

ENERGIZING AMERICA

A Roadmap to Launch a National Energy Innovation Mission

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“A plan to make the United States the world leader in clean energy innovation and rise to an existential challenge – creating exciting new jobs along the way.”

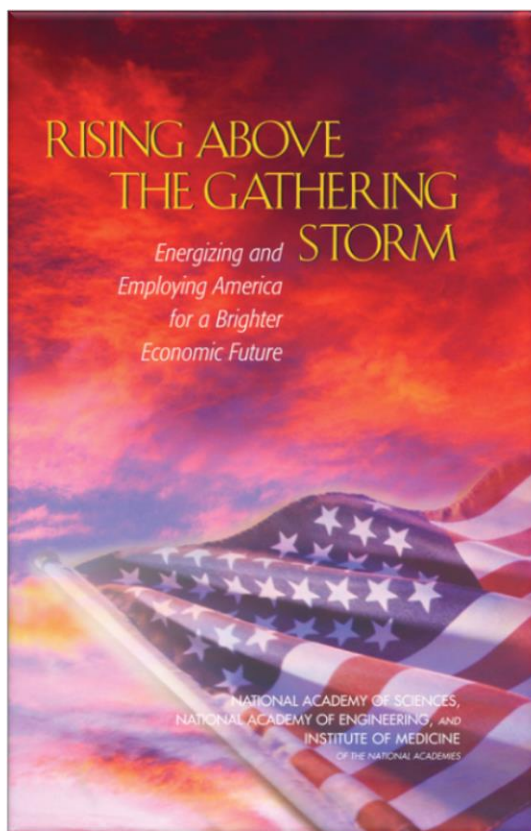
—John F. Kerry, 68th US Secretary of State

Project overview

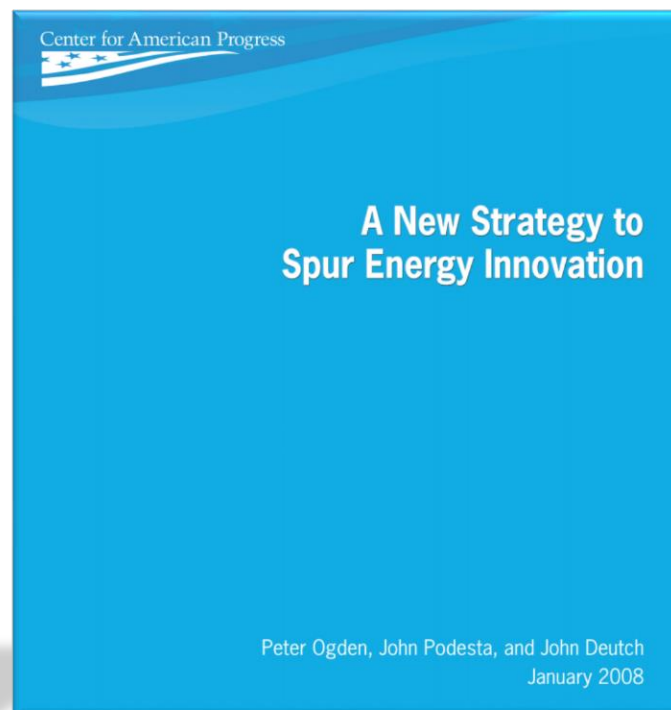


Authoritative reports have shaped U.S. energy innovation policy. This volume frames a new U.S. strategy for the next five years

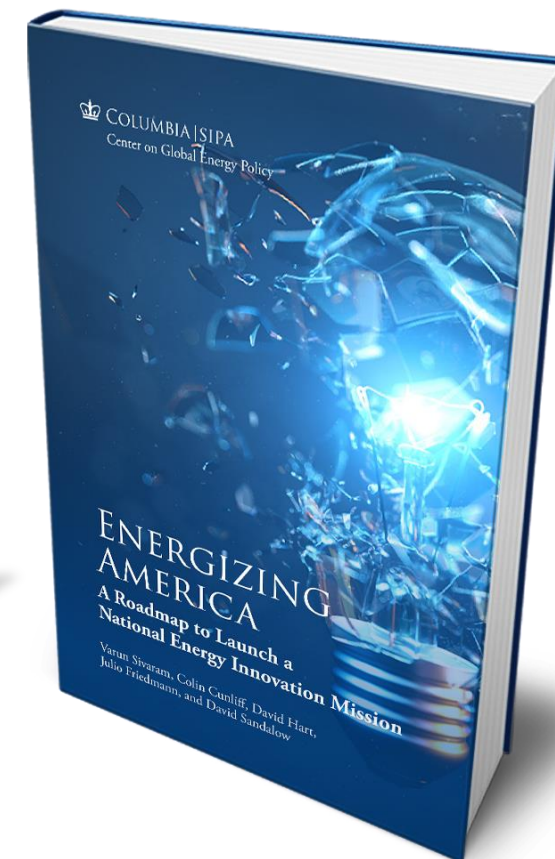
2007



2008



2020



A bipartisan consensus has emerged around increasing federal energy RD&D funding...

