clean tomorrow | Re-Energizing America

Looking Back at the U.S. Energy Innovation Strategy

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),[1] 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.

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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.

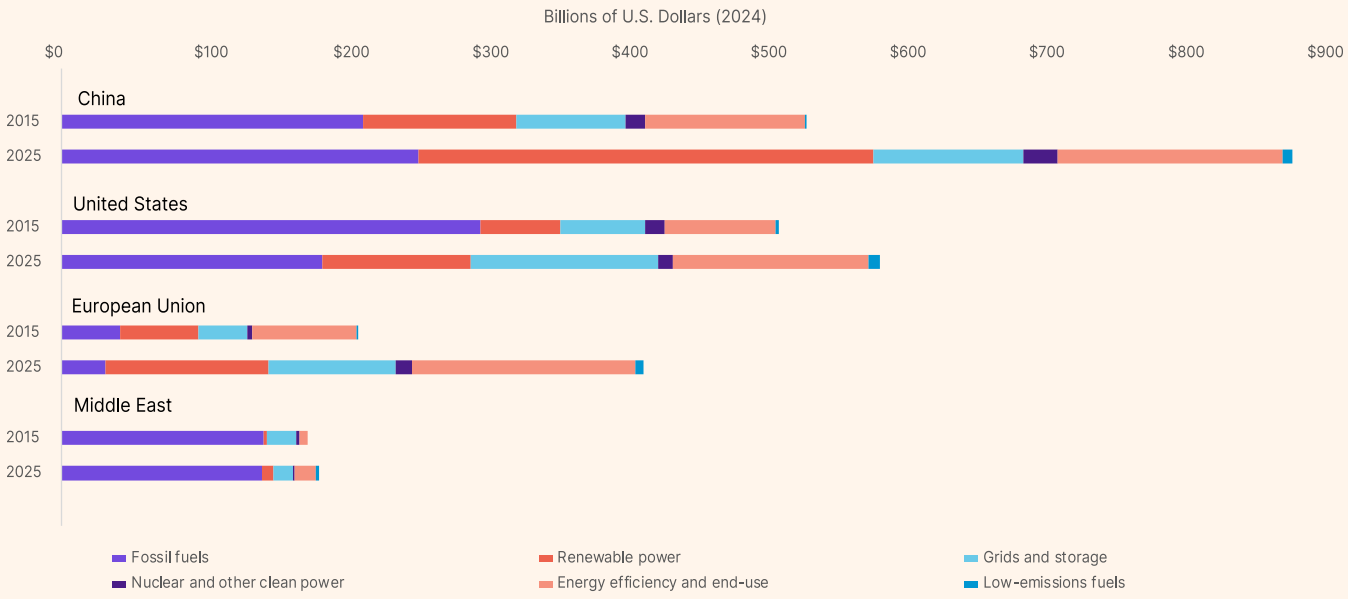
The energy system is the source of about

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.[13]



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.[2] 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.[3] 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.[4] 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.[5]

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.[6]

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.[7] 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.[8] 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.[9] 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.[10] The energy system is the source of about 75% of climate pollution, primarily because of unabated fossil fuel combustion.[11] 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.[12] 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.

Artificial intelligence, electric vehicles, and other new users of electricity are **putting further pressure on prices** by driving up demand.

