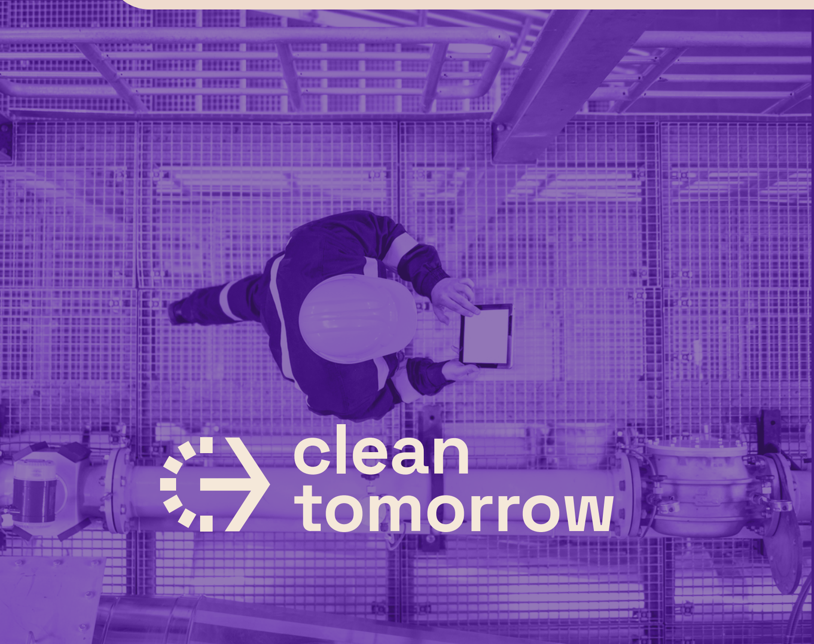
Re-Energizing America

Reclaiming American Leadership in Energy Innovation

NOVEMBER 2025



clean tomorrow

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Clean Tomorrow is a nonprofit organization that advances policies that reduce climate emissions by turning policy ambition into action. We work to catalyze rapid change that will accelerate the innovation and growth of clean energy.

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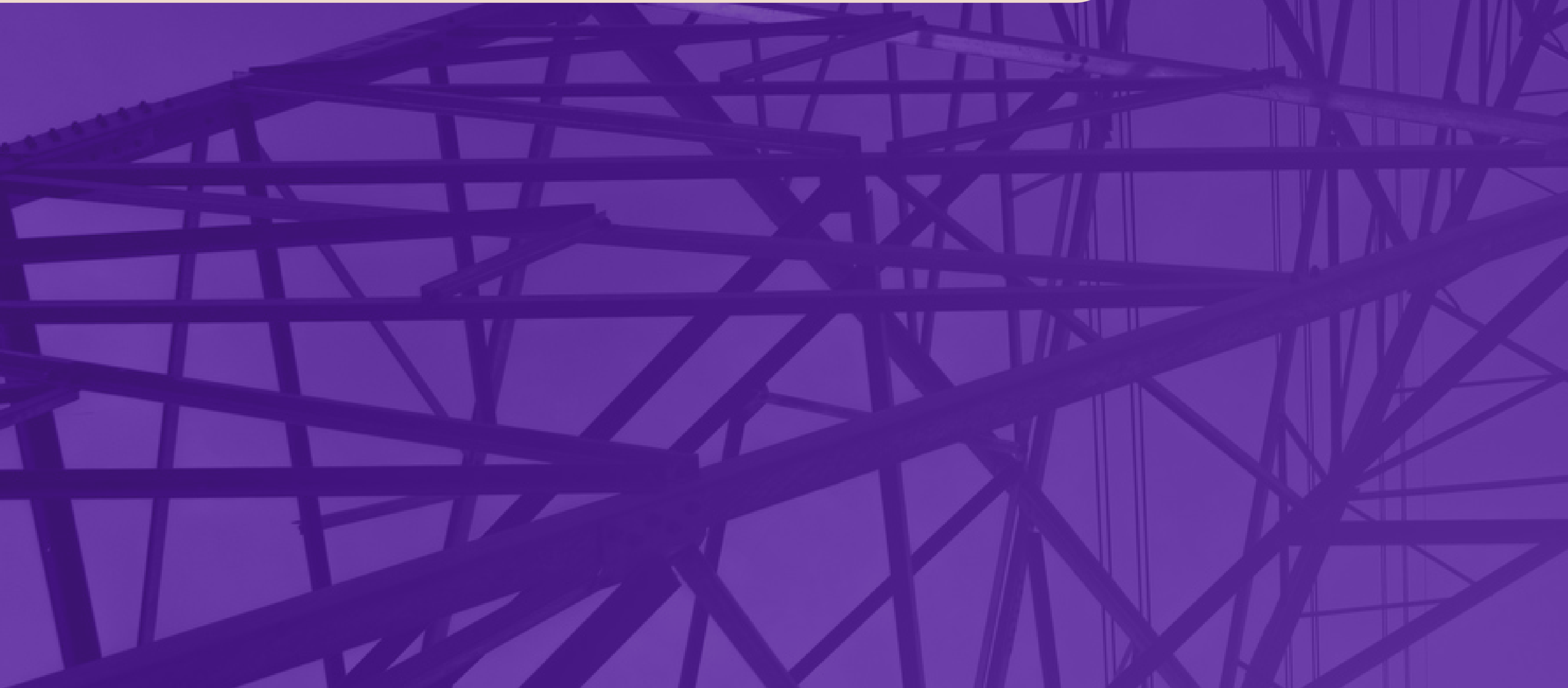

Re-Energizing America

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Foreword

From Moonshots to Megawatts: Reclaiming America's Energy Edge

For more than a century, American innovation has powered global progress. We invented mass production, split the atom and put men on the Moon. We created computers, connected them through the Internet and pioneered the digital world.

The American energy system underpinned all these achievements. But today, the system is facing unprecedented challenges. If we fail to rapidly deliver clean technology at scale, the United States' national security and economy, as well as the global environment, will suffer.

Half a century ago, a global oil crisis sent shockwaves through the U.S. economy. In response, we did what we do best: we innovated. We founded the Department of Energy (DOE) and made massive investments in new energy technologies.

The decision paid off. DOE-led research unlocked private innovation, helping entrepreneurs and industries thrive, bolstering domestic production and opening export opportunities. The returns on public investment have been massive. One study found that investments by DOE's Office of Energy Efficiency and Renewable Energy have delivered a 630% return for taxpayers, with conservative assumptions.[1]

We must act boldly again today. If we do, we can lower costs for Americans families, strengthen U.S. national security and help lead the world in meeting global challenges.

The rest of the world isn't waiting. China, especially, isn't waiting: it's flooding world markets with subsidized goods and controlling vital supply chains.

The next 50 years will be defined by how we respond to today's challenges. Their scale and urgency require forward-looking investment and a renewed sense of national purpose.

Now is the time to choose. Let's show the world that the United States can meet this moment—decisively, boldly and with an unwavering focus on the defining challenges of the 21st century.

David Sandalow
Center on Global Energy Policy, Columbia University
former senior official, The White House, State Department
and U.S. Department of Energy
Original co-author of *Energizing America*

Executive Summary

The United States has led the world in energy technology development for over 150 years, from developing the first modern oil wells and catalyzing the petroleum industry that powered the 20th century to generating the technologies that led us to the civil atomic age to inventing the solar cells that are helping power the world today. Entering the 2020s, though, the United States was a laggard on clean energy innovation, with China dominating technology development and manufacturing in key sectors where America once led. In response to this troubling situation, the Information Technology & Innovation Foundation (ITIF) and Columbia University Center for Global Energy Policy published *Energizing America* (2020),[2] an energy innovation roadmap that sought to re-establish American leadership and accelerate global progress in reducing carbon emissions by dramatically expanding federal investment in energy research, development, and demonstration (RD&D) through 2026.

...it is time for a new roadmap, one that takes **stock of progress made since 2020** and **charts a path forward** through the end of this decade.

Amid transformation of our domestic energy policies and ongoing alterations to the international economic order, it is time for a new roadmap—one that takes stock of progress made since 2020 and charts a path forward through the end of this decade. Significant legislative achievements have taken place since *Energizing America* was published, but implementation challenges and changing economic, political, and geopolitical circumstances have left America's energy innovation enterprise vulnerable. With substantial federal funding set to expire in 2026, our nation faces a coming "innovation cliff." To ensure continued momentum and to set the course for the future, four policy imperatives now drive the need for renewed federal investment: energy security, affordability, economic opportunity, and decarbonization.

The Road Traveled

Funding for energy RD&D reached its peak following the 1970s energy crisis, when Congress created DOE in 1977 and appropriated what would now be close to $32 billion for the new department, exceeding 0.1% of the national GDP.[3] For nearly all of the following 40 years, as the size of the U.S. economy more than doubled, funding levels for energy RD&D dropped or remained essentially stagnant relative to GDP.

The 2020s marked a turning point in the nation's commitment to clean energy innovation. In this decade so far, Congress has passed landmark bipartisan legislation signed and championed by presidents of both parties to increase funding for energy innovation, including the Energy Act of 2020, the Infrastructure Investment and Jobs Act (IIJA), the CHIPS and Science Act, and the Inflation Reduction Act (IRA). These measures meaningfully increased RD&D funding across multiple technology areas.

FIGURE ES-1. The four policy imperatives to re-energize America.

FIGURE ES-2. DOE RD&D funding from 1978–2025.

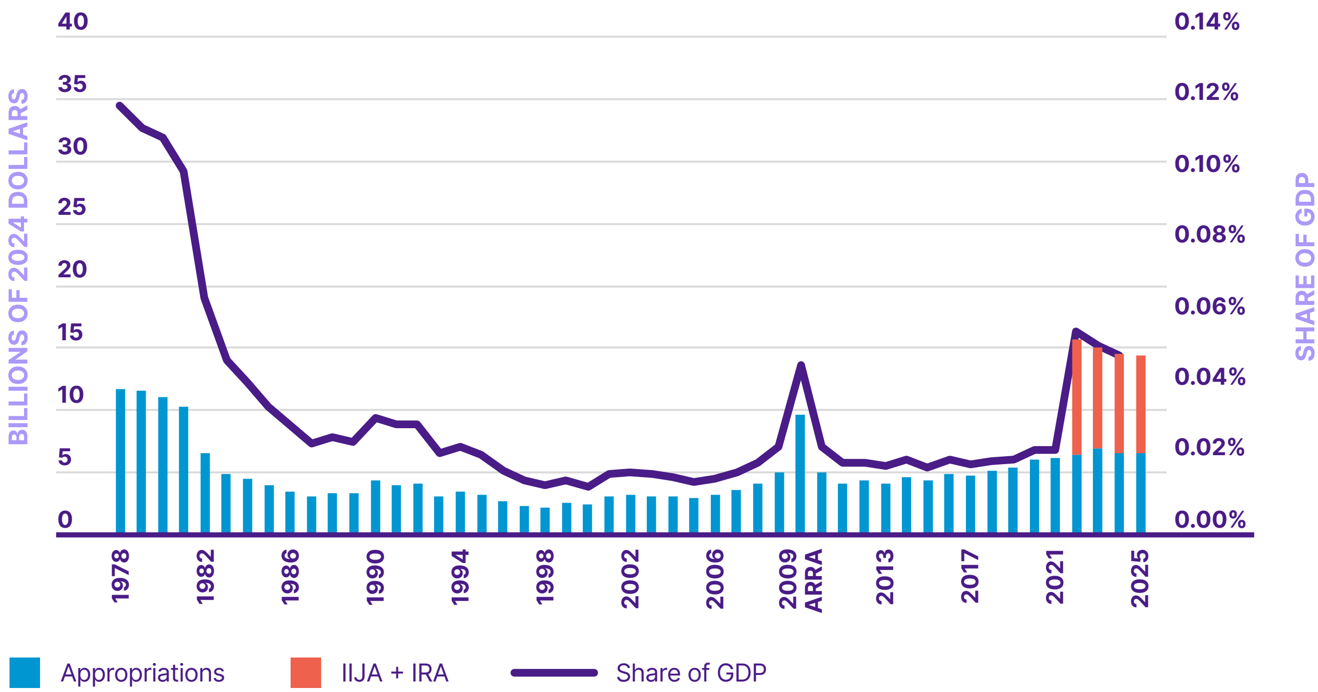
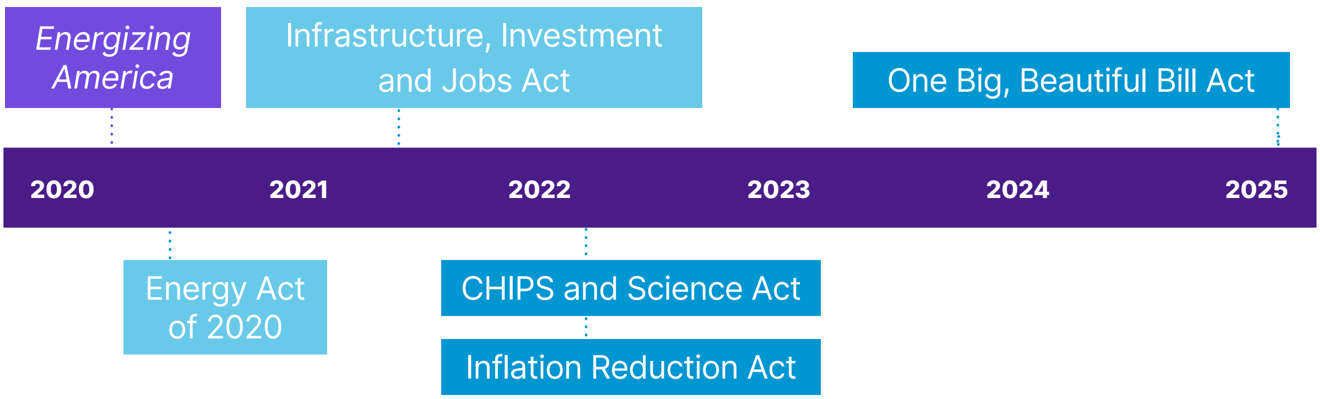


FIGURE ES-3. Major legislative actions since *Energizing America*.



By fiscal year 2025, total funding allocated for clean energy RD&D at DOE reached approximately $15 billion—roughly 2.5 times the FY 2020 level and nearing levels appropriate to ensure continued American leadership.

These federal investments prompted strong responses from the innovation ecosystem. Funding announcements were often oversubscribed by factors of two to four times available funding.[4] Private investment followed federal investments.

...implementation challenges delayed disbursement of essential funding and left private sector innovators, startups, and investors vulnerable to program and project cancellations under a new Administration.

Unfortunately, the full impact of Congress's renewed commitment to energy innovation remains unrealized. Implementation challenges delayed disbursement of essential funding and left private sector innovators, startups, and investors vulnerable to program and project cancellations under a new administration. Less than half of IIJA funding was obligated by early 2025, with just 5% disbursed to recipients—nearly four years after IIJA was passed into law.[5] With many of these federal funds not disbursed, and many projects not yet having even broken ground, the current administration has proposed rescinding much of the available unobligated clean energy-related funding. This administration has considered canceling an additional $23 billion in funding already allocated to projects, representing significant portions of the innovation investments made by DOE in recent years.

THE ROAD AHEAD:

Federal Budgets and Priorities

To restore American energy innovation leadership, we recommend increasing energy RD&D funding by 80% from the FY 2025 baseline, reaching $25 billion in FY 2030.

This target—equivalent to less than 0.4% of the federal budget and only 1.4% of discretionary spending—would restore the United States to top-tier global standing in energy innovation as a share of GDP.

Table 2. Multipliers for priority technology pillars.