Growing momentum and support...

- DOE energy budgets have *increased* in the past four years, despite Trump administration proposals for cuts
- A chorus of voices has set ambitious targets for federal clean energy RD&D
 - Proposed American Energy Innovation Act would invest in energy RD&D and comprise measures sponsored by 60+ Senators from both parties
 - Vice President Joe Biden's campaign platform pledges \$400 billion over ten years



But overall vision and details are scarce.



No strategy to achieve goals

- The 117th Congress and next administration need a roadmap.
- They will also need a set of immediate action items to hit the ground running and seize the political moment before momentum dissipates

This volume aims to fill that gap.

Part I answers the questions: “Why should the United States ramp up funding for clean energy innovation—and what is the right target?”

Considerations

Advantages of elevating clean energy innovation as a national priority for:

- (a) Confronting climate change
- (b) Boosting U.S. competitiveness



Lessons from historical examples of U.S. innovation missions (e.g., defense, health, space)

Research on the benefits of federal RD&D spending and the absorptive capacity of U.S. research institutions and private firms for additional funding

Recommendation

The United States should urgently increase annual federal funding for clean energy RD&D. **\$25 billion by 2025** is an ambitious and achievable target for annual federal clean energy RD&D funding:

How? Part II lays out a roadmap comprising three dimensions:

Technology Pillars	Strategic Principles	Immediate Actions
1. Foundational science & platform techs	1. Match the funding portfolio to critical decarbonization needs	1. The President should launch the National Energy Innovation Mission 
2. Clean electricity generation	2. Support all stages of the innovation pipeline	2. Congress should increase energy RD&D funding by 30% in FY22 
3. Advanced transportation systems	3. Marshal the full capacity of the federal government	3. The United States should reassert international leadership on energy innovation 
4. Clean fuels	4. Harness the innovative capacity of National Laboratories, universities and the private sector	
5. Modern electric power systems	5. Partner with state & local gov'ts to support regional innovation	
6. Clean and efficient buildings	6. Set predictable long-term funding targets, while adapting to new data	
7. Industrial decarbonization		
8. Carbon capture, use, & sequestration		
9. Clean agricultural systems		
10. Carbon dioxide removal		

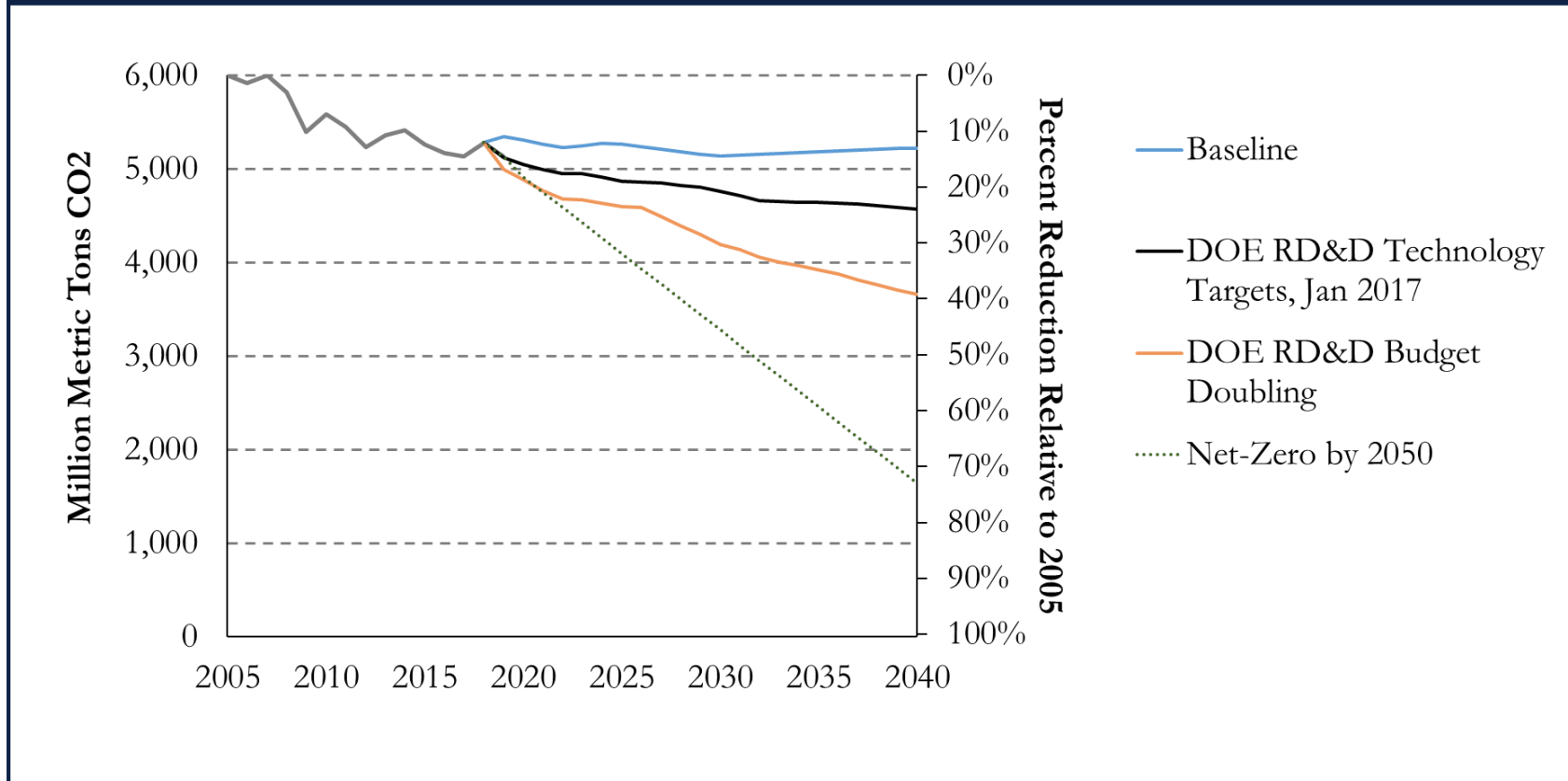
A close-up photograph of a Black woman with curly hair, wearing a white lab coat and clear safety goggles. She is looking intently at a piece of equipment in a laboratory setting. The background is slightly blurred, showing other lab equipment and a clean, professional environment. The lighting is soft and focused on her face and hands.