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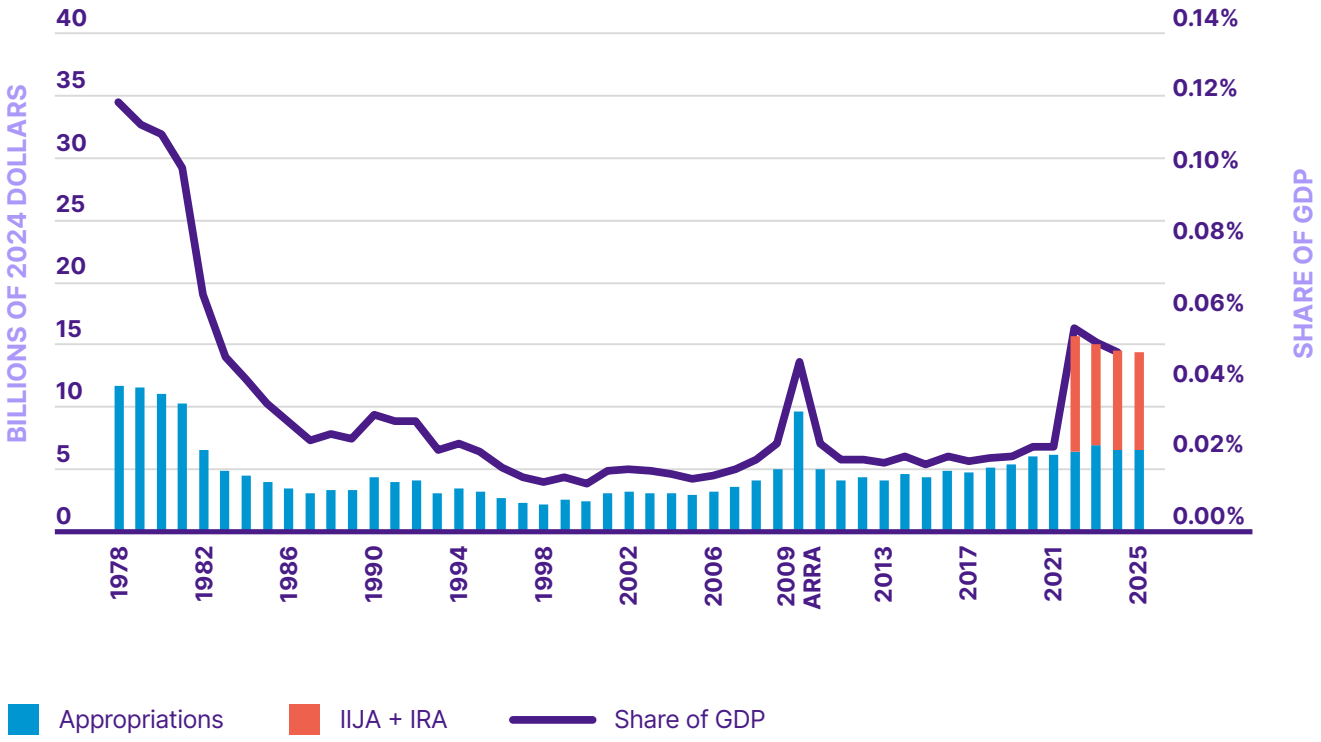
The Federal Role in Energy Innovation

For many decades, Democrats and Republicans have agreed that federal investment in science and innovation is a vital national interest.[14] 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.[15]

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.[16] The quest to harness nuclear power after World War II gave the field a major impetus.[17] 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).[18]

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.[19]

FIGURE 4. DOE RD&D funding from 1978–2025.[28, 29, 30]