PRIORITY ONE	PRIORITY TWO	PRIORITY THREE
Secure, efficient, digitally enabled power systems: Advanced transmission, storage, cybersecurity, and digital technologies to support AI, manufacturing, and electrification while ensuring reliability and security of the electric grid	**Foundational science at platform technologies:** Platform technologies, including advanced materials, quantum computing, and AI, enabling breakthroughs across energy systems	**Variable electricity generation:** Next-generation solar, floating wind, and marine energy, building on renewable momentum and staying ahead of rapidly advancing technologies
Clean firm electricity generation: Around-the-clock, low-emission power from advanced nuclear, fusion, and enhanced geothermal to compete with China and power critical sectors	**Sustainable fuels:** Advanced biofuels, hydrogen, and synthetic hydrocarbons for transportation, industry, and agriculture security	**Advanced transportation systems:** Electrification and autonomous systems across all modes, from passenger vehicles to heavy-duty trucking and aviation
Secure supply chains: Domestic capacity for critical minerals, battery chemistry, and materials processing to reduce dependence on China	**Efficient buildings:** Heat pumps, smart controls, and advanced envelopes to reduce the 40% of U.S. energy consumed by buildings	**Carbon management:** Capture, storage, and removal technologies for hard-to-abate industrial and power sector emissions
Clean and competitive manufacturing: Process innovations and electrification for chemicals, steel, cement, and energy component production to meet global sustainability standards		

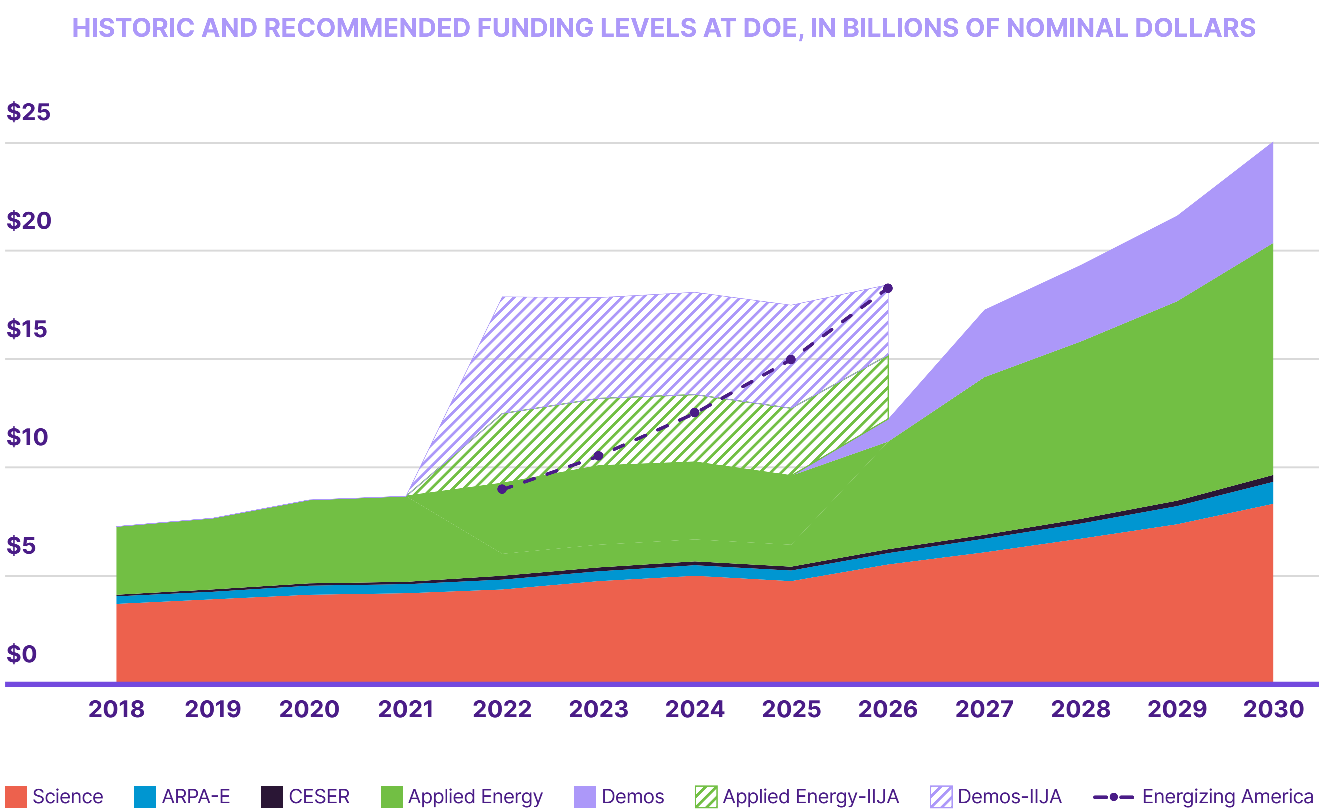
We structured this funding around 10 technology pillars: thematic groupings that advance specific energy outcomes or services. Each pillar encompasses technologies at varying stages of market readiness, with funding levels tailored to sector needs and commercialization stage.

We prioritized pillars based on the key imperatives of affordability, national security, economic competitiveness, historic underinvestment, decarbonization potential, and geopolitical dynamics. Affordability was based on the technologies' potential to reduce energy costs. Security considerations encompassed defense applications, critical material supply chains, and grid stability—related but distinct dimensions we weighted toward pillars with defense nexus and infrastructure resilience potential. Economic opportunity and competitiveness drew on market analyses, including DOE Liftoff Reports and technology deep dives from several sources.[6,7,8,9] Historic underinvestment was assessed against *Energizing America* targets described above. Decarbonization prioritized sectors with the highest emissions.[10]

We then estimate the degree to which each DOE office advances each pillar and recommend budgets for each. This bottom-up prioritization of technology pillars, combined with current DOE office funding levels and alignment with priority pillars, yielded the proposed funding targets in Figure ES-4.

In FY 2026, we propose increasing DOE's energy innovation budget by 11%, with the largest increases going to offices supporting grid modernization (Office of Electricity), nuclear energy (Office of Nuclear Energy), and breakthrough science (Office of Science and ARPA-E). From there, we recommend a steady ramp-up across all civilian DOE offices to the target, building capacity and achieving consistent, sustained funding levels going forward.

FIGURE ES-4. Historical and recommended funding levels for DOE.



THE ROAD AHEAD:

How to Deliver on Energy Innovation

The ambitious energy innovation agenda outlined in this report will only be successful if DOE's capacity to execute matches its strategic vision. While Congress has provided unprecedented funding over the past five years, implementation challenges have limited its impact. The core problem is fragmentation across the innovation pipeline: promising technologies stall in two "valleys of death"—first between early research and pilot-scale demonstration, and then between demonstration and commercialization. Technologies languish not from technical flaws, but from lack of institutional coordination, with no single entity managing handoffs between DOE offices. Simultaneously, "supply-push" RD&D support must be matched with market and commercialization levers to advance technology adoption and to compete with our global competitors.

Transforming DOE will require both structural reforms and cultural changes that prioritize collaboration, speed, and long-term thinking. High-level recommendations include:

Building a Unified Innovation Framework: Establish structural reforms and realigned incentives to create a seamless pipeline from research to deployment, redefining success around shared outcomes across programs and establishing specific milestones for priority technologies as they move through the commercialization process.

Enabling Cross-Program Planning and Funding: Create financial mechanisms allowing sustained collaboration across organizational boundaries. Congress should expand multi-year appropriations for demonstration projects—as it did in IIJA—enabling DOE to make reliable funding commitments and reducing pressure to obligate funds hastily at fiscal year-end.

Enhancing Program Agility and Responsiveness: Supplement traditional procurement with alternative funding tools, including other transaction authorities, milestone-based payments, prizes, and demand-side support. Experiment with rolling and annual competitions aligned with applicant timing, and design solicitations with sufficient flexibility to accommodate innovative technologies.

Strengthening Industry Partnerships for Market-Driven Innovation: Systematically expand programs that make national laboratory resources available to private companies facing specific technical challenges, including technology prototype test facilities, voucher programs for lab access, and entrepreneurial programs designed to incubate new technologies.

Building for Institutional Continuity: Design programs for durability through multi-year budget authority; strong partnerships with states, universities, and industry that create external constituencies; and demonstrated value through measurable outcomes. While no design can fully insulate programs from political change—as recent cuts show—these features can enhance resilience.

These principles represent a pragmatic starting point rather than a comprehensive blueprint. The complexity of DOE's institutional challenges—and the lessons from recent implementation efforts—warrant deeper analysis of specific reform mechanisms and their application across different technology pillars. Success demands not just increased funding, but also fundamental changes in how federal agencies approach energy innovation—creating an institution built for continuity that serves as a reliable partner to American innovators and a trusted engine for the nation's energy security and economic future.

Reclaiming American Leadership

Today, the United States ranks 13th in energy innovation investments globally, adjusted for GDP. DOE was established in 1977 to "use energy efficiently," to "encourage additional production of available expendable energy supplies in our own country," and to "shift towards more abundant supplies of energy."[11] In the years since, the United States has met much of its energy demand through increased efficiency,[12] has become the world leader in oil and gas production,[13] and has contributed to the development of the technologies—from horizontal drilling to unlock shale reserves to solar cells that harvest the energy of the sun to the battery technologies that are helping balance grid demand—that power the world today. These innovations and others were spurred by American investment, and if we are to see the United States once again develop and build the energy technologies of the future, then we must see sustained investment and federal support for this critical work.

United States ranks

13th

in energy innovation investments globally

Energizing America: The Energy Innovation Roadmap in Retrospect and the Road Ahead

The United States left the 2010s as a clean energy technology laggard. China had forged ahead, securing dominant positions in fields which the United States had once led, while promising opportunities were left unrealized. Meanwhile, greenhouse gas emissions from unabated fossil fuel combustion continued to rise worldwide.

In response to this troubling situation, the ITIF and Columbia University's Center for Global Energy Policy published *Energizing America* (2020),[14] an energy innovation roadmap that sought to re-establish American leadership and accelerate global progress in the fight against climate change by dramatically expanding federal investment in energy RD&D through 2025.

This call to action hit a chord. Congress passed landmark legislation to fund neglected fields, like carbon management and grid modernization, and to get nascent energy technologies out of the lab and into the field. DOE and other federal agencies expanded existing programs and built new ones to fulfill Congress's vision. The push won bipartisan backing and mobilized robust state, private, academic, and philanthropic support.

This momentum has now ebbed. Some federal energy RD&D programs encountered snags in execution, while others evoked opposition. New challenges emerged in the first half of the decade that demand new responses. As *Energizing America's* five-year window elapses, it's clear that the nation has progressed only partway down the road the report mapped out.

The time has come to not only look back, but to map the journey ahead once more. Well-crafted innovation policies can help unlock opportunities for American firms and workers to build a cleaner global energy system—and to profit from it. These policies must take heed of lessons learned over past five years to continue to build and upgrade the federal energy innovation enterprise.

Why Re-Energize American Innovation?

Energizing America offered two broad rationales for accelerating U.S. energy innovation: deep decarbonization and economic opportunity. Both remain powerful arguments. The intervening years have brought two additional policy imperatives to the fore: energy security and affordability. Russia's invasion of Ukraine put the former in the spotlight, while pandemic-era inflation triggered the latter.

The economic opportunities that could be created through more rapid and widespread American energy innovation, both at home and abroad, are enormous. Although incumbent energy technologies have proven enduring, important new industries—such as wind and solar power, lithium-ion batteries, and electric vehicles—have scaled up to meaningful levels in this century. These sectors ought to be the first of many waves of innovation that transform global energy production and use.

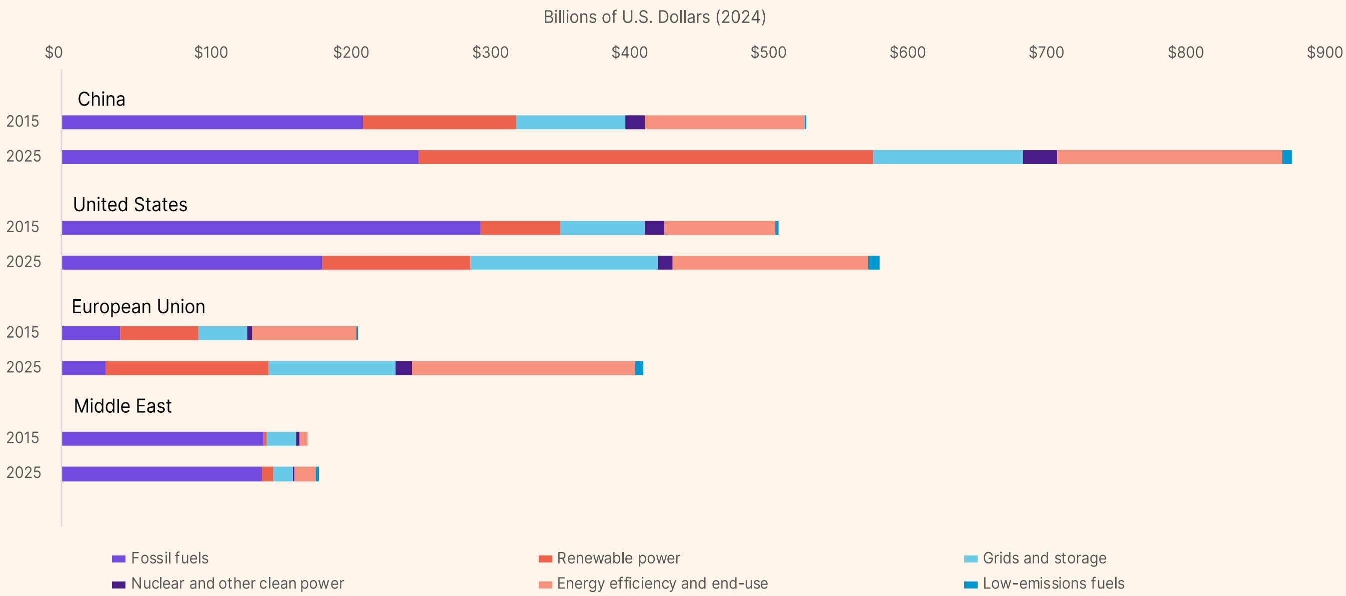
The energy system is the source of about

75%

of climate pollution

FIGURE 1. The four policy imperatives to re-energize America.

FIGURE 2. Energy investment across regions and sectors, 2015 and 2025.[26]



Source: IEA (2025)

Taken together, these waves could open some of the biggest economic opportunities of the century. A 2022 study by McKinsey Global Institute estimated that $275 trillion of capital investments would be required in a net-zero transition.[15] That figure is likely an underestimate given the recent and anticipated increase in energy demand since the study was conducted.

China has taken commanding positions in the first wave, frequently exploiting inventions made in the United States.[16] Figure 2 shows energy investment across geographical areas and how China is outpacing the United States in capital formation in 2025. It is now investing in the next wave of emerging technologies, including advanced nuclear power, fusion, carbon capture, green steel, and more.[17] Unless the United States not only continues to innovate, but acts to secure greater value from its innovations, our nation may miss out on future economic opportunities as well.[18]

National security as much as economic opportunity motivated Chinese investment in new energy sectors. China's energy consumption has skyrocketed over the course of the 21st century, and it is particularly dependent on imports for petroleum and natural gas. Renewables, batteries, and electric vehicles have begun to reduce this dependence. The United States, thanks largely to rapidly growing domestic oil and gas output, is less dependent on imports for these commodities than it used to be. However, domestic prices remain subject to global instability, as geopolitical shocks over the past three years have shown.[19]

Moreover, China's dominance of many emerging energy technologies is creating new national security risks for the United States. China's recent imposition of export controls on rare earth minerals, which are used in a wide range of energy and defense technologies, clearly illustrates these risks.[20] The risks are not likely to recede unless domestic producers master key technologies and pursue innovations, including new battery chemistries that utilize Earth-abundant materials. More broadly, China's position as the central node of global energy technology trade networks and supply chains, ranging from nuclear power to renewables, enhances its geopolitical clout and even its soft power.

The resurgence of inflation due to pandemic-induced supply shortages focused attention on energy prices and affordability. Now, artificial intelligence, electric vehicles, and other new users of electricity are putting further pressure on prices by driving up demand.[21] Although the share of the average American family's budget spent on energy has declined over the long term, many families still struggle to pay these essential bills. Energy affordability is an even bigger issue in emerging markets globally, where consumption and emissions are growing most rapidly.[22] Energy prices and availability impact industrial competitiveness as well, shaping where economic activity occurs. Innovation to enhance energy efficiency as well as to develop low-cost clean resources is vital to improve energy affordability.