PART 1

**THE NEED TO
INCREASE FEDERAL
INVESTMENT IN
CLEAN ENERGY
INNOVATION**

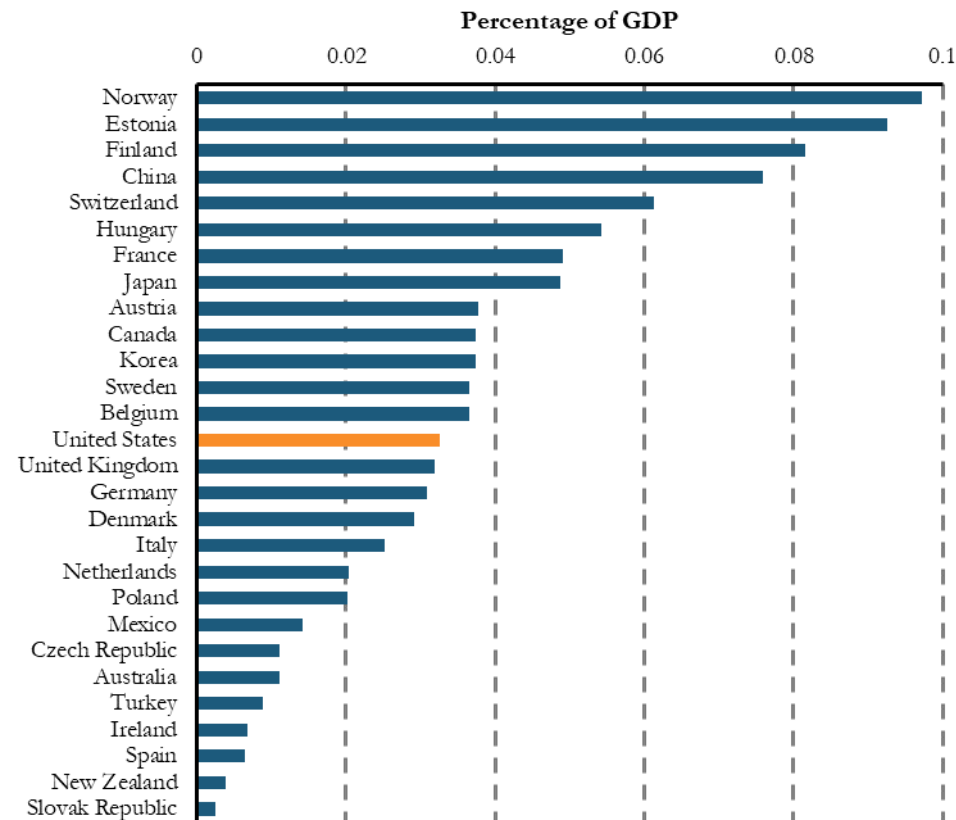
Clean energy innovation can accelerate deep decarbonization

Effect of public funding for energy innovation on U.S. emissions (Source: DOE)



In addition, investments in innovation can advance U.S. competitiveness in burgeoning energy industries

U.S. public investments in energy RD&D as a % of GDP trail those of global competitors