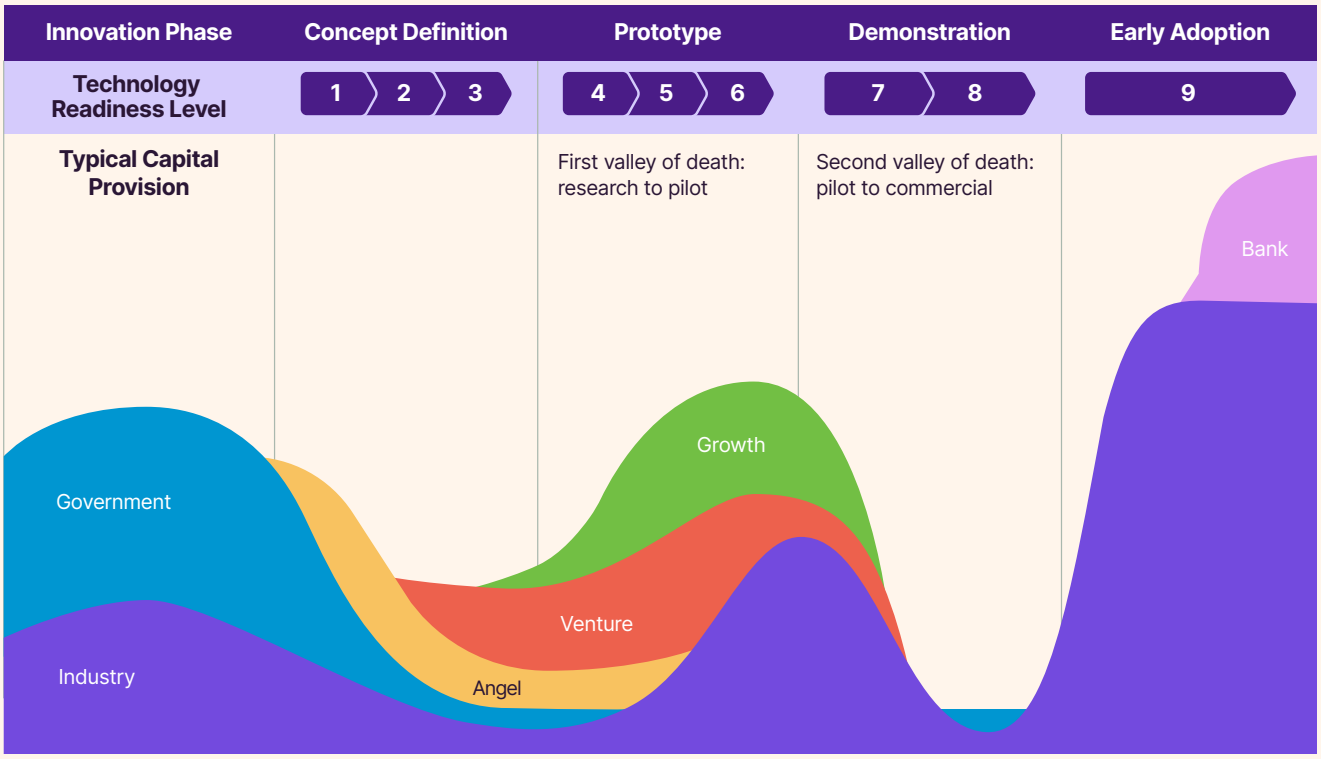
Sources: Kelly Sims Gallagher and Laura Diaz Anadon, ITIF, Clean Tomorrow

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."[20] 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.[21]

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.[22]

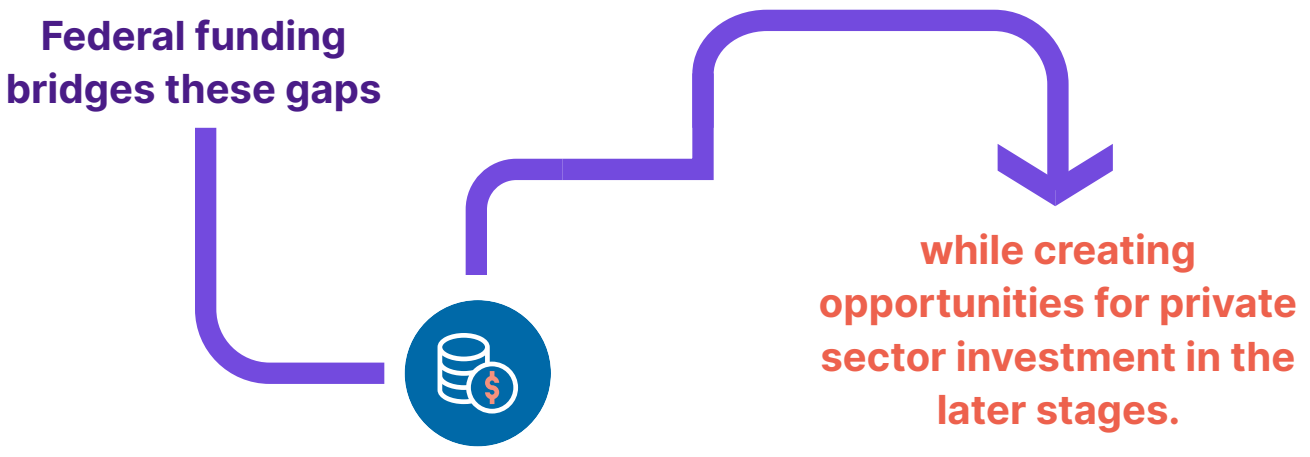
Federal investment in demonstration projects and support for early adopters could carry some innovations through these valleys of death.[23] Civilian nuclear power and hydraulic fracturing are proof points.[24, 25] Both benefited from federal policies that included but went well beyond RD&D investment, and both have become mainstays of the global energy system. However, such policies have been episodic and inconsistent over the years.[26]