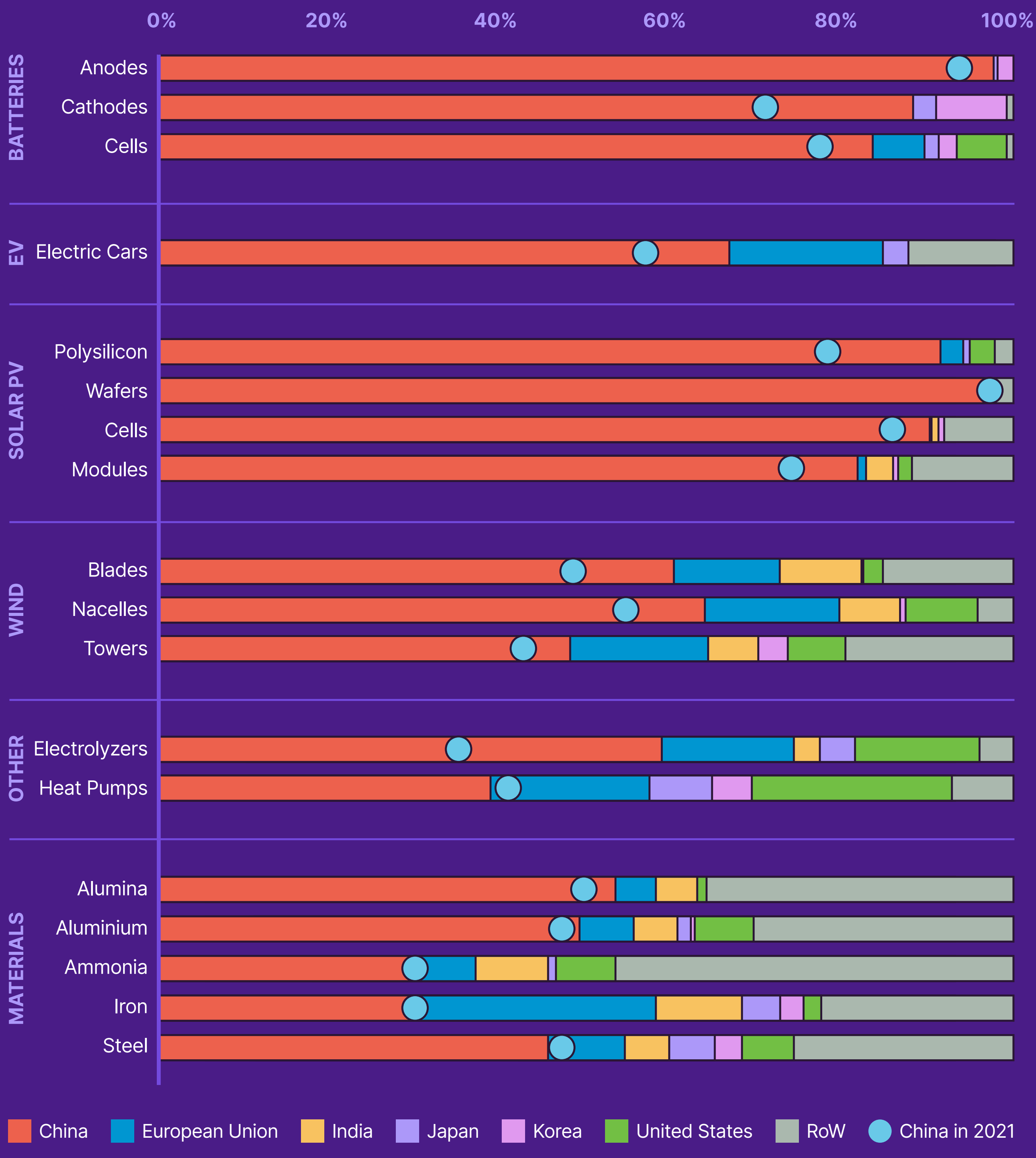
Finally, the purpose of decarbonization is to reduce greenhouse gas emissions that are driving climate change. Climate change is already imposing significant costs on people and ecosystems around the world.[23] The energy system is the source of about 75% of climate pollution, primarily because of unabated fossil fuel combustion.[24] Fossil fuels supply about 80% of global primary energy, a figure that has not changed much over the past 30 years, much less the past five years.[25] It will not change much in the future, either, unless innovation is sustained across a wide variety of applications, yielding technologies that can match or exceed the performance of the existing system in providing the energy services that are so vital to our society.

China's Control of Key Clean Energy Supply Chains

China's industrial strategy for clean energy sectors has been comprehensive. Beijing has sought to control global markets for end-use technologies, such as solar panels and electric vehicles; components, like solar cells and batteries; raw materials, such as polysilicon and lithium; and industrial equipment, like robotics and specialized production machinery. Its systematic approach, backed by massive investments of public resources, diverges radically from conventional western development models.

Data collected by the International Energy Agency provides insights into China's position. Across six key clean technologies—electric vehicles, batteries, solar panels, wind turbines, heat pumps, and hydrogen electrolyzers—China's share of global manufacturing capacity

FIGURE 3. Manufacturing capacity by country/region in 2023.[34]



Note: RoW = Rest of World. "Electric cars" values are calculated based on 2023 production numbers, adjusted according to the utilisation rates of car assembly plants in the region.

Source: IEA analysis based on IEA (2024a); and IEA (2023b).

is around 70% (Figure 3).[27] For electric vehicles and solar panels, China's capacity is so large that it must export its surplus, often at rock-bottom prices.[28] Government support enables many companies that would not be viable in competitive markets to survive for years without making profits.

The supply chain for nuclear power provides a vertical example of China's approach. China is a latecomer to nuclear construction and exports, but it is rapidly making up ground.[29] In addition to offering the capacity to build and finance reactors, China can supply many key components—notably those that require large-scale forging and casting—that the United States currently cannot. Once a supply relationship is established in this industry, it is nearly impossible to switch vendors since the components are so specialized.[30]

Minerals and materials lie at the base of clean energy supply chains, and China's control at this level is daunting. In extreme cases like graphite (used in anodes for EV batteries), rare earths (magnets for wind turbines and EV motors), and manganese (cathodes for EV batteries), China accounts for over 90% of at least one stage of the supply chain.[31] In cases like nuclear fuel, where China lacks the domestic natural resources for key inputs, it seeks to own mines overseas that can feed refineries at home.

Finally, when it comes to production equipment, China is closing the gap with or taking the lead from international competitors. China is the world's largest user of robotics, which are used across clean energy supply chains.[32] It is similarly gaining ground or leading the world in making specialized production equipment, such as mills, dryers, and furnaces used in battery factories.[33]

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China accounts for over

90%

of at least one stage of the supply chain

China is the world's

largest

user of robotics, which are used across clean energy supply chains

These advances are not staying within China's borders. Chinese clean energy manufacturing firms are investing and building globally, expanding their footprint geographically. This strategy capitalizes on access to global primary resources and unlocks emerging markets for a wide range of energy technologies.[35]

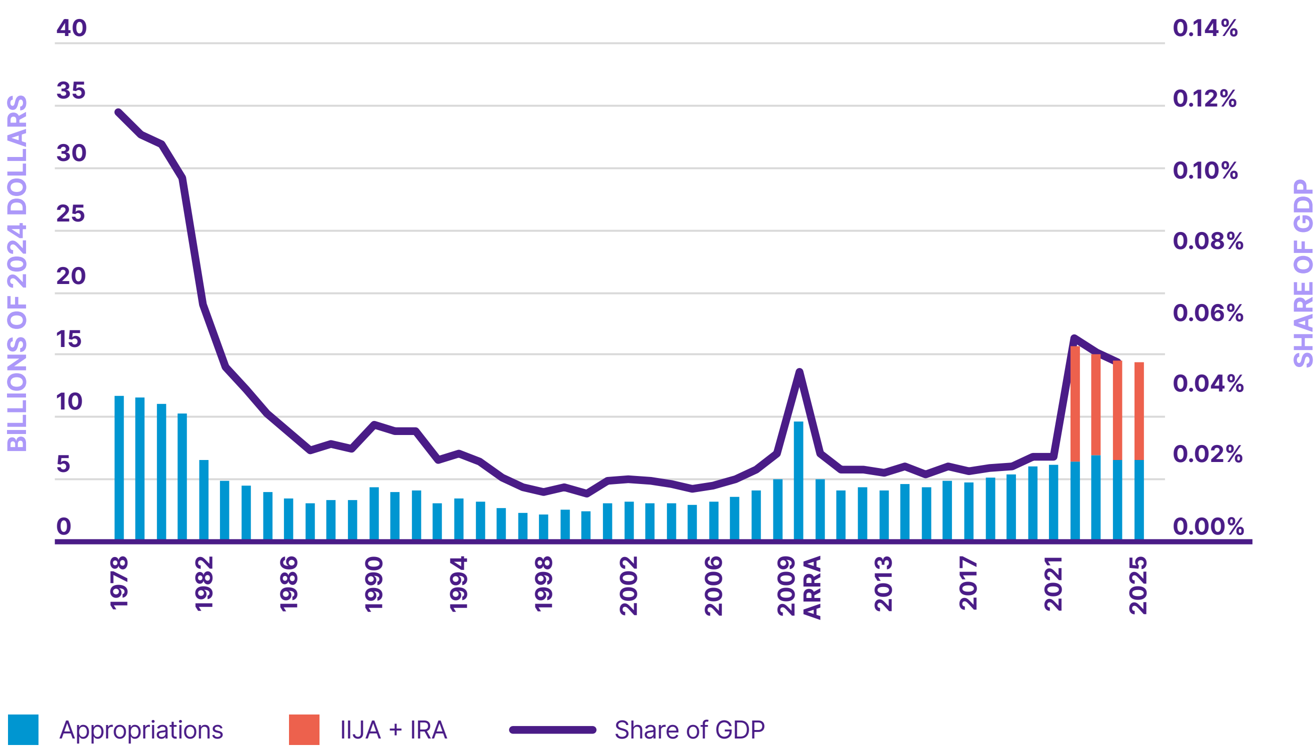
The Federal Role in Energy Innovation

For many decades, Democrats and Republicans have agreed that federal investment in science and innovation is a vital national interest.[36] While they have frequently disagreed about the purposes and levels of this funding, the principle that the market would underinvest in knowledge creation was shared across partisan lines. Private investors in new ideas and capabilities cannot reap all the benefits of their investments, because these benefits take a long time to materialize, may arise in unexpected ways, and can be diminished by imitators. Moreover, many fields that would benefit from innovation, such as public health and national defense, were of little interest to the private sector. Federal funding bridges these gaps while creating opportunities for private sector investment in the later stages. A recent estimate is that federal non-defense R&D funding has accounted for 20–25% of productivity growth since World War II.[37]

The federal government has invested in energy innovation for more than a century. The U.S. Geological Survey, which was formed in 1879, embraced discovering energy resources as part of its mission.[38] The quest to harness nuclear power after World War II gave the field a major impetus.[39] However, it was the energy crisis of the 1970s that elevated energy to the top tier of federal priorities. The crisis prompted the formation of DOE, which consolidated and added to existing scientific and technological capabilities from across the government. In fact, federal energy RD&D investment hit an inflation-adjusted peak in 1979 that has not yet been reattained (Figure 4).[40]

Federal innovation investment makes a particular difference in the energy sector because the gaps left by the market in this sector are very wide. Private industry spends relatively little on energy RD&D. New energy technologies are frequently capital-intensive, must be integrated into complex systems controlled by other parties, appeal to risk-averse buyers, and fit into highly structured or regulated markets. Their environmental and security benefits are not necessarily rewarded by the market. As a result, they tend to be adopted slowly and take a long time to mature.[41]

FIGURE 4. DOE RD&D funding from 1978–2025.[50, 51, 52]



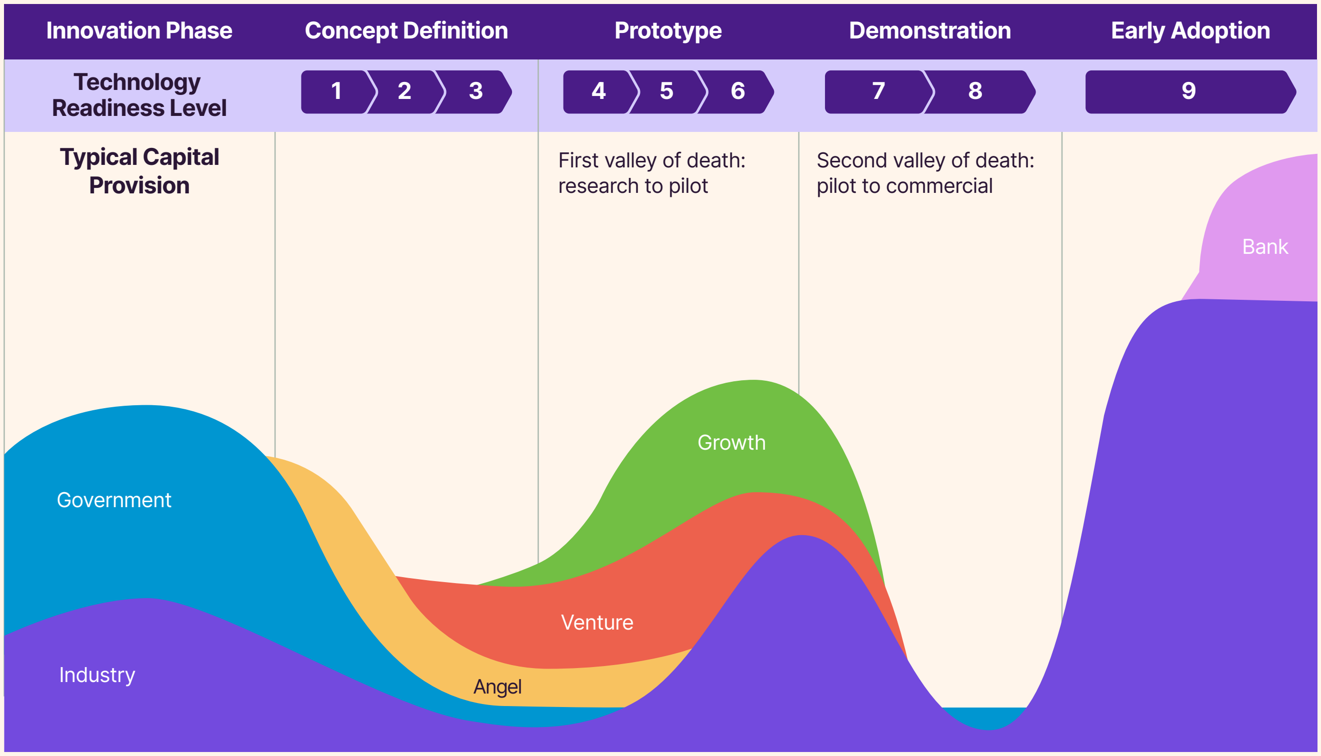
Sources: Kelly Sims Gallagher and Laura Diaz Anadon, ITIF, Clean Tomorrow

Retrospective evaluations generally concur that the benefits of federal energy R&D spending have significantly outweighed its costs. One of the most detailed, a National Academies study of R&D investments by DOE's energy efficiency and fossil energy offices over a 22-year period, concluded that they "yielded significant benefits (economic, environmental, and national security-related)…important technological options…and important additions to the stock of engineering and scientific knowledge."[42] Similarly, a set of case studies of DOE investments spanning diverse technological fields carried out by the American Energy Innovation Council, a group of CEOs convened by the Bipartisan Policy Center, found that the agency functioned as both instigator and catalyst of private sector innovation.[43]

Yet, while DOE RD&D programs may have positive benefit/cost ratios, U.S. energy innovators remain highly vulnerable to the commercialization and demonstration "valleys of death" (Figure 5). A new technology may work in the lab or in a pilot installation, and it may promise a pathway to cost competitiveness if produced at scale. However, investors may not have the patience to wait for such opportunities to materialize, while potential customers may keep their pocketbooks shut in the hope that someone else takes the risk of early adoption. Such all-too-rational reluctance starves innovative companies of the capital they need to survive while their technologies mature.[44]

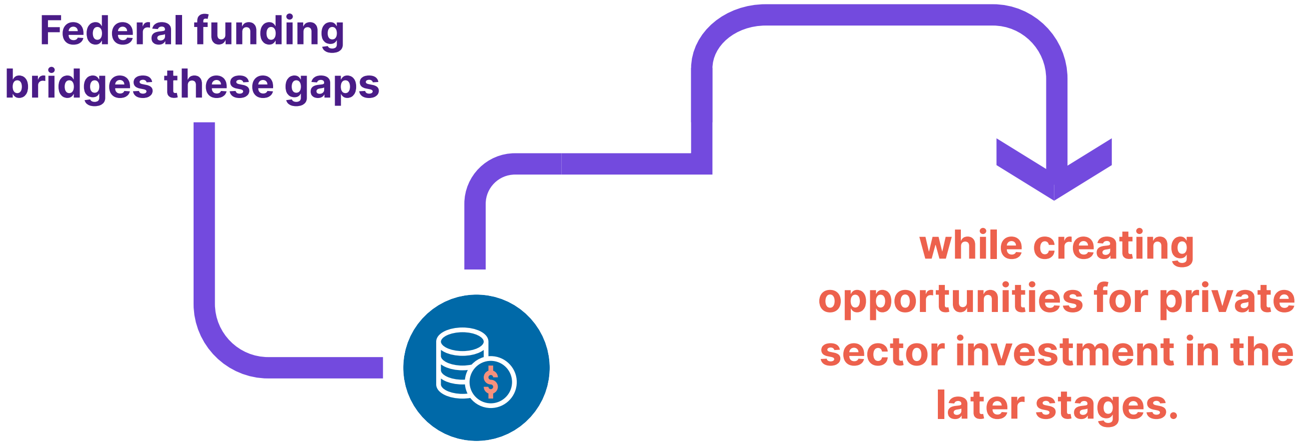
Federal investment in demonstration projects and support for early adopters could carry some innovations through these valleys of death.[45] Civilian nuclear power and hydraulic fracturing are proof points.[46, 47] Both benefited from federal policies that included but went well beyond RD&D investment, and both have become mainstays of the global energy system. However, such policies have been episodic and inconsistent over the years.[48]

FIGURE 5. Illustrative funding sources across the energy technology commercialization pipeline.[53]