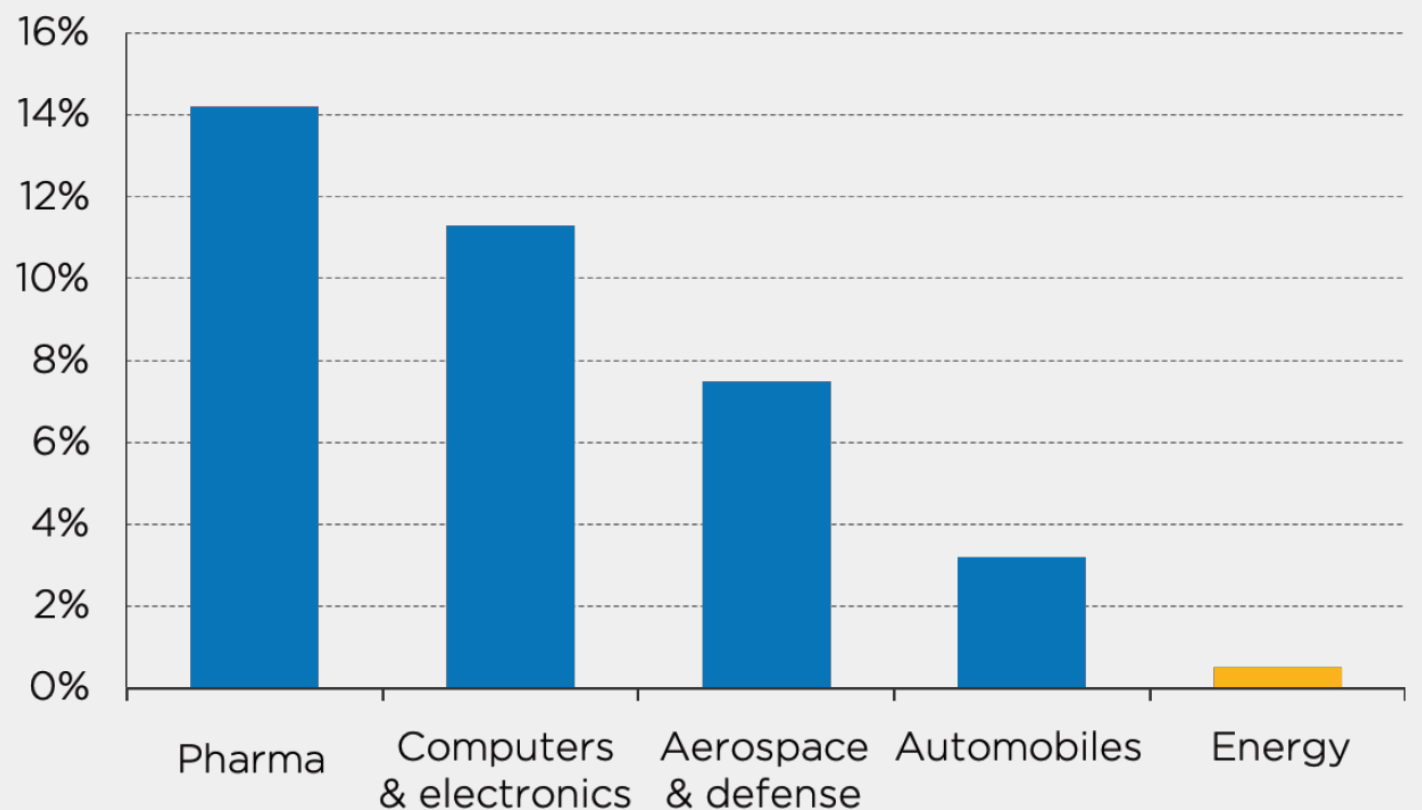


A critical moment to build U.S. leadership in new industries

- Around the world, countries from China to Germany are devoting some of their COVID stimulus packages to investments in new energy industries, from electric vehicle manufacturing to hydrogen RD&D.
- The United States is well positioned to lead on a range of nascent industries (e.g., carbon capture, advanced nuclear, digital energy systems, advanced transportation) and reap long-term benefits for the recovering economy