FIGURE 5. Illustrative funding sources across the energy technology commercialization pipeline.[31]



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.[27]



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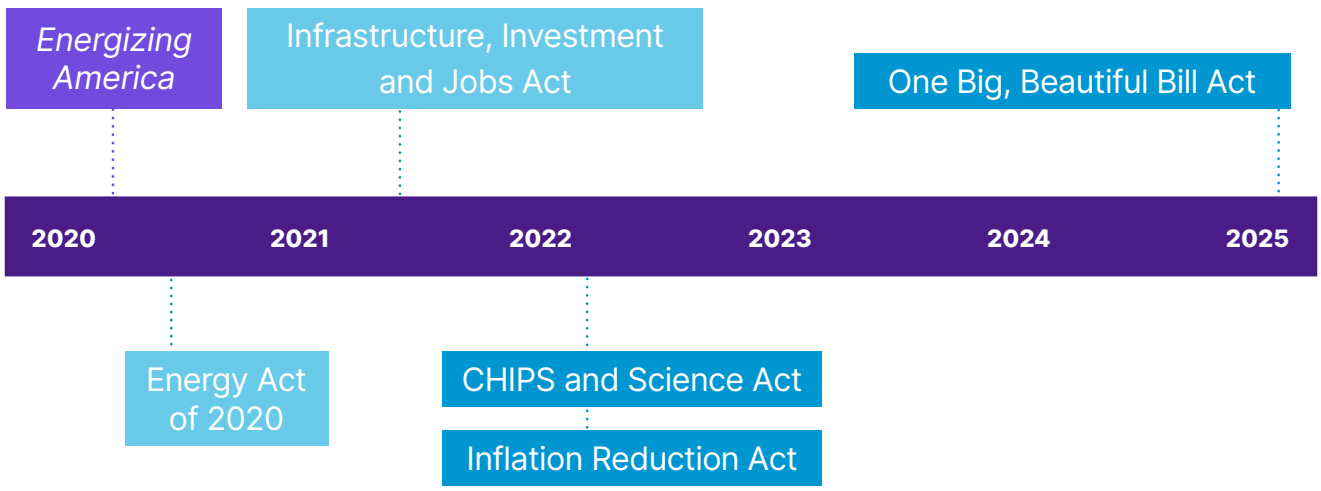
The Road Traveled, 2020–2025

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.[32, 33]

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

Legislative Timeline



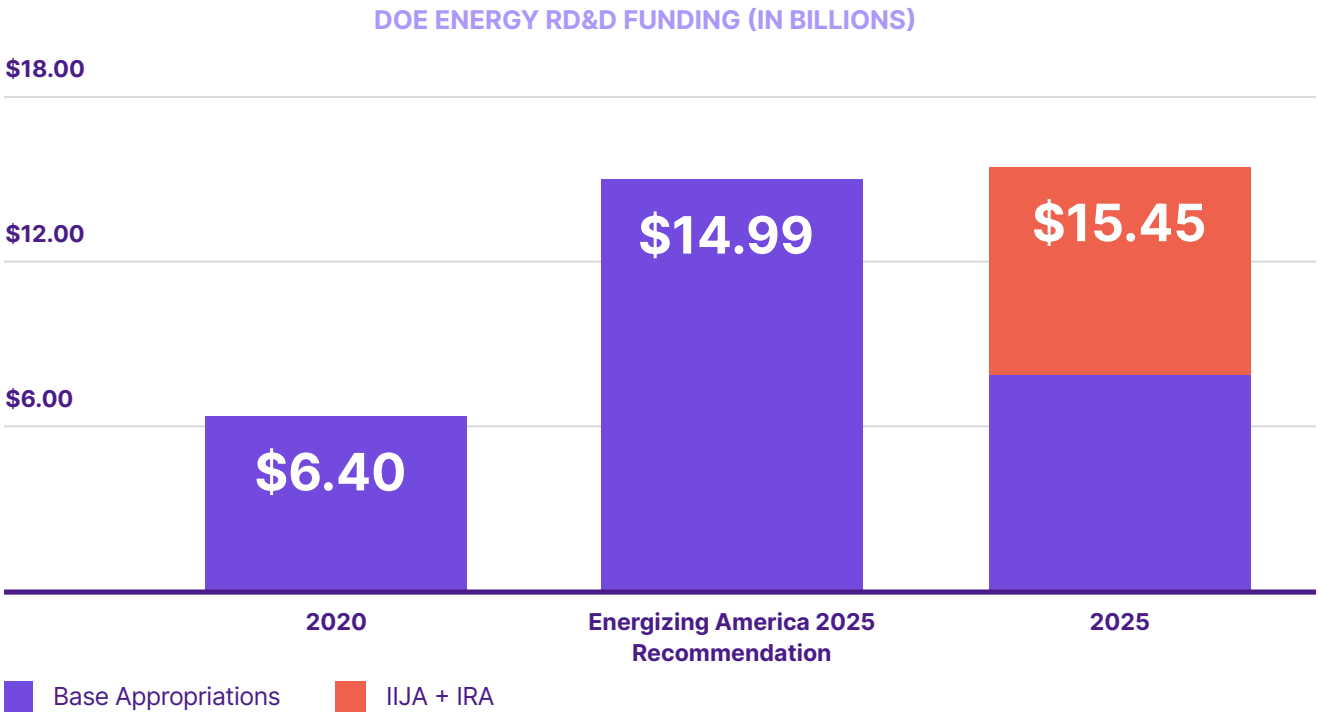
Nearly one year later, the IIJA, which won 17 Republican votes in the Senate, funded many programs authorized or augmented through EA2020. Crucially, an amendment to the IIJA sponsored by Senator Bill Cassidy (R-LA) established a new DOE Office of Clean Energy Demonstrations (OCED).[34] In IIJA, OCED 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.[35] 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.[36] 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.[37]