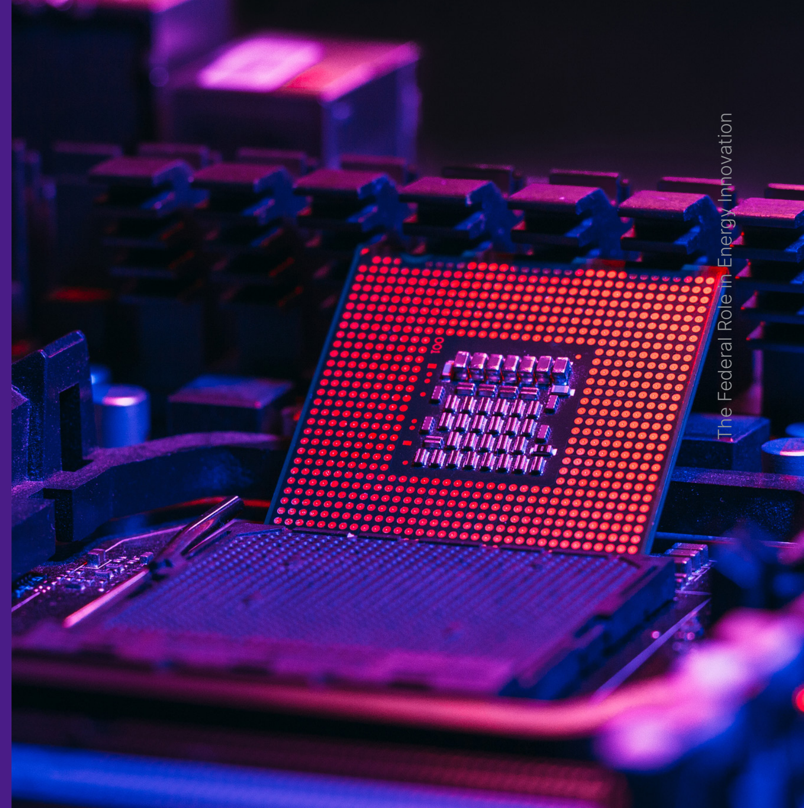


Source: Sightline Climate, RMI, McKinsey

In a less troubled world, energy innovation policy's inability to bridge these valleys of death would be much less damaging. The most promising orphaned technologies could be revived by latecomers. Customers would never know what they were missing in the meantime. But today, delays in scaling energy innovations are very costly. Emissions cumulate over time; every ton adds to the damage. Security risks are evergreen, and competitors abroad are poised to seize U.S.-made opportunities. China has proven particularly adept at doing so, with the central government prioritizing energy innovation and lower levels of government supporting local champions in targeted industries.[49]



Power Electronics: A Cleantech Success Story (in Progress)



Power electronics are an essential, albeit hidden, component of the clean energy economy that will ultimately avoid gigatons of greenhouse gas emissions.[54] Power electronics make LED lightbulbs, solar panel inverters, electric vehicles, and many other technologies work. They rely on semiconductors made of materials like silicon carbide and gallium nitride that have a wider bandgap (a key property for electronics that determines how effective a conductive material is) than the crystalline silicon used in conventional electronics.

RD&D investments from multiple DOE and other federal programs helped turn the concept of wide bandgap semiconductors into a growing array of useful products. As an example, government support enabled the commercialization of silicon carbide as a wide bandgap semiconductor. The technology was first invented at General Electric, refined at North Carolina State University (NC State) with support from the Office of Naval Research, and commercialized by Cree (now known as Wolfspeed), a company founded in 1987 by former NC State students. The Department of Defense and National Institutes of Standards and Technology were key supporters in its early years.[55, 56, 57] Cree found success selling chips for LED lightbulbs, but was stymied by technical barriers in other applications.

Picking up the baton, ARPA-E's SWITCHES (begun in 2013) and CIRCUITS (2017) programs supported public-private research partnerships seeking to break through these barriers.[58, 59] In parallel, the PowerAmerica Manufacturing Innovation Institute, a DOE-sponsored consortium of industry, universities, and national labs founded in 2015 and based at NC State, sought to cut production costs, demonstrate benefits, and build the industry's ecosystem.[60] The consortium's flagship project is X-FAB, the world's first silicon carbide chip foundry, which enables many U.S.-based chip designers to manufacture domestically. DOE's vehicle and manufacturing technology offices have also invested in this technology.[61, 62]

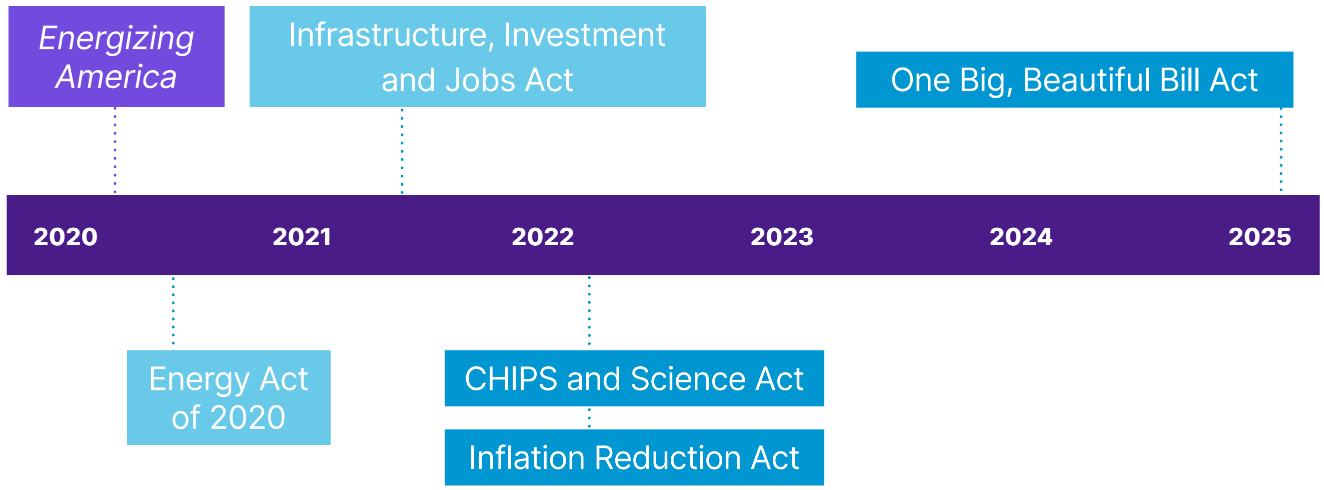
Some $2 billion worth of wide bandgap semiconductors were sold in 2024, and sales are expected to triple in the next decade as these products reach cost parity in an ever-growing array of applications. [63] The five major players in this market are all are based in the United States, Europe, or Japan and have substantial U.S. operations. However, early signs suggest China may be catching up: researchers there produced more than twice as many high-quality research outputs regarding wide and ultrawide bandgap semiconductors than the United States between 2019 and 2023.[64]

The Road Traveled, 2020–2025

Broad, bipartisan support enabled policymakers to make significant progress toward reinvigorating federal support of the energy innovation pipeline, both before President Trump left office in 2021 and during the Biden administration. The Energy Act of 2020 (EA2020), which incorporated proposals supported by members of both parties, restructured DOE's RD&D portfolio and authorized funding for large-scale demonstration projects.[65, 66]

FIGURE 6. Major legislative actions since *Energizing America*.

Legislative Timeline



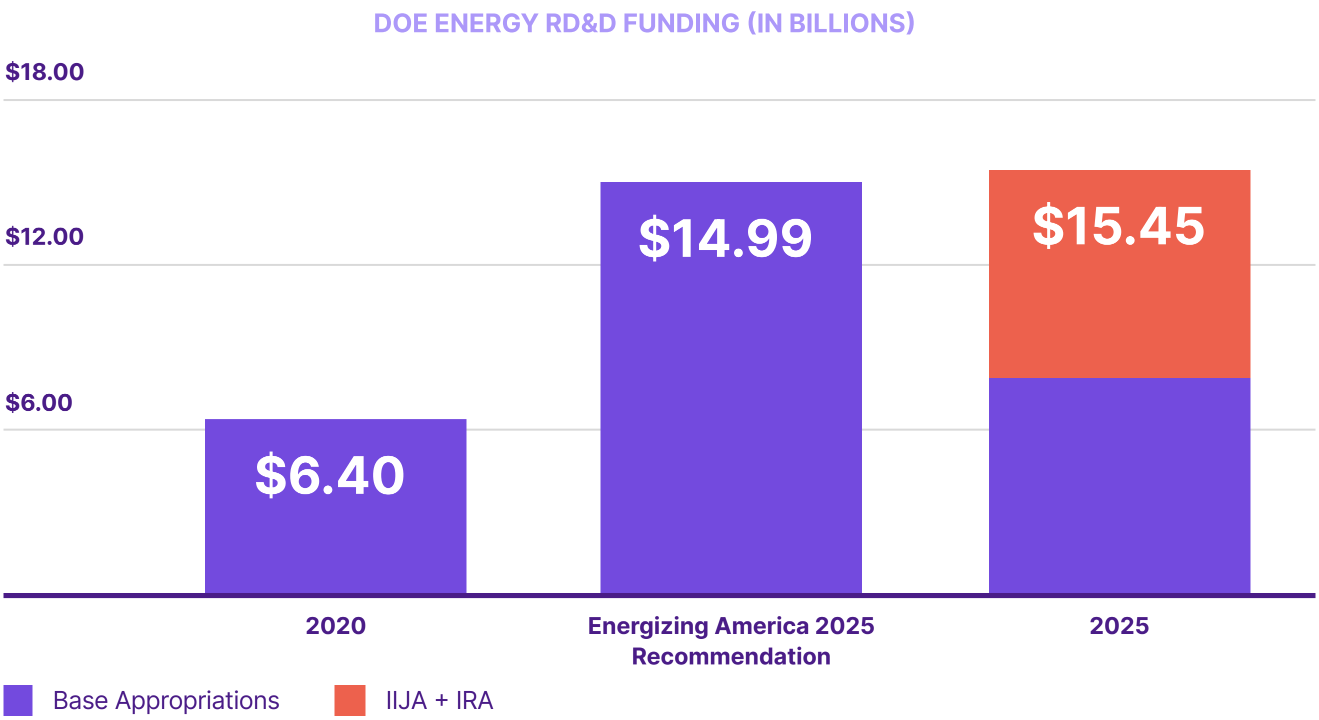
Nearly one year later, the IIJA, which won 17 Republican votes in the Senate, funded many programs authorized or augmented through EA2020. Crucially, an amendment to the IIJA sponsored by Senator Bill Cassidy (R-LA) established a new DOE Office of Clean Energy Demonstrations (OCED).[67] In IIJA, OCED received over $20 billion for projects spanning nuclear power, energy storage, carbon capture, hydrogen, industrial decarbonization, and grid modernization projects.

The 2022 CHIPS and Science Act, which also garnered bipartisan support in Congress, authorized additional funding for many important energy RD&D programs.[68] Finally, in August 2022, the IRA added $6 billion to OCED's industrial decarbonization portfolio, expanded the DOE Loan Programs Office (LPO), and gave generous support for the adoption of clean energy technologies through tax incentives and other measures.[69] Although the IRA was approved on a party-line vote through the reconciliation process, many of its energy innovation provisions had won bipartisan support when initially offered as standalone bills.

The funding provided by these measures was spread out over several years, often running from FY 2022 to FY 2026 or FY 2027. This was in addition to appropriations Congress provided for clean energy RD&D through annual appropriations bills.[70]

The total amount of energy innovation funding provided by Congress in FY 2025 is very close to the goals set by *Energizing America*. Base appropriations and mandatory IIJA and IRA funding allocated to FY 2025 surpassed $15.4 billion (Figure 7), roughly two and a half times FY 2020 appropriations just five years earlier.

FIGURE 7. Federal energy RD&D funding in FY 2020 and FY 2025, compared to *Energizing America* recommendations.



Note: Funding includes base and IIJA/IRA funding. See Appendix A for methodology on determining RD&D funding at DOE.

For this analysis (and our recommended funding levels later in this report), we focused specifically on appropriated dollars at DOE for RD&D activities: research, development, and demonstration. This meant that we excluded funding for infrastructure, operations, and deployment—including programs like the Weatherization Assistance Program and the Federal Energy Management Program, the Loan Programs Office, power market administrations, as well as the international affairs, statistics, and regulatory offices of the department. These offices tend to favor more mature, commercially available technologies. To be sure, demand-side, commercialization, and deployment investments are important tools for advancing innovation as well. We discuss them later in this report, and we anticipate follow-up work on the full suite of innovation policy tools and levers at the federal government's disposal. (Appendix A shares the full methodology we used to distinguish RD&D funding from other funding at DOE.)

However, appropriations figures alone do not necessarily measure DOE's actual spending in recent years. Congress gave DOE the flexibility to support large-scale demonstration projects in phases, stretching out for the better part of a decade to match commercial project timelines. Delays in awarding and obligating RD&D funding left energy innovation appropriations vulnerable to cancellation, recission, and clawbacks by the incoming administration. The EFI Foundation reports that just 47% of DOE's appropriated IIJA funding was obligated by early 2025, and only about 5% was disbursed to funding recipients.[71] Heatmap News reported that while 67% of IRA grant money had been awarded, much less had been obligated.[72] The One Big Beautiful Bill Act rescinded unobligated funding from several energy programs, and the president's FY 2026 budget request stated that it would cancel another $15 billion in DOE funding. At the time of the writing of this report, it is difficult to estimate precisely how much DOE will invest in energy RD&D in FY 2026 and beyond.

The amount of funding by DOE office today, following the flurry of legislation passed from 2020–2025, differs from the *Energizing America*

Definitions of Federal Funding Terms[75,76]

Appropriating/Funding:
Congress provides budget authority to a federal agency for a specific purpose, often for a certain program, project, or activity.

Awarding/Selecting:
The federal agency selects a project for a financial award (this award can be a grant, cooperative agreement, contract, loan, or other).

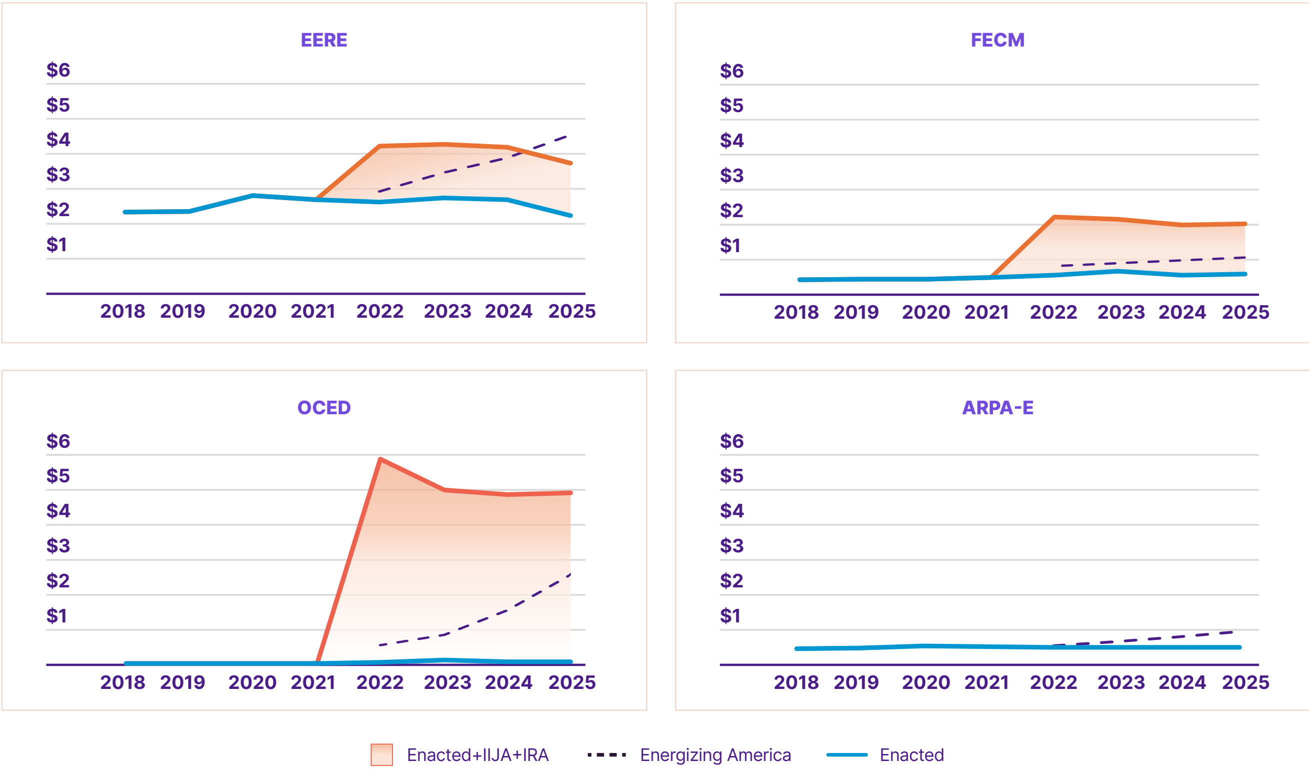
Obligating:
Often after a period of award negotiation with the recipient, the federal agency enters a legal, contractual agreement with the award recipient for a certain amount of funding.