Private cleantech investment is returning—but much more is needed

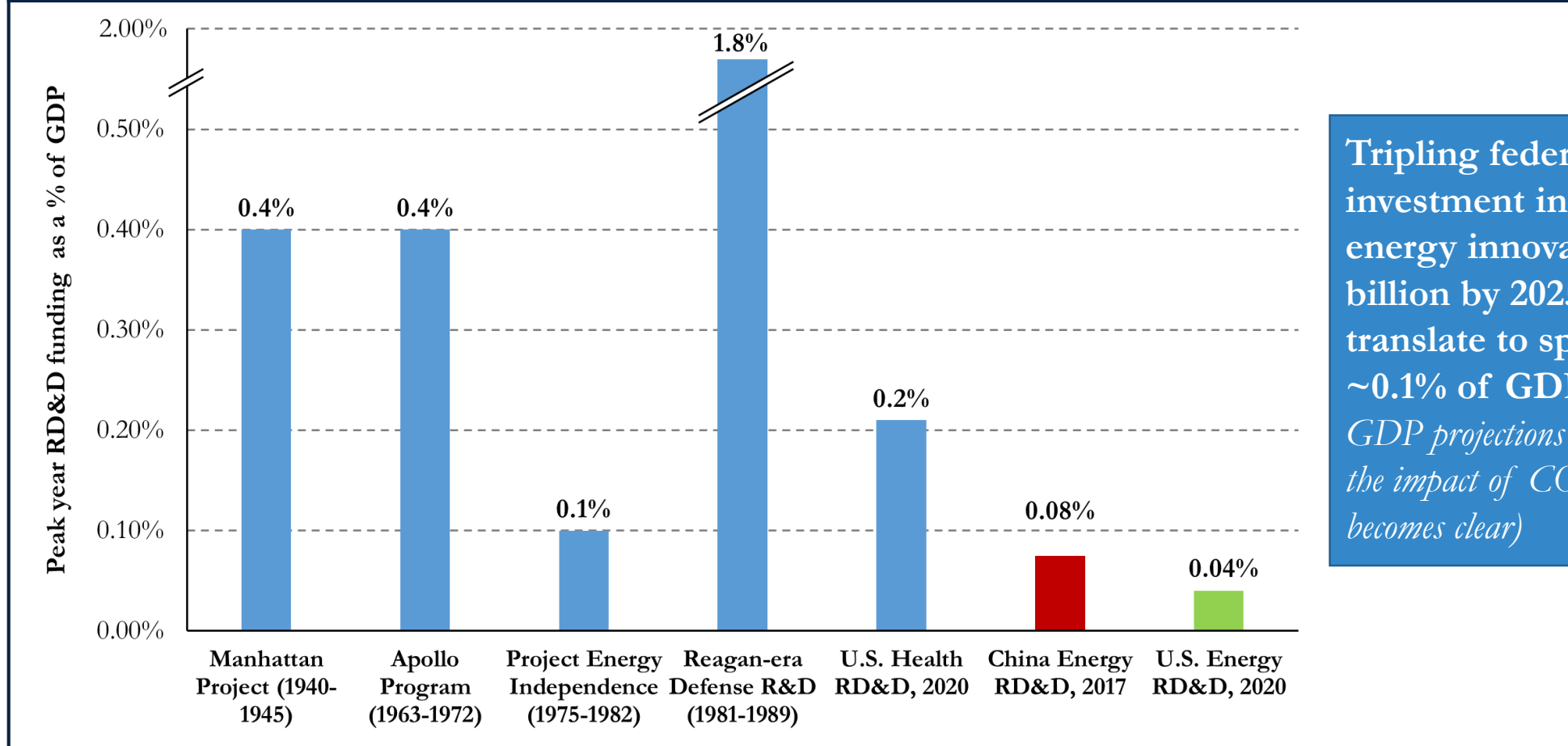
Research and development spending as a percentage of revenue across major global industries, 2018 (Source: PwC, NSF)



Although clean energy technology deals are on the rise, valleys of death for promising technologies still exist, and corporate investment in clean energy RD&D is far lower than in a range of other industries. **Public investment is critical to “crowd in” private funding**

A goal of \$25 billion by 2025 for clean energy RD&D would be far from unprecedented

Federal RD&D funding as a % of GDP, selected national missions (Sources: Third Way, ITIF)