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.[38] Heatmap News reported that while 67% of IRA grant money had been awarded, much less had been obligated.[39] 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[42,43]

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).

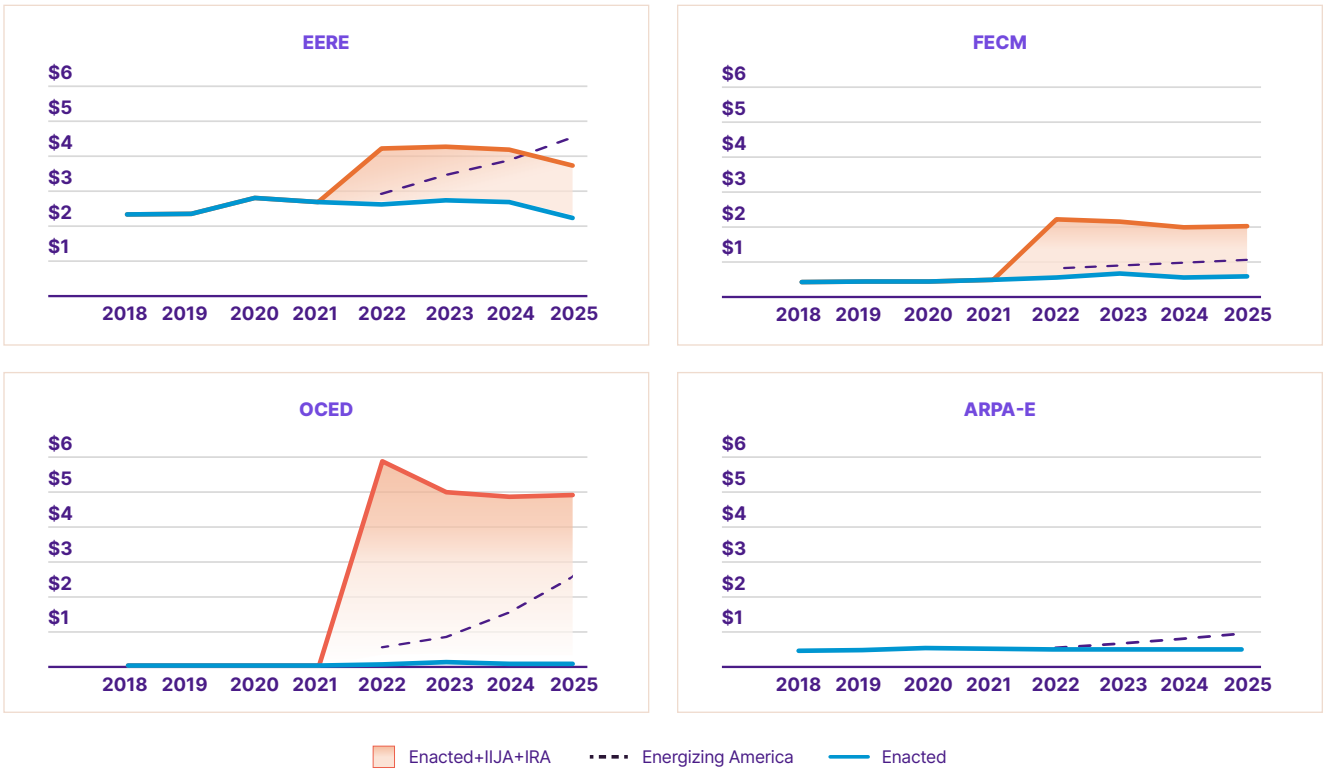
Obligating:
Often after a period of award negotiation with the recipient, the federal agency enters a legal, contractual agreement with the award recipient for a certain amount of funding.