Outlays/Spending:
Outlays occur when a federal agency disburses funds to the recipient to meet an obligation.

Rescinding:
Congress can cancel previously appropriated budget authority before it expires under law.

FIGURE 8. Historical funding versus *Energizing America* recommendations by DOE office.

Y-axis is in billions of 2024 dollars, inflation adjusted by CPI. The orange gradient represents IIJA and IRA funding, annualized, showing the range of what may be vulnerable to recission, based on EFI Foundation's estimate of 5% actually going to outlays.[77]



roadmap. In addition to demonstration projects, energy RD&D funding for the Office of Fossil Energy and Carbon Management exceeded the report's recommendations by a factor of two in its FY 2025 budget. Conversely, the FY 2025 budget for the ARPA-E was about half of what *Energizing America* proposed.

These variations have important consequences for the effectiveness of energy innovation policy. For instance, funding for carbon management grew almost fivefold from FY 2021 to FY 2022. It is possible that researchers, firms, and investors in this field may not have been adequately prepared to absorb such large investments.

Complementary policies, such as certain tax incentives, regulations, and non-DOE infrastructure investments, as well as financing made available through the LPO, accelerated energy innovation by adding demand-pull to the supply-push provided by DOE's RD&D spending. The 45Q tax credit, to give an example, complemented carbon management RD&D by incentivizing real-world sequestration. "Buy Clean" programs for construction materials, run by the General Services Administration and the Department of Transportation, sought to pull along manufacturing projects to decarbonize cement and steel.

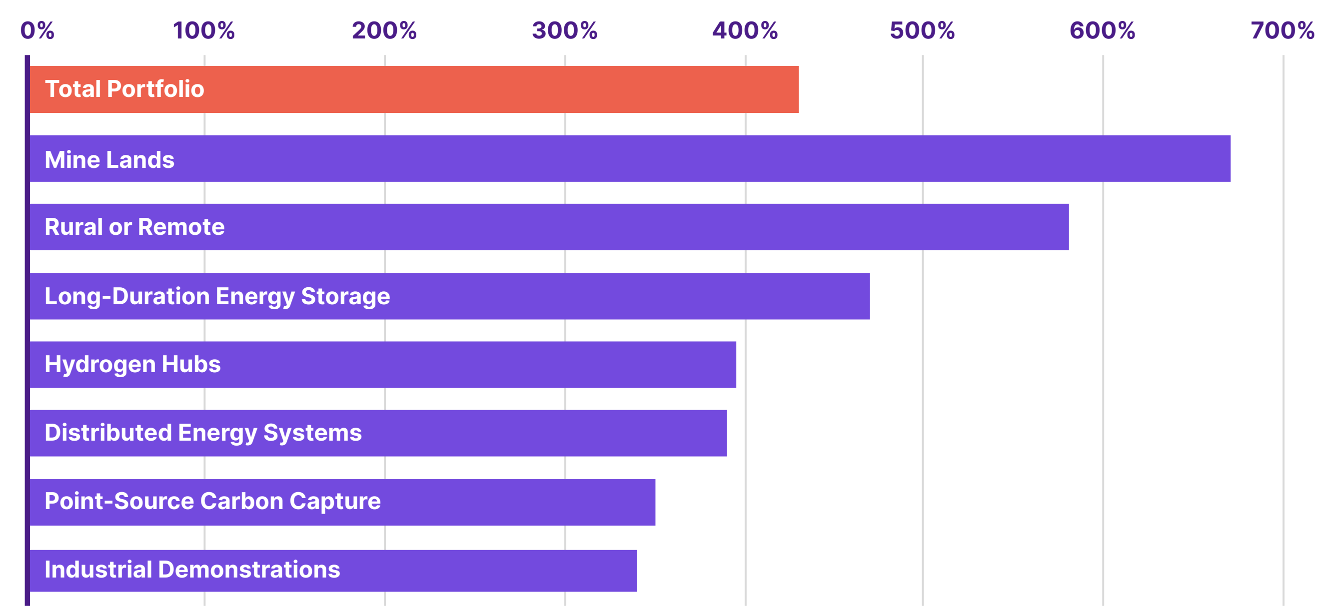
Federal energy innovation policy prompted strong positive responses from other parts of the energy innovation ecosystem. Many funding opportunity announcements were oversubscribed, indicating an abundance of ideas for advancing clean energy technologies. OCED received proposals totaling more than four times the available funding.[73] Along with firms and universities, states and localities also participated in project development. The Midwest Alliance for Clean Hydrogen, which won an award from OCED's hydrogen hubs program, for example, included "carbon-free energy producers, national labs, leading universities, hydrogen technology providers, diverse hydrogen end users across sectors and environmental justice organizations."[74]

Energy innovations take many years to mature. While it is too soon to expect to see an upturn in early-stage innovation indicators like publications and patents or in mass adoption of emerging technologies, the most concrete sign of policy impact can be found in private investment statistics. Industry investment in sustainable aviation fuel, for instance, grew from virtually nothing in 2021 to over $2 billion in 2024. Carbon management, similarly, started the decade with undetectable levels of private investment and rose to over $1.8 billion in 2024.[79]

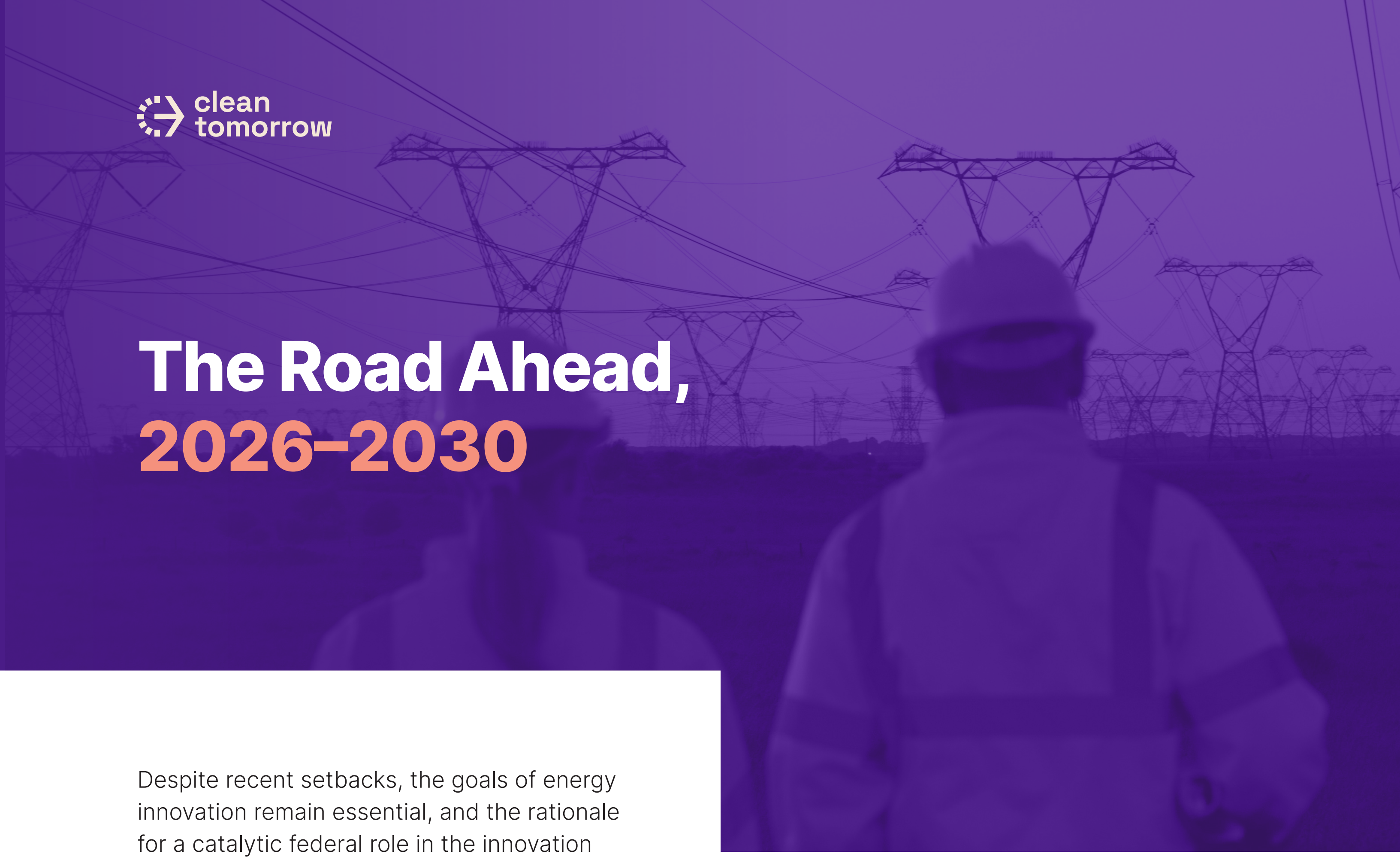
While the ambitious innovation agenda pursued by Congress from 2020 to 2022 made strides towards the vision that *Energizing America* presented, in 2025, its status is on shaky ground. Some of the barriers to unleashing the full potential of federal energy innovation support were built into legislation, while others emerged as DOE and other agencies wrestled with implementation of their expanded responsibilities. DOE not only had to stand up a multitude of new offices and programs, but also had to rapidly staff those programs with both people with experience managing large government programs and people with private industry and financial sector knowledge to serve DOE's new demonstration and deployment focus. Implementation challenges not only delayed disbursement of essential funding, and by extension the intended climate impact of these grants, but they also left programs vulnerable to rollbacks by a new administration.

During the months spent writing this report, many of the programs working on the technology areas we highlight faced significant political headwinds, with staffing and budget cuts that undermine energy innovation as a whole. In May 2025, DOE announced the termination of 24 grants issued for industrial decarbonization projects, including projects that would advance critical technologies like carbon capture and lower-carbon versions of cement and steel.[80] More recently, in October 2025, DOE announced further project cancellations totaling over $7 billion and ranging across projects for clean hydrogen, energy storage, supply chains, and the electric grid.[81] Potential further cancellations up to a total of $23 billion threaten projects across the country, significantly curtailing federal investment in the technologies of the future and in our energy infrastructure.[82] These proposed and actual cuts have been accompanied by a significant loss in federal staff to early retirements, the deferred resignation program, and reductions-in-force (RIFs), threatening the ability of remaining and future projects to be adequately managed and overseen.[83, 84]

FIGURE 9. Degree to which OCED portfolio areas were oversubscribed when announcements were issued.[78]



Source: DOE



The Road Ahead, 2026–2030

Despite recent setbacks, the goals of energy innovation remain essential, and the rationale for a catalytic federal role in the innovation process remains crucial. To re-energize American energy innovation leadership through the rest of this decade, federal policymakers must reclaim the bipartisan momentum of 2020 to 2022 while incorporating lessons learned and addressing changing circumstances in the economic and geopolitical landscape.

The "Road Ahead" calls for a federal investment of $25 billion for DOE's RD&D programs by 2030, resetting ambitious and strategic targets for American investment in the technologies of the future. These budgets are strategically focused on 10 technology pillars and aligned to the imperatives of security, affordability, decarbonization, and economic opportunity. Increased and sustained federal investment must be accompanied by implementation improvements that address legal and organizational roadblocks at DOE that were laid bare over the past few years. To fully support an ambitious innovation agenda with the funding levels this report calls for, we also propose several reforms that would augment DOE's innovation capability, unleash the full potential of DOE, and ensure the nation reaps the economic benefits of those investments.

The "Road Ahead" calls for a federal investment of **$25 BILLION** for DOE's RD&D programs by 2030.

As in the original *Energizing America* report, growth in federal funding for its own sake is not the goal, especially in a fiscal environment of a ballooning federal deficit. Our funding target of $25 billion by the end of the decade is built from a strategic assessment of technology priorities, historic investment, and how the United States compares to global peers and competitors. Additionally, DOE must be equipped and empowered to fully leverage this funding efficiently and with maximum impact via smart, thoughtful reforms in how the department operates.

Enabling a rejuvenated energy innovation mission, both through funding and institutional reforms, will only be successful with support from across the political spectrum. The foundation for bipartisan American energy leadership remains largely intact. However, sustained progress will require regular, consistent support that reflects national strategic priorities. The alternative to sustained investment in innovation is continued vulnerability to feast and famine cycles of funding that leave American innovators and workers adrift without a consistent national strategy. China's comprehensive industrial strategy for clean energy technologies succeeds precisely because it transcends short-term political considerations in favor of long-term strategic planning. If America is to continue to lead the world in energy innovation, we must ensure that what should be enduring national investments are not subject to policy whiplash. This is not only possible, but imperative for our nation to meet the moment.

Federal Budgets and Priorities

To meet this renewed energy innovation mission, our methodology for generating recommended budgets consisted of:

Identifying 10 strategic technology pillars based on the original work of *Energizing America*, updated to meet today's imperatives.

Setting an ambitious topline goal of $25 billion by 2030 to restore the United States to funding levels established when DOE was established and set us back on par with leading peer and competitor nations globally.

Prioritizing technology pillars based on their potential to meet the goals of security, affordability, decarbonization, and economic opportunity.

Mapping the path to achieve that target over the next five years.

Technology Pillars

Energizing America identified 10 technology pillars for which federal innovation support would advance our nation toward its goals of deep decarbonization and economic opportunity. In the years since its publication, rapidly rising energy prices and an evolving geopolitical order have expanded the urgency for energy innovation to address affordability and national security. Our updated technology pillars reflect this broadened set of policy criteria. Listed below, the pillars are described in more detail in the following pages.

TABLE 1. Re-Energizing America's 10 technology pillars.

1	Foundational science and platform technologies
2	Secure, efficient, digitally enabled power systems
3	Clean firm electricity generation
4	Variable electricity generation
5	Advanced transportation systems
6	Sustainable fuels
7	Efficient buildings
8	Clean and competitive manufacturing
9	Secure supply chains
10	Carbon management

These pillars are not technology-specific; instead, they advance outcomes or services that a range of technologies can perform. Each includes a broad array of technologies at different levels of market readiness. Within each pillar, types and levels of federal funding for specific technologies will vary based on what is needed for that sector and their progression along the commercialization pipeline.

At a more tactical level, specific technologies within each pillar should be assessed regularly by experts. If progress has stalled, funding should be redirected toward more promising technologies. If progress has been made, new funding mechanisms (such as cost-shared partnerships) or policy tools (such as tax incentives for technology adoption) may be in order. Technology and adoption readiness frameworks, such as those used by the International Energy Agency and DOE Liftoff Reports, can provide helpful guidance, although no algorithm can fully substitute for well-informed, deliberative technical judgments.[85, 86]

Technology Pillars for Re-Energizing Energy Innovation

Pillar 1: Foundational science and platform technologies

Foundational scientific research across a range of fields can enable breakthroughs in energy technologies—nuclear power, which emerged from basic physics, is the quintessential example. The United States is a world leader in basic scientific RD&D investments and must continue to foster investigator-driven discovery to unlock revolutionary opportunities.[87] This pillar includes advanced materials, electrochemistry, and quantum computing, in addition to platform technologies, such as machine learning, smart manufacturing, and digitalization, which are essential to bring our energy systems into the modern moment.

Pillar 2: Secure, efficient, digitally enabled power systems

Secure, efficient, digitally enabled power systems are the cornerstone of this century's economy. Rising electricity demand and aging infrastructure create urgency and an opportunity to accelerate grid innovation to meet the needs of artificial intelligence data centers, clean and competitive manufacturing, and electric vehicles, all while ensuring affordability, reliability, and security for everyday Americans.[88] This pillar includes advanced grid technologies and components, electricity transmission, storage, grid and energy system cybersecurity, virtual power plants, and system integration and planning.

Pillar 3: Clean firm electricity generation

Clean firm electricity generation refers to power generators that can produce electricity around-the-clock with low emissions and high certainty. Affordable technologies of this type are essential to power work, transportation, manufacturing, education, and many other activities. Clean firm technologies are also major domains of competition for global influence with China.[89] Emerging technologies such as advanced nuclear fission, fusion energy, and enhanced geothermal fall under this pillar.

Pillar 4: Variable electricity generation

Electricity generation based on variable natural inputs, such as solar and wind power, has made tremendous strides in recent years. Variable renewable energy technologies account for the majority of new capacity being installed on grids in the United States and around the world.[90] These technologies continue to advance at a remarkable rate, and global markets dominated by Chinese firms continue to grow rapidly. Key opportunities in next-generation renewable technologies under this pillar include tandem and flexible photovoltaics, floating wind, and marine and tidal energy.

Pillar 5: Advanced transportation systems

Autonomous, connected, and electrified systems are disrupting the world's transportation industries. China has seized a commanding early lead in the development and deployment of technologies for rapid charging, range extension, and low-cost production. However, many chapters of this story remain to be written.[91] This pillar encompasses all modes of transportation, including medium and heavy-duty trucking, maritime, air, and rail as well as passenger vehicles.