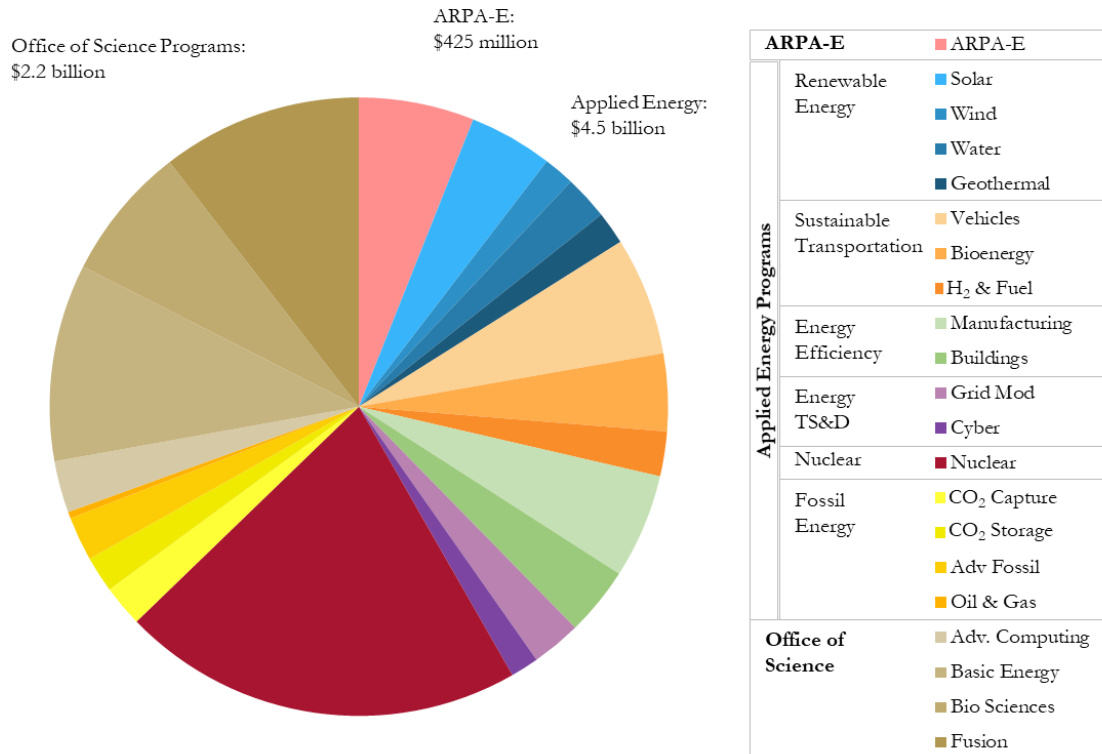


Tripling federal investment in clean energy innovation to \$25 billion by 2025 would translate to spending ~0.1% of GDP (Note: GDP projections will change as the impact of COVID-19 becomes clear)

Tripling federal funding does not mean tripling the DOE budget. Critical to diversify funding across federal agencies and recipients.

U.S. federal funding for clean energy RD&D in FY 2020 by agency (Source: authors' estimates)

Department of Energy: \$7.1 billion



Other agencies: \$1.8 billion

- Department of Defense: \$804 million
- Department of Agriculture: \$205 million
- NASA: \$339 million
- National Science Foundation: \$417 million
- Other (e.g., NIST): \$169 million

Tripling this budget is feasible:

- Increases won't be concentrated in a single agency's budget (a la NIH doubling 1998-2003)
- Research universities, private firms, demonstration projects are all underfunded today

PART 2

A NATIONAL
ENERGY
INNOVATION
MISSION



The federal government should organize the national energy innovation mission around ten technology pillars

Technology Pillars
1. Foundational science & platform techs
2. Clean electricity generation
3. Advanced transportation systems
4. Clean fuels
5. Modern electric power systems
6. Clean and efficient buildings
7. Industrial decarbonization
8. Carbon capture, use, & sequestration
9. Clean agricultural systems
10. Carbon dioxide removal

Rationale and explanation of this framework

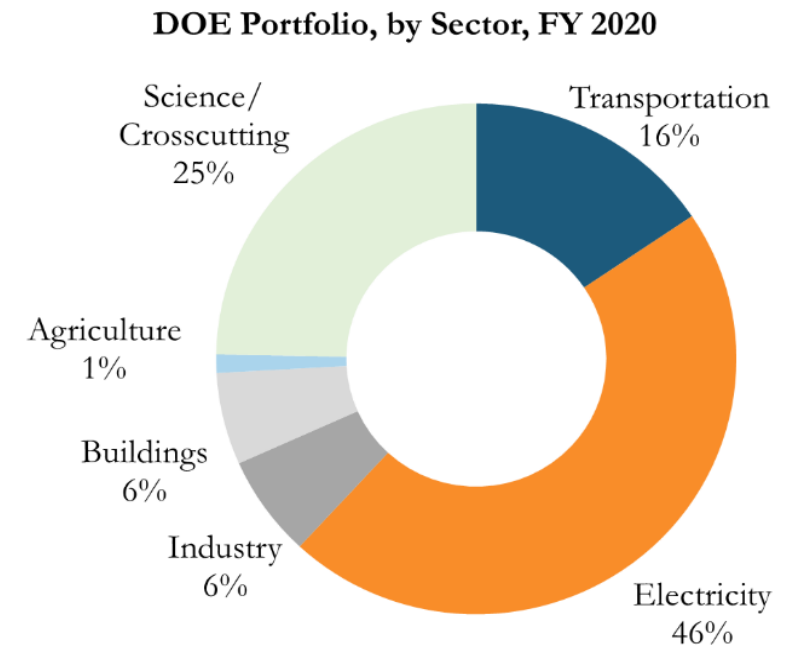
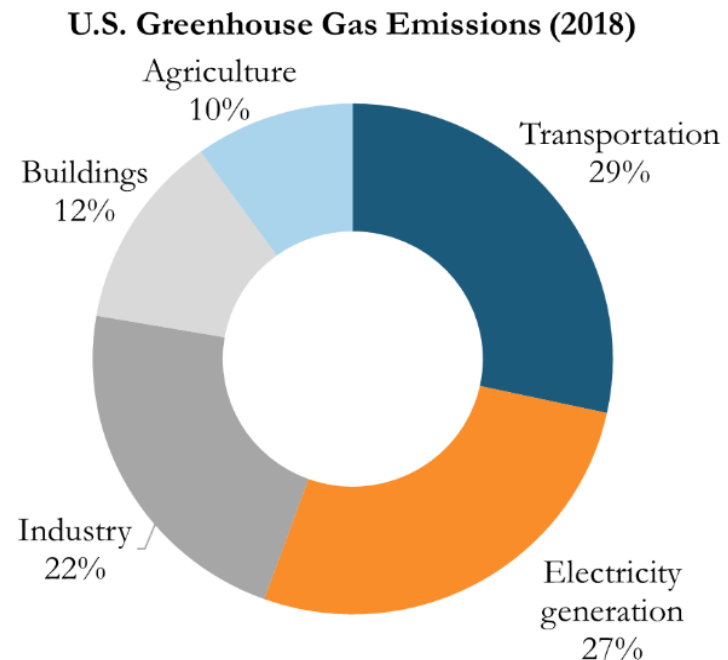
- Each pillar groups technologies together based on **distinct applications** (the first pillar encompasses cross-cutting and basic research)
- This approach places the focus on **achieving the functionality needed for deep decarbonization** and helps policymakers **address underfunded pillars**
- Examples of mapping technologies to pillars:
 - Nuclear and renewable power generation are in Pillar 2: Clean electricity generation
 - Energy storage is split among Pillars 3, 4, and 5
 - Efficiency touches all pillars and is concentrated in Pillars 3, 6, and 7