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.[44]



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.

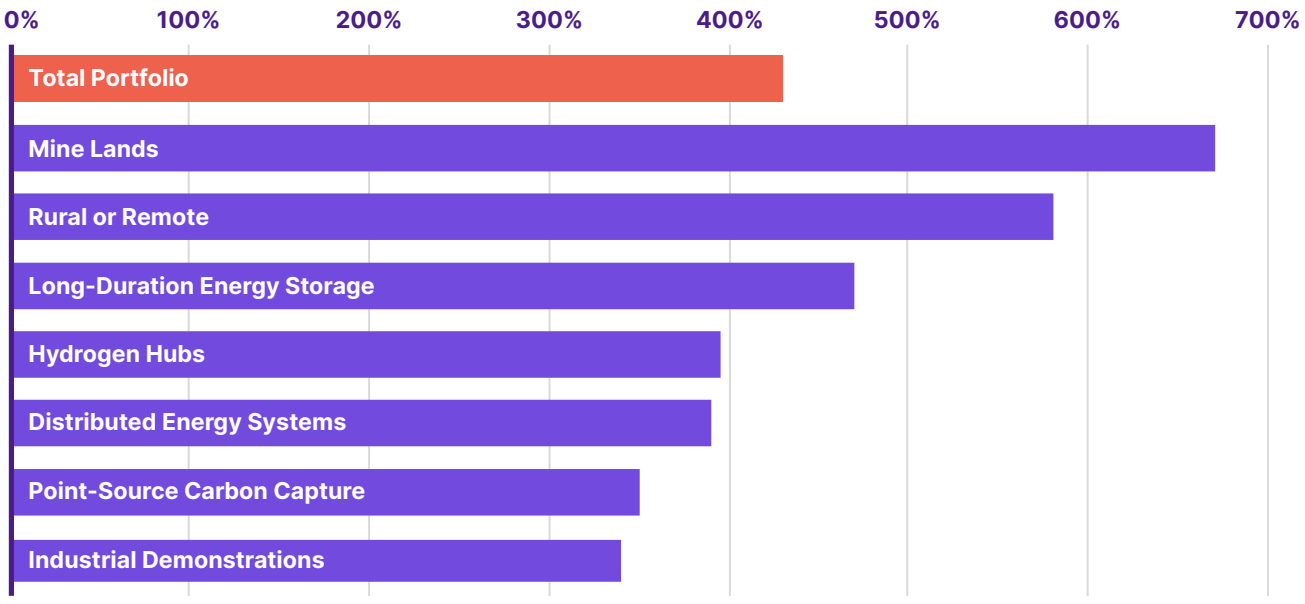
Federal energy innovation policy prompted strong positive responses from other parts of the energy innovation ecosystem. Many funding opportunity announcements were oversubscribed, indicating an abundance of ideas for advancing clean energy technologies. OCED received proposals totaling more than four times the available funding.[40] 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."[41]

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.[46]

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.[47] 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.[48] 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.[49] 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.[50, 51]

FIGURE 9. Degree to which OCED portfolio areas were oversubscribed when announcements were issued.[45]



Source: DOE

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