Pillar 6: Sustainable fuels

Sustainable fuels can strengthen the security, reliability, and affordability of the fuels used in transportation, industry, agriculture, and other key sectors of the economy, while also reducing pollution. Unabated fossil fuel combustion not only creates greenhouse gases, but it also leaves the United States dependent on volatile global markets, major increases in domestic oil and gas production notwithstanding. Work under this pillar may include advanced biofuels, synthetic hydrocarbons, and hydrogen and ammonia made with carbon capture and sequestration (CCS), clean electricity, or waste sources.

Pillar 7: Efficient buildings

Residential and commercial buildings, directly and through use of electricity, are responsible for about 40% of U.S. energy consumption. Deploying advanced technologies developed and championed by U.S. innovators means less energy use, lower costs, greater comfort, and improved health for Americans. Advanced technologies can even turn buildings into interactive resources for the power grid. This pillar focuses on using advanced technologies like ground-source heat pumps, improved building envelopes, and smart sensors and controls that enable buildings to use less energy and reduce system costs.

Pillar 8: Clean and competitive manufacturing

Global markets increasingly demand high-quality goods that meet strict sustainability standards. Many U.S. manufacturers are meeting this multi-faceted challenge but face stiff international competition going forward. This pillar touches a wide range of sectors, including heavy industries like chemicals, steel, and cement, as well as process innovations ranging from artificial intelligence applications and robotics to electrification and clean heat. It also includes advanced manufacturing of energy system goods, such as power system components and vehicles.

Pillar 9: Secure supply chains

Supply chain vulnerabilities became apparent during the COVID pandemic, when supply shocks sparked inflation and limited availability of vital goods. The experience laid bare U.S. dependence on China—a threat reinforced by new export controls on critical minerals. This pillar requires innovation in fields like battery chemistry, natural resource exploration and extraction, and materials processing and recycling.

Pillar 10: Carbon management

Carbon management is a new discipline that provides an opportunity to mitigate emissions from hard-to-abate sectors, including industry, power, and aviation. The United States is currently poised to be a global leader in developing carbon management technologies due to expertise in fossil fuel infrastructure and significant investments over the past several years, yet currently risks ceding its position to other countries. This pillar encompasses carbon management at the facility and regional level through carbon capture, utilization, and storage, as well as at the global level through removal of carbon dioxide and methane from the atmosphere.

Several of these pillars are similar to those in *Energizing America*, including foundational science and platform technologies, transportation, fuels, buildings, and manufacturing. The power systems pillar is updated to reflect an increased focus on grid reliability, security, and modernization. We divide *Energizing America*'s single electricity generation pillar into two—clean firm and variable generation—to emphasize the need for innovation to meet rising electricity demand and balance a growing variable renewables portfolio. We have combined *Energizing America*'s two pillars on carbon capture, use, and sequestration and carbon dioxide removal (from the atmosphere) into one on carbon management. Finally, we have added a new pillar on secure supply chains to respond to threats to critical minerals, materials, and components used in energy innovations.

Setting an Ambitious but Justified Topline Goal

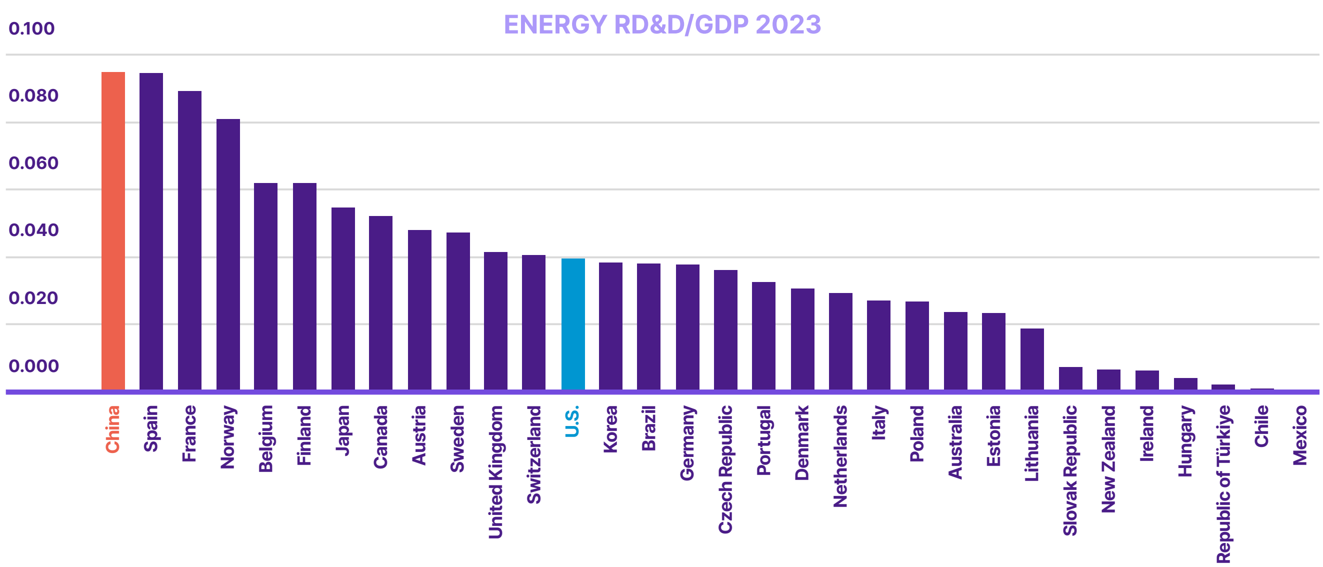
We recommend increasing energy RD&D funding by 80% from the FY 2025 baseline[92] in the remainder of this decade, ramping to $25 billion in FY 2030. Now is not the time to pull back; it is the time to double down on investments that bring down technical risk, support American innovators, and build out the energy system we need to power the modern economy. Twenty-five billion dollars by the end of the decade, strategically applied to technology pillars and incorporating lessons learned on how DOE can effectively and impactfully deliver this funding (as we dive into more fully below), will put the United States on a path toward more affordable energy, greater national security, increased economic opportunity, and reduced global emissions.

In 2020, *Energizing America* set a goal of ambitiously expanding federal energy RD&D funding over five years, with DOE receiving over $18 billion in FY 2026 (if this number is inflation-adjusted from 2020, it would correspond to $22 billion in today's dollars).[93] The authors argued that this investment would provide the foundation for the United States to achieve key goals in the coming decades and that the target was in line with funding responses to similarly urgent science and technology challenges in the past as well as those of other countries.

As we have seen, progress was made toward this goal, but American energy innovation is now in jeopardy amidst increasing energy demand, rising energy costs, China's technology dominance, and faltering emissions reductions. Now is the time for Congress to reclaim leadership on global energy innovation.

China's public energy RD&D spending is a reminder of what we're up against. As Figure 10 shows, China spent a greater share of GDP than any other country on energy innovation. Even that is likely an underestimate given the Chinese government's deep involvement in China's private sector. The United States spends less than half that of China on energy innovation as a share of GDP and invests less than 11 other countries.[94] "We're number 13!" is not a slogan that Americans can be proud of. Our proposed target, if adopted today, would restore the United States to the top tier of this year's rankings and set us within competitive distance of China.

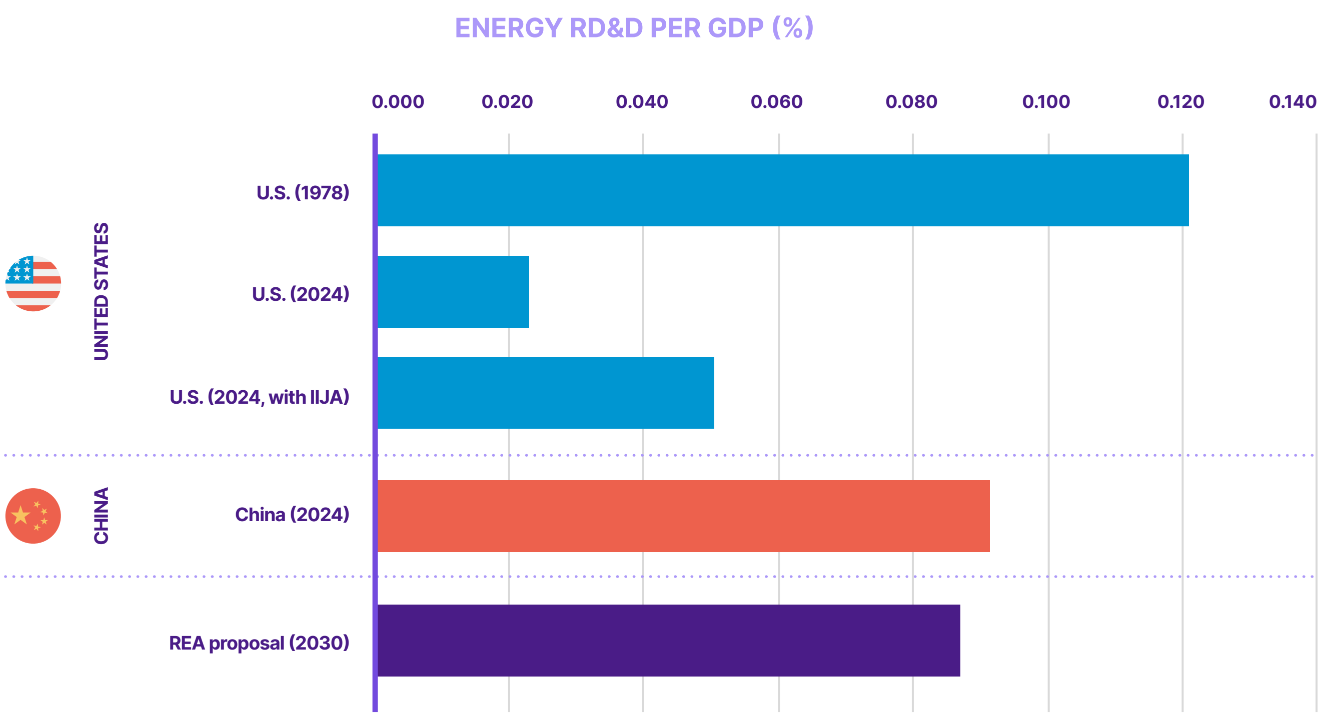
FIGURE 10. Energy RD&D as a share of GDP for select countries. Data from IEA (2023 is the latest year available for all the countries).



It would also bring the priority placed on energy innovation within the national context up to where it was during the energy crisis of the 1970s, when DOE was founded. Today's challenges are no less compelling than those of 50 years ago. Those investments in the 1970s set the United States up to be a global leader in the 20th century, and we must not lose the opportunity to lead again in the 21st century and beyond with the technologies of the future.

For some perspective, this report's target of $25 billion for energy RD&D funding is less than half a percent (0.4%) of the total federal budget, and only 1.4% of all discretionary spending. In fact, it is less than half of DOE's total budget.[95] With the returns on investment that RD&D funding provides for our nation, the benefits of meeting our proposed funding target are critical and worth every dollar.

FIGURE 11. Federal RD&D funding as a percentage of GDP for selected countries and years.[96, 97, 98]



Setting Priorities and Allocating Resources within DOE

Funding across DOE offices and programs should be allocated based on the likelihood and urgency of their work to impact the four policy imperatives of affordability, national security, economic opportunity, and decarbonization. To build out our funding recommendations, we divided the 10 technology pillars by level of priority and assigned a five-year funding multiplier to each level (Table 2). Technology pillars for grid, clean firm generation, manufacturing, and supply chains have the highest multipliers. Technology pillars for science, fuels, and buildings fall into our medium prioritization category, while pillars for variable generation, transportation, and carbon management are prioritized lowest.

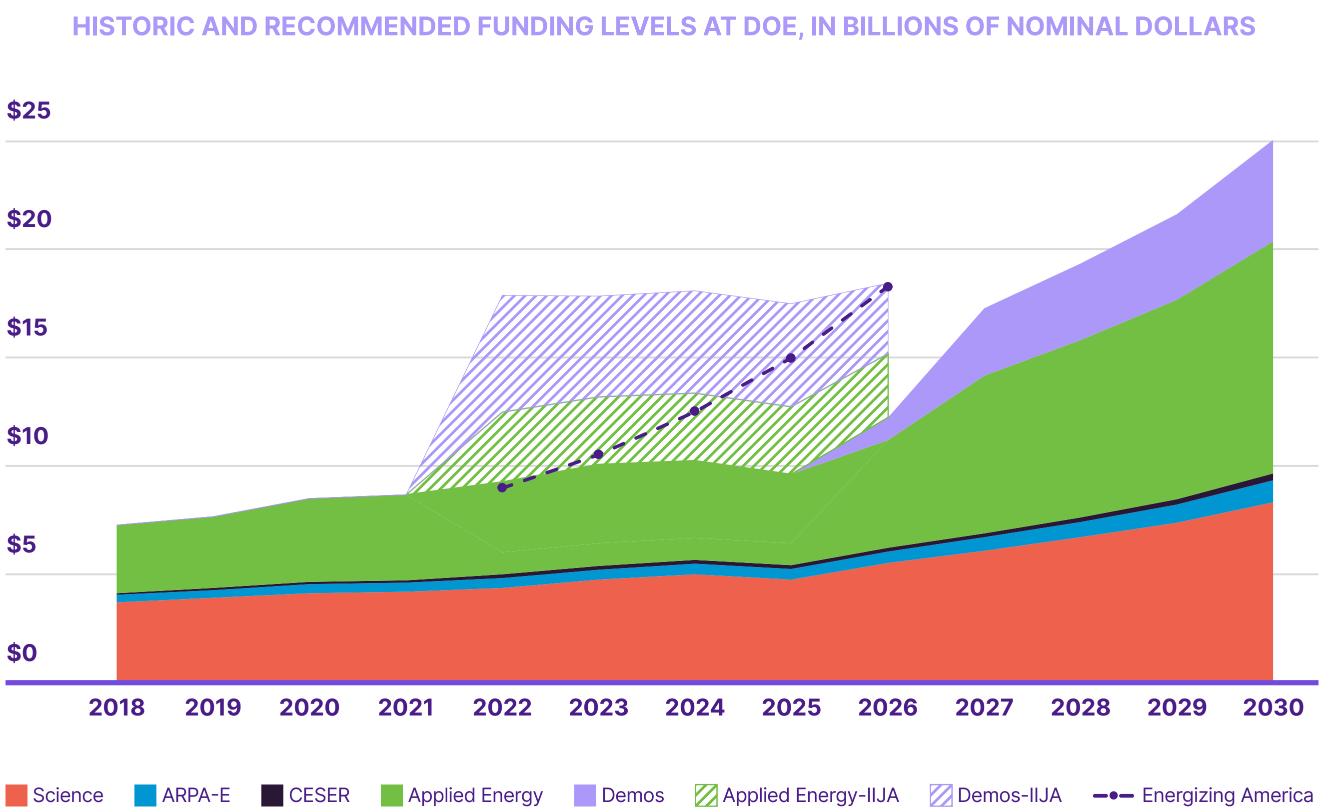
Table 2. Multipliers for priority technology pillars.

PRIORITY ONE	PRIORITY TWO	PRIORITY THREE
Secure, efficient, digitally enabled power systems: Advanced transmission, storage, cybersecurity, and digital technologies to support AI, manufacturing, and electrification while ensuring reliability and security of the electric grid	**Foundational science at platform technologies:** Platform technologies, including advanced materials, quantum computing, and AI, enabling breakthroughs across energy systems	**Variable electricity generation:** Next-generation solar, floating wind, and marine energy, building on renewable momentum and staying ahead of rapidly advancing technologies
Clean firm electricity generation: Around-the-clock, low-emission power from advanced nuclear, fusion, and enhanced geothermal to compete with China and power critical sectors	**Sustainable fuels:** Advanced biofuels, hydrogen, and synthetic hydrocarbons for transportation, industry, and agriculture security	**Advanced transportation systems:** Electrification and autonomous systems across all modes, from passenger vehicles to heavy-duty trucking and aviation
Secure supply chains: Domestic capacity for critical minerals, battery chemistry, and materials processing to reduce dependence on China	**Efficient buildings:** Heat pumps, smart controls, and advanced envelopes to reduce the 40% of U.S. energy consumed by buildings	**Carbon management:** Capture, storage, and removal technologies for hard-to-abate industrial and power sector emissions
Clean and competitive manufacturing: Process innovations and electrification for chemicals, steel, cement, and energy component production to meet global sustainability standards		

These priorities reflect our collective judgment. The highest-priority pillars can contribute to multiple policy imperatives, have suffered from historic underinvestment, and are geopolitically important. We use the *Energizing America* targets and funding levels (as described in earlier sections of this report) to assess historic underinvestment. Affordability and economic opportunity were assessed based on existing analyses for market potential in the United States, including the DOE Liftoff Reports and technology deep dives from several sources.[99, 100, 101, 102] Security was trickier to assess, as national security, economic security, and physical infrastructure security are all related but distinct aspects of security. We placed a higher priority on pillars that had a defense nexus, addressed securing supply chains for critical materials and components, and had the potential to improve grid and infrastructure stability. Decarbonization was based on sectors with the highest emissions.[103]

We then estimate the degree to which each DOE office advances each pillar. That calculation yields a recommended pace of funding increase for each office over our five-year time horizon. For instance, DOE's Buildings Technology Office primarily contributes to the efficient buildings pillar, but a portion of its work is devoted to the electricity grid pillar, because buildings increasingly interact with the grid. The pace of growth for the office thus blends the two multipliers. (The full methodology for priority setting and resource allocation can be found in Appendix A.) Combining this bottom-up analysis with our overarching goal yields the proposed funding targets shown in Figure 12.