Policymakers should heed six strategic principles to manage the growing clean energy RD&D portfolio (1/6)

Principle 1:

Match the funding portfolio to critical decarbonization needs

2018 U.S. GHG emissions vs. FY20 DOE clean energy RD&D funding
(Sources: EPA, updated from EFI, 2019)

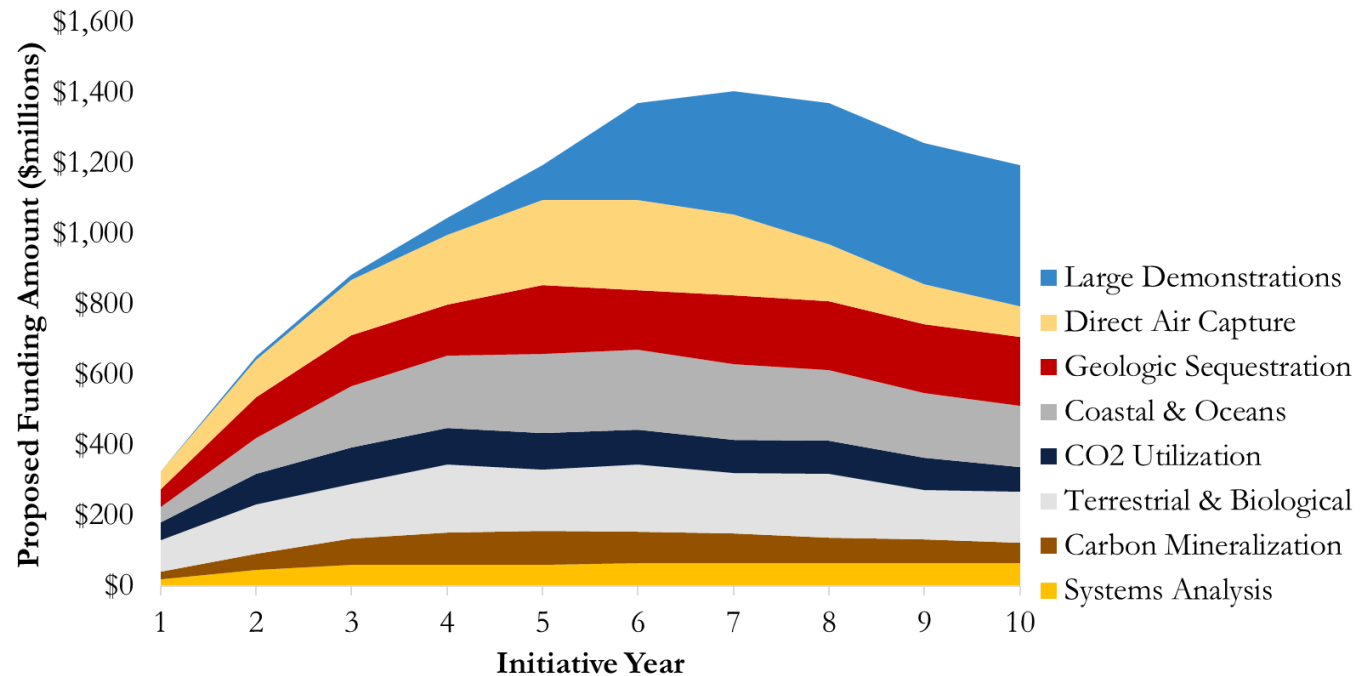


Policymakers should heed six strategic principles to manage the growing clean energy RD&D portfolio (2/6)

