up federal energy RD&D spending in pursuit of more ambitious goals.[64]

Figure 10: Energy RD&D programs in the appropriations process, FY 2017–FY 2021[65]



CONCLUSION

Congress has taken the reins of energy innovation policy with a tremendous opportunity to accelerate clean energy and shape the U.S. response to the climate and competitiveness challenges of the 21st century with the decisions it makes in the coming year. It should reject the administration's budget proposal and continue to elevate energy innovation as a national priority.

APPENDIX A

Table 1. President Trump's FY 2020 budget request for DOE, in millions of dollars

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 WH Request	Change
DOE Total Budget	35,685	38,586	35,362	-8%
Defense	16,089	17,611	20,855	30%
Environmental Management	7,175	7,425	6,066	-15%
Basic Science Research	3,755	4,016	3,377	-10%
DOE Energy RD&D Programs*	7,917	8,788	5,311	-40%
ARPA-E	366	425	-311	-173%
Energy Efficiency & Renewable Energy	2,379	2,790	720	-74%
Sustainable Transportation				
Vehicle Technologies	344	396	74	-81%
Bioenergy Technologies	226	260	45	-83%
Hydrogen & Fuel Cell Tech	120	150	42	-72%
Renewable Energy				
Solar Energy	247	280	67	-76%
Wind Energy	92	104	22	-79%
Water Power	105	148	45	-70%
Geothermal Technology	84	110	26	-76%
Energy Efficiency				
Advanced Manufacturing	320	395	95	-76%
Building Technologies	226	285	61	-79%
Fossil Energy R&D	740	750	731	-3%
CCUS and Advanced Power	486	491	546	11%
Natural Gas Technologies	51	51	15	-71%
Unconventional Oil Tech	46	46	17	-63%
NETL Research	51	50	46	-8%
Nuclear Energy	1,326	1,493	1,180	-21%
Reactor Concepts RD&D	324	267	112	-58%
Nuclear Energy Enabling Tech	153	113	116	2%
Fuel Cycle R&D	264	305	187	-39%
Advanced Reactor Demos**	--	230	20	-91%
Versatile Test Reactor***	--	--	295	n/a
Electricity Delivery	156	190	195	3%
Cybersecurity (CESER)	120	156	185	19%
Science	6,585	7,000	5,838	-17%
Basic Energy Sciences	2,166	2,213	1,936	-13%
Fusion Energy Sciences	564	671	425	-37%
BER Bioenergy Research	100	100	100	0%

* Program office totals include some non-RD&D functions. ITIF has estimated total energy RD&D to be approximately $8 billion for FY 2020.

** Advanced Reactor Demonstrations was added as a control point in the FY 2020 appropriations bill.

*** The Versatile Test Reactor was previously funded in FY 2018 and FY 2019 out of the Reactor Concepts RD&D subprogram.

ENDNOTES

1. The federal budget does not provide a definition, or establish a separate category, for demonstration; it is encompassed within the definition of "development." However, many energy technologies must be demonstrated at full scale after they have been developed to the point of practical use at bench or pilot scale and before they can be widely deployed and integrated into the energy system. In this report, therefore, we use the term "RD&D" when referring to the overall federal energy innovation investment, but the term "R&D" when discussing specific appropriations that fall within the official budgetary definition of "R&D," or when using data from particular statistical sources, such as *Science and Engineering Indicators*.
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ACKNOWLEDGMENTS

The author wishes to thank David M. Hart and Rob Atkinson for providing input to this report. Any errors or omissions are the author's alone.

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