FIGURE 12. Historical and recommended funding levels for DOE.



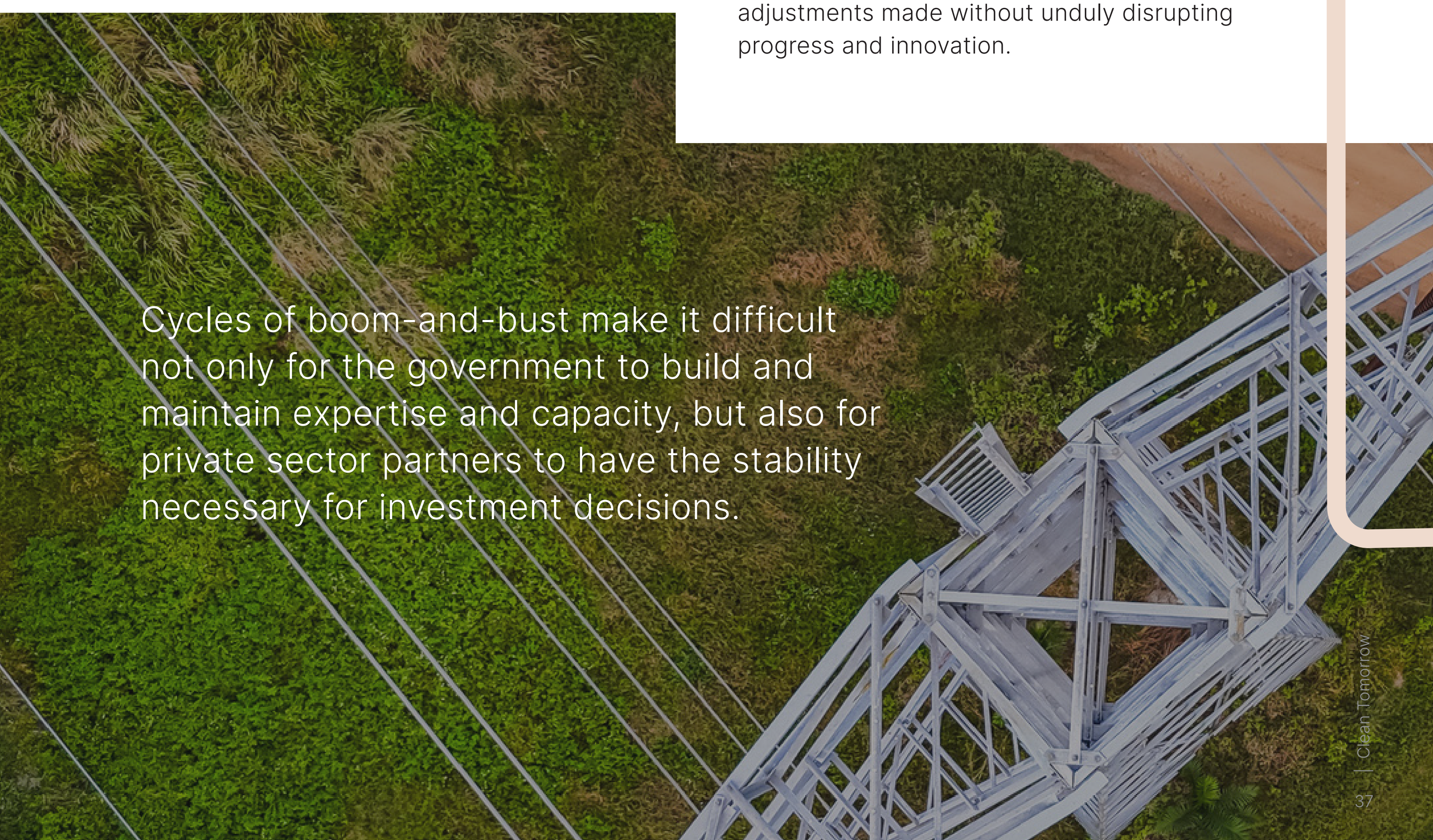
Note: While OCED has essentially been dismantled at the time of writing of this report, we retain demos as an important area of funding for DOE. The "demos" funding we recommend in this figure and more broadly in this report may remain in a distinct office, be subsumed under a different DOE office, or spread out across distinctive technology offices. See below for a discussion on demonstration-scale projects.

Stable Growth and Regular Assessment

As Figure 12 shows, we propose a smooth ramp-up to meet our goal. Short-term volatility in funding damages the long-term mission of energy innovation. Cycles of boom-and-bust make it difficult not only for the government to build and maintain expertise and capacity, but also for private sector partners to have the stability necessary for investment decisions.

Funding allocations from the IIJA go through FY 2026 and no further. This heralds an "innovation cliff" in FY 2026—the exact type of boom-and-bust that Energizing America cautioned against. To that end, Congress must increase funding in FY 2027 to accommodate for that drop-off and meet innovation funding targets that ensure robust and continued investment. Given current circumstances and what the past few years have shown, it is likely that IIJA funds will remain available beyond FY 2026. Those funds should be reallocated and invested to help meet our recommended targets, not squandered.

The ramp-up, of course, cannot be sustained indefinitely. We recommend it level out to match the pace of overall economic growth, so that the target level of 0.1% of GDP is sustained on an inflation-adjusted basis beyond 2030. Similarly, the technology pillars and priorities should not be set in stone, but rather revisited and updated periodically. New imperatives will emerge, along with unexpected scientific discoveries and technological developments. These opportunities can be seized and adjustments made without unduly disrupting progress and innovation.



Cycles of boom-and-bust make it difficult not only for the government to build and maintain expertise and capacity, but also for private sector partners to have the stability necessary for investment decisions.

A Discussion of Demonstration-Scale Projects

In the years leading up to *Energizing America* and the major legislative actions taken in 2020 and 2021, a growing chorus of experts across science, business, academia, and technology highlighted the "demonstration valley of death" that prevents many energy technologies from moving from pilot scale to widespread adoption. Reporting and research alike have noted that the trend of moving overseas has enabled some technologies invented in the United States, including polycrystalline silicon solar panels and lithium iron phosphate batteries, to cross the valley, leading to the commercialization of these technologies abroad—and taking many benefits with them.[104, 105]

Various models for federal support of these riskier, first-of-a-kind generating facilities and industrial plants were proposed, from creating a government-funded "energy technology corporation" to an independent federal administration to a new office within DOE.[106, 107, 108] Congress voted in 2021 to establish the DOE OCED and appropriated over $20 billion for cost-shared projects that would not attract fully private investment.[109]

By the end of the Biden administration, OCED had obligated less than half its budget and outlaid much less.[110] This slow and deliberative approach, while justified by the technical complexity of the projects and the limited administrative resources available to OCED as the office grew, left funding vulnerable to recission and projects vulnerable to cancellation. The Trump administration has essentially dismantled OCED, canceled many projects overseen by the Office, and left others in limbo as of this report's publication.

The key argument offered by OCED's critics is that it unfairly subsidizes certain technologies and spends taxpayer dollars where the private sector should instead step in.[111] Yet, as the response to DOE's cancellations reveals, there is little evidence that the market will fill the gap. Moreover, the Trump administration recognizes the essential role of catalytic public funding for demonstration projects in specific cases, such as advanced nuclear power.[112]

As the United States pulls back, China is ramping up. This year, the central government announced 101 new demonstration projects, on top of 47 funded last year.[113] While the United States may not be poised to compete with China in manufacturing commodity products like solar cells, the complex, large-scale technologies like those OCED sought to demonstrate offer many promising opportunities to unlock private investment and capture economic benefits.

Additionally, there are clear examples that when public demonstration project funding is successfully layered onto the U.S. RD&D innovation advantage, there can be widespread gains towards all desired outcomes—national security, economic opportunity, decarbonization, and affordability. DOE's investments in hydraulic fracturing are perhaps the best, most recent example— the United States continues to lead globally in horizontal drilling and natural gas production, and this technology advance has changed the modern energy landscape. To this end, we maintain funding for demonstration projects in our budget proposal. They are vital tools of energy innovation policy without which many technologies will fail to commercialize.

Immediate Goals for FY 2026 and FY 2027

Each year presents a new opportunity to put ourselves on a path to revitalize U.S. energy innovation, to rebuild the momentum of the last five years, and to compete on the global stage, and we begin with fiscal year 2026. Recommended budgets for FY 2026 and FY 2027 are in the table below.

TABLE 3. Planned and recommended FY26 budgets for selected DOE offices (in millions of nominal dollars).

	FY 2025		FY 2026			FY 2027
Office	**Base Appropriation**	**IIJA Allocation***	**Proposed Base Appropriation**	**IIJA Allocation***	**% Increase (Base + IIJA)**	**Proposed Base Appropriation**
Science	$4,770		$5,500		16%	$6,100
Energy Efficiency and Renewable Energy (EERE)	$2,200	$1,490	$2,620	$1,450	10%	$3,780
Fossil Energy and Carbon Management (FE)	$570	$1,430	$710	$1,300	0%	$1,480
Nuclear Energy (NE)	$1,040		$1,190		15%	$1,360
Office of Electricity (OE)	$380	$200	$450	$200	13%	$630
ARPA-E	$470		$540		15%	$620
Office of Cybersecurity, Energy Security, and Emergency Response (CESER)	$120	$50	$140	$50	13%	$190
Office of Technology Commercialization (OTC)	$20		$23		15%	$26
Energy Demonstrations**	$50	$4,770	$1,000	$3270	-11%	$3,100

* IIJA allocation is the annualized appropriation for the multi-year appropriations for IIJA programs. As of the writing of this report, while some IRA funding has been rescinded and projects funded by those programs have been terminated (or proposed to be terminated), that funding remains appropriated by law for those programs.

** While OCED has essentially been disbanded, we recommend maintaining funding for demonstration-scale projects, whether in its own office, under a new office, or under the applied offices.

Across DOE offices, recommended budget increases from FY 2025 to FY 2026 fall between 0% and 16%, with the greatest increases for the Offices of Science, Nuclear Energy, and ARPA-E. The Offices of Electricity and Cybersecurity, Energy Security, and Emergency Response play essential roles in supporting innovation and improvements for our electric grid and also see substantial budget increases in our recommendations. The Office of Technology Commercialization, while not technology-specific, plays a key role in coordinating and supporting technology commercialization and program development at the Department, and we recommend an increase of 15% in their budget for FY 2026. These increases will set the United States on the path for increased energy RD&D investments and rebuilt federal funding mechanisms to advance strategic technology priorities along the innovation commercialization pipeline.

FY 2027 is included in the table to highlight the necessity of increasing appropriations in FY 2027 to fill the gap left by the loss of IIJA funding. Our funding targets seek to rebuild to IIJA levels and beyond, gradually over time to allow for staffing and capacity-building within DOE. With these sustained and gradual increases, DOE can be fully unleashed to re-establish U.S. dominance in energy innovation.

How to Deliver on Energy Innovation

The ambitious energy innovation agenda outlined in this report can only succeed if the federal government's capacity to execute matches its strategic vision. While Congress has provided unprecedented funding for energy innovation over the past five years, implementation challenges have limited the impact of these investments. Some programs encountered delays in disbursing funds, others struggled with complex procurement processes, and many operated in isolation rather than as part of a coordinated innovation pipeline.

These challenges are not failures of individual leadership or political will, but evidence of the difficulties of adapting a decades-old federal agency to nimbly meet the needs of today. To realize the full potential of federal energy innovation investment, DOE must transform from a collection of semi-autonomous programs into a unified system capable of moving technologies seamlessly from early-stage research to commercial-scale deployment. Simultaneously, caution in oversight of taxpayer dollars must be balanced with taking risks to ensure that federally funded projects have the opportunity to succeed. This transformation requires both structural reforms and cultural changes that prioritize collaboration, speed, and long-term thinking, without sacrificing technical chops and market savvy.

One prominent lesson learned from the past few years is that "supply-push" RD&D support for innovative technologies must be matched with complementary market and commercialization levers to advance technology adoption, especially if we aim to compete with China. The next chapter of energy innovation support must include close collaboration with the private sector and innovative ways of leveraging federal resources to reduce barriers, provide investment at key points in the innovation pipeline, and foster an ecosystem that allows American innovators to flourish.

Below, we lay out some initial recommendations on how to ensure that funding for energy innovation actually translates into meaningful emissions reductions. Passing policy is only the first step—we must effectively implement programs to support the full innovation pipeline, catalyze private investment, and deliver maximum impact and benefits for the nation. We anticipate a follow-up report with more detail on the lessons learned from the past few years on implementation of DOE programs and how to reinvigorate the department to meet future opportunities.

THE CORE CHALLENGE:

Fragmentation Across the Innovation Pipeline

DOE's organizational structure reflects its historical evolution rather than the demands of modern energy innovation. The Department operates as a collection of programs and program offices focused on discrete missions with separate appropriations and constituencies. This architecture creates few incentives for the cross-functional collaboration across DOE offices essential for moving technologies through the full innovation pipeline from basic research to commercial deployment.

One damaging consequence of this fragmentation is the first "valley of death" that opens between early-stage research and larger-scale pilot and demonstration projects. Technologies that show promise at the proof-of-concept stage frequently stall before reaching prototype and demonstration not because of technical flaws, but because no single entity within DOE takes responsibility for managing the handoff between offices or programs. The second "valley of death" in between pilot-scale and commercialization was just beginning to be addressed with the creation of OCED, but certain OCED-funded technologies lacked a pipeline of prototype and pilot projects ready for scale-up.

This systemic problem ensures that only the most resilient—or politically favored—technologies survive the journey from lab to market. Meanwhile, innovations that could transform entire sectors languish for want of institutional coordination and long-term planning. For example, several long-duration energy storage technologies have languished without adequate funding and without a designated DOE program to support their scale-up.

The Department of Energy operates as a collection of programs and program offices focused on discrete missions with separate appropriations and constituencies.

THE OPPORTUNITIES:

Empowering the Department to Unleash Energy Innovation

High-level recommendations for how to reform DOE to better enable a modern energy innovation ecosystem in the United States include:

Building a Unified Innovation Framework

Establishing a unified and enduring innovation framework requires structural reforms to DOE operations and realigned incentives. The goal is a seamless, durable pipeline from research to deployment, with clearly aligned funding, governance, and collaboration incentives. It must be a system built for continuity and designed to empower fast, mission-driven action regardless of the administration. This framework should include redefining success around shared outcomes across DOE programs and establishing specific milestones for priority technologies as they move along the commercialization pipeline.

Enabling Cross-Program Planning and Funding

Beyond management changes, DOE needs new financial mechanisms that enable sustained collaboration across organizational boundaries. The rigid "color of money" rules that prevent pooling funds between different appropriations, combined with annual budget cycles, make long-term joint planning exceptionally difficult. Where possible, Congress should provide multi-year appropriations for demonstration projects and other initiatives that span the traditional annual cycle, as it did in IIJA. This authority would enable DOE to make reliable funding commitments to partners and reduce the pressure to obligate funds hastily at fiscal year-end.

Enhancing Program Agility and Responsiveness

Rigid solicitation structures and lengthy review cycles can cause DOE to miss opportunities or fund yesterday's priorities instead of tomorrow's breakthroughs. Traditional federal procurement processes, designed for predictable purchases of established technologies, often prove inadequate for the dynamic world of energy innovation. DOE should expand its use of alternative funding tools, including but not limited to other transaction authorities, milestone-based payments, prizes, and demand-side support, and experiment with rolling and annual competitions that would allow for better alignment with applicant timing.

Strengthening Industry Partnerships for Market-Driven Innovation

In addition to unblocking the innovation pipeline for new technologies, DOE and the national laboratories have important roles to play in ensuring that technologies that have already been deployed continue to improve. Partnerships with industry should strengthen the private sector's capacity to lower costs, add functionality, and respond to market demands. DOE should systematically expand programs that make laboratory resources available to private-sector innovators facing specific technical challenges. This includes expanding technology prototype test facilities, voucher programs for companies to access lab resources, and entrepreneurial programs designed to incubate new technologies and ideas.[114]

Building for Institutional Continuity

Perhaps the greatest challenge facing federal energy innovation programs is the whiplash that accompanies changes in political leadership, creating uncertainty that undermines long-term investment and partnership between the federal government and industry. While no institutional design can fully insulate programs from political change, certain features can enhance durability. Multi-year budget authority reduces vulnerability to annual appropriations politics; although, as recent cuts show, even the most thoughtful approach to budget authority cannot fully protect programs from a hostile political environment. Strong partnerships with states, universities, and industry create external constituencies that advocate for program continuation. Programs should prioritize strong partnerships with states, universities, and industry to ensure program continuation and demonstrate clear value through measurable outcomes, showing that they consistently produce results that benefit constituencies across political lines.

Transforming DOE from a collection of competing programs into a unified innovation system will require sustained effort from leadership, staff, and external partners. The changes outlined here represent a pragmatic starting point rather than a comprehensive blueprint. Some can be implemented through administrative action, while others will require congressional cooperation.

The ultimate goal is an institution built for continuity—one that serves as a reliable partner to American innovators and a trusted engine for the nation's energy security and economic future. Achieving this vision will require not just new funding, but new ways of thinking about federal agencies and policy implementation.

Conclusion

Now is the time to rebuild American energy innovation leadership and forge a cleaner, more affordable, and more secure energy future. The convergence of rising energy costs, geopolitical instability, and climate urgency creates both necessity and opportunity for decisive action.

America's energy challenges demand American solutions. Skyrocketing electricity demand from artificial intelligence and manufacturing reshoring threatens grid reliability and affordability. Our dependence on Chinese-dominated supply chains exposes critical vulnerabilities, from rare earth minerals to battery components. Meanwhile, global emissions continue rising, demanding breakthrough technologies that only sustained innovation can deliver.

The foundation for American leadership remains strong. Our national laboratories, universities, and entrepreneurial ecosystem possess unmatched capabilities in foundational sciences, advanced materials, and complex systems integration. Despite setbacks, recent legislative victories proved bipartisan energy innovation policy remains achievable when focused on shared economic and security interests.

However, foundation without construction yields nothing. China spends twice as much as the United States on energy innovation as a share of GDP, cementing advantages in technologies that will power the next century. The boom-bust cycles that have plagued American energy policy must end, and we must reinvigorate sustained investment and federal support to develop and build the energy technologies of the future.


Appendix


Appendix A

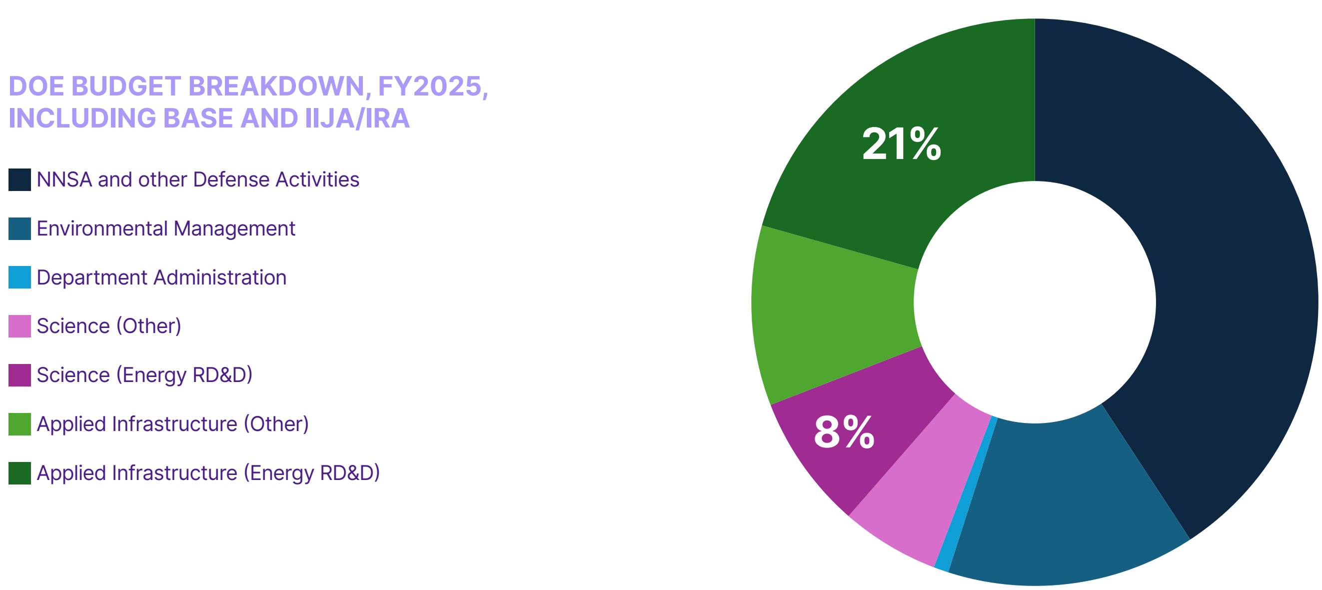
Methodology for Proposed Budgets, FY 2026–2030

To develop budget proposals, the Clean Tomorrow team followed the approach of *Energizing America*. This approach involved establishing an energy RD&D funding baseline for 2025, mapping DOE offices to technology pillars, and setting priorities and ramp rates among those pillars to yield a target level and growth rate for each office.

Establishing RD&D Funding Baseline

To home in on RD&D funding for DOE, we focused our analysis on dollars going to RD&D activities: research, development, and demonstration. This meant that we excluded funding for infrastructure, operations, and deployment—including programs like the Weatherization Assistance Program and the Federal Energy Management Program, the Loan Programs Office, power market administrations, and the international affairs, statistics, and regulatory offices of the department. We acknowledge that these deployment and implementation efforts often create demand pull for energy technologies, but those tend to be mature technologies for energy efficiency and more established electricity generation. For the Office of Science, we counted 50% of the Advanced Scientific Computing Research program as energy RD&D, as the program supports a number of other sectors and

FIGURE 13. DOE budget breakdown for FY 2025, including base and IIJA/IRA. We categorized ~29% of DOE's budget for RD&D.

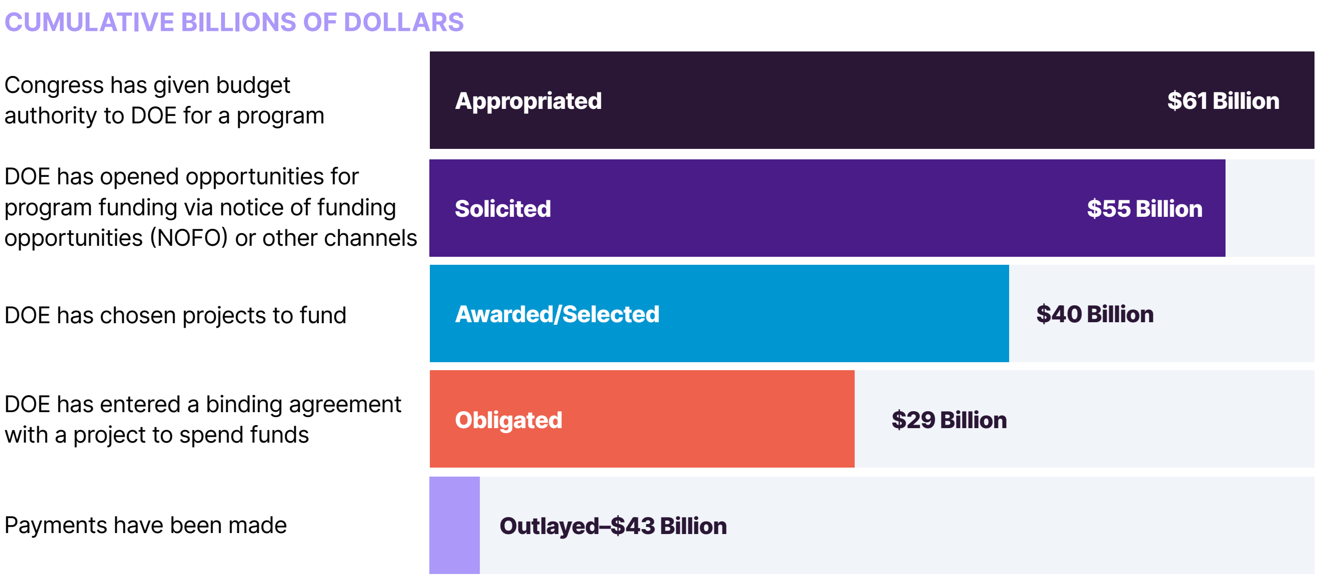


fields beyond energy. As shown in Figure 13, we categorized less than a third (29%) of DOE's FY 2025 budget as RD&D, including annualized IIJA and IRA appropriations. For a database of DOE funding across deployment and commercialization in addition to RD&D, the Rhodium Group released a report in March 2025 that includes those levels of funding as well.[115]

We then added annualized allocations of mandatory, multi-year appropriations included in the IIJA and IRA. Although Congress spread these allocations across specific fiscal years for accounting purposes, actual DOE outlays (money disbursed to funding recipients) frequently were not consistent with these notional plans. Spending for large projects, notably, was expected to be backloaded; relatively inexpensive preparatory and design stages were to be followed by high-dollar construction. In addition, as described in the main body of this report, implementation of these laws under President Biden did not necessarily proceed at the pace that Congress envisioned. The Trump administration then froze many planned expenditures and formally canceled some. The exact amount of outlays remains uncertain.

Given this variation and uncertainty, we reduced IIJA/IRA contributions to 50% of their FY 2025 annual allocation for the baseline we used to build out our projections. We used 50% as an estimate based on our independent analysis of obligated funding via USASpending.gov and EFI Foundation's reported estimate that 47% of IIJA funds were obligated as of May 2025 (Figure 14).[116] As of the writing of this report, some unobligated IRA funds were rescinded in the One Big, Beautiful Bill Act,[117] and unobligated IIJA funds have been targeted for rescission

FIGURE 14. Flow of IIJA dollars, in cumulative totals, through the DOE award pipeline.[119]



Note: Status as of March 31, 2025. These estimates are based on the best available government data through Q2 of 2025, but some data may be missing or out of date. The numbers for awards, obligations, etc., should be considered minimum estimates. DOE's total does not include borrowing authority given to Bonneville Power Administration. Funding totaling $9 billion was appropriated in advance for FY 2026 and is not yet available for DOE to obligate (see below). Full methodology is available in the appendix. Totals may not sum due to independent rounding. Data from: Outlayed and obligated funds published on the Department of Treasury's USASpending.gov and awards and appropriations reported by the White House on the now-archived Invest.gov.

Source: EFI Foundation

Appendix A: Methodology for Proposed Budgets, FY 2026–2030

in the president's budget request.[118] However, funds obligated to selected projects have yet to be de-obligated and formally rescinded by Congress. Even if those funds are clawed back through project terminations, they may remain available for re-obligation unless Congress takes further action to rescind them.

Another step in establishing the baseline was linking funding to specific offices within DOE. Both administrations and Congress have changed the Department's structure since *Energizing America* was written. The Biden administration created a new Undersecretary for Infrastructure, which oversaw offices newly authorized by the IIJA, including Grid Deployment (GDO), Manufacturing and Energy Supply Chains (MESC), and OCED. As of publication, the Trump administration has not announced a full reorganization, but its budget proposal assigns GDO to OE and MESC to EERE (which is consistent with their treatment by the congressional appropriations committees) and proposes shuffling OCED's projects to other parts of the agency. The Advanced Reactor Demonstration Program (ARDP), for example, which had been jointly managed by the Office of Nuclear Energy (NE) and OCED, is now managed solely by NE. In order to create a consistent time series from 2020 to 2030, we have kept MESC under EERE and GDO under OE, but we have left OCED as a separate line (except for ARDP, which we assigned to NE).

A final note on the baseline is about program direction (PD). For our calculations in this report, we applied a blanket 7% for PD for base appropriations across DOE offices. The text of IIJA specified that up to 3% of the appropriated funds were to be designated for PD, so we excluded IIJA-funded programs from our 7% calculation. Since program direction is what funds staff and overhead for program management, it is essential that there is sufficient funding to hire staff with the necessary skills to effectively manage taxpayer dollars and implement the programs.

To summarize, the general formula we used for establishing the baseline is below:

Appropriations baseline =

[FY 2025 base appropriations] + 0.07 [FY 2025 base appropriations]

+ 0.5 [FY 2025 allocation of IIJA and IRA multi-year appropriations]

Mapping DOE Offices to Technology Pillars

The second step involved gauging the degree to which each DOE office advanced each of the 10 technology pillars. This step required the team to make judgments based on the descriptions of office activities in documents like Congressional Budget Justifications. For example, the Solar Energy Technologies Office (SETO) currently puts a substantial level of effort into improving photovoltaic technologies, which are inherently variable generation (Pillar 3), but also invests in concentrating solar technologies, which can provide firm generation (Pillar 4). In some cases, determining which pillar certain technologies or activities fell under could have been categorized in a few different ways and again, our team had to make a judgement call. For example, we have categorized all energy storage (including pumped storage hydropower) under the grid pillar, while some people in the field would consider it under firm generation due to storage's ability to level demand and firm the grid. See Appendix B for a detailed percentage breakdown of how we assigned offices to technology pillars.

In general, these pillar breakdowns are estimates and used here as a general guide for how to increase funding top lines strategically by office. We welcome feedback on these breakdowns and are open to suggestions on more accurate pillar alignments. Also, we are interested in how these assignments may change over time by DOE office and may update our numbers in the future.

Setting Prioritization and Ramp Rates to Derive Budgets

The third step was setting priorities across the pillars, so budgets would emphasize activities most likely to speed progress toward key policy goals. We divided the pillars into three groups, which were ramped up at different speeds over the five-year horizon. The ramp rates were adjusted so the total budget remained within our overall growth constraint.

Finally, the ramp rates were applied to the pillars according to our prioritization and propagated through how we assigned DOE offices to those pillars. This step yielded a unique rate of growth for each office to meet our ultimate target of an 80% increase from our baseline to reach $25 billion, or 0.1% of GDP.

Appendix B

Allocation of DOE Offices to Technology Pillars

Office	Science	Grid	Firm Gen.	Variable Gen.	Transportation	Fuels	Buildings	Manufacturing	Supply Chains	Carbon Management
Office of Science										
Advanced Scientific Computing Research	100%									
Basic Energy Sciences	55%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Biological and Environmental Research	70%					10%		10%		10%
Fusion Energy Sciences	50%		50%							
Office of Energy Efficiency and Renewable Energy										
Vehicle Technologies		5%			65%	15%			15%	
Bioenergy Technologies						75%		10%	10%	5%
Hydrogen and Fuel Cell Technologies		8%	8%		15%	35%		35%		
Solar Energy Technologies		10%	10%	60%				10%	10%	
Wind Energy Technologies		10%		70%				10%	10%	
Water Power Technologies		20%	70%						10%	
Geothermal Technologies			80%				20%			
Industrial Technologies								70%	30%	
Advanced Materials and Manufacturing Technologies								70%	30%	
Building Technologies		15%					85%			
Manufacturing and Energy Supply Chains								10%	90%	

Appendix B: Allocation of DOE Offices to Technology Pillars

Office	Science	Grid	Firm Gen.	Variable Gen.	Transportation	Fuels	Buildings	Manufacturing	Supply Chains	Carbon Management
Office of Fossil Energy										
Carbon Capture			10%					10%		80%
Carbon Transport and Storage + Carbon Storage Validation and Testing										100%
Carbon Utilization + Carbon Utilization Program: Grant Program						100%				
Advanced Energy and Hydrogen Systems + Hydrogen with Carbon Management		10%	10%			40%		40%		
Carbon Dioxide Removal + Carbon Removal										100%
Methane Mitigation Technologies										100%
Natural Gas Infrastructure and Decarbonization			50%							50%
Oil, Gas, and Critical Minerals									100%	
Office of Nuclear Energy										
Reactor Concepts RD&D										
Fuel Cycle Research and Development			67%			11%		11%	11%	
Nuclear Energy Enabling Technologies			100%							
Advanced Reactor Demonstration Program	20%		60%					10%	10%	

Appendix B: Allocation of DOE Offices to Technology Pillars

Office	Science	Grid	Firm Gen.	Variable Gen.	Transportation	Fuels	Buildings	Manufacturing	Supply Chains	Carbon Management
Office of Electricity										
Energy Storage	100%									100%
Grid Mod = Grid Controls and Comms + Transformer Resilience and Advanced Components + Applied Grid Transformer Solutions	100%									100%
Grid Innovation Program (GDO)	100%									100%
Advanced Energy and Hydrogen Systems + Hydrogen with Carbon Management		10%	10%			40%		40%		
CESER										
Risk Management Tools & Technologies + Cybersecurity RD&D		100%								
Enhanced Grid Security: Cybersecurity for the Energy Sector Research, Development, and Demonstration Program		100%								
Advanced Research Projects Agency—Energy	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Energy Demonstrations		20%	20%					20%	20%	20%

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