Principle 2:

Support all stages of the innovation pipeline

Example of a funding roadmap for the carbon dioxide removal technology pillar, which includes substantial demonstration funding (Source: EFI)

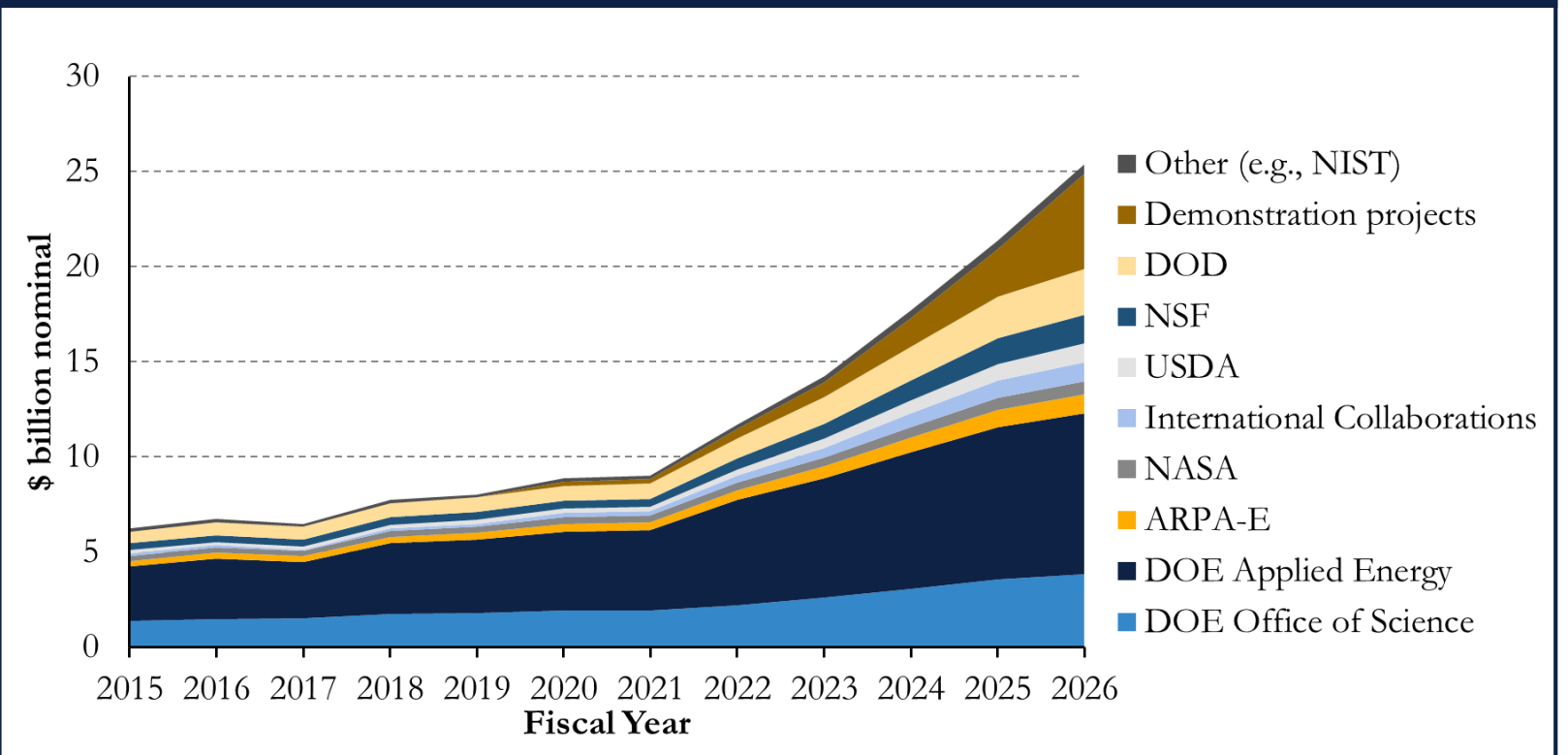


Policymakers should heed six strategic principles to manage the growing clean energy RD&D portfolio (3/6)

Principle 3:

Marshal the full capacity of the federal government to support energy innovation

Proposed five-year tripling of federal clean energy RD&D funding by federal agency (Source: Authors' analysis)



Policymakers should heed six strategic principles to manage the growing clean energy RD&D portfolio (4/6)

Principle 4:

Harness the innovative capacity of universities and the private sector

Recommendations

Expand Energy Frontier Research Centers and Energy Innovation Hubs

Make more grants to private firms, building on success of SBIR, ARPA-E, etc.

Fund National Labs to anchor regional innovation hubs, expand LEEP & other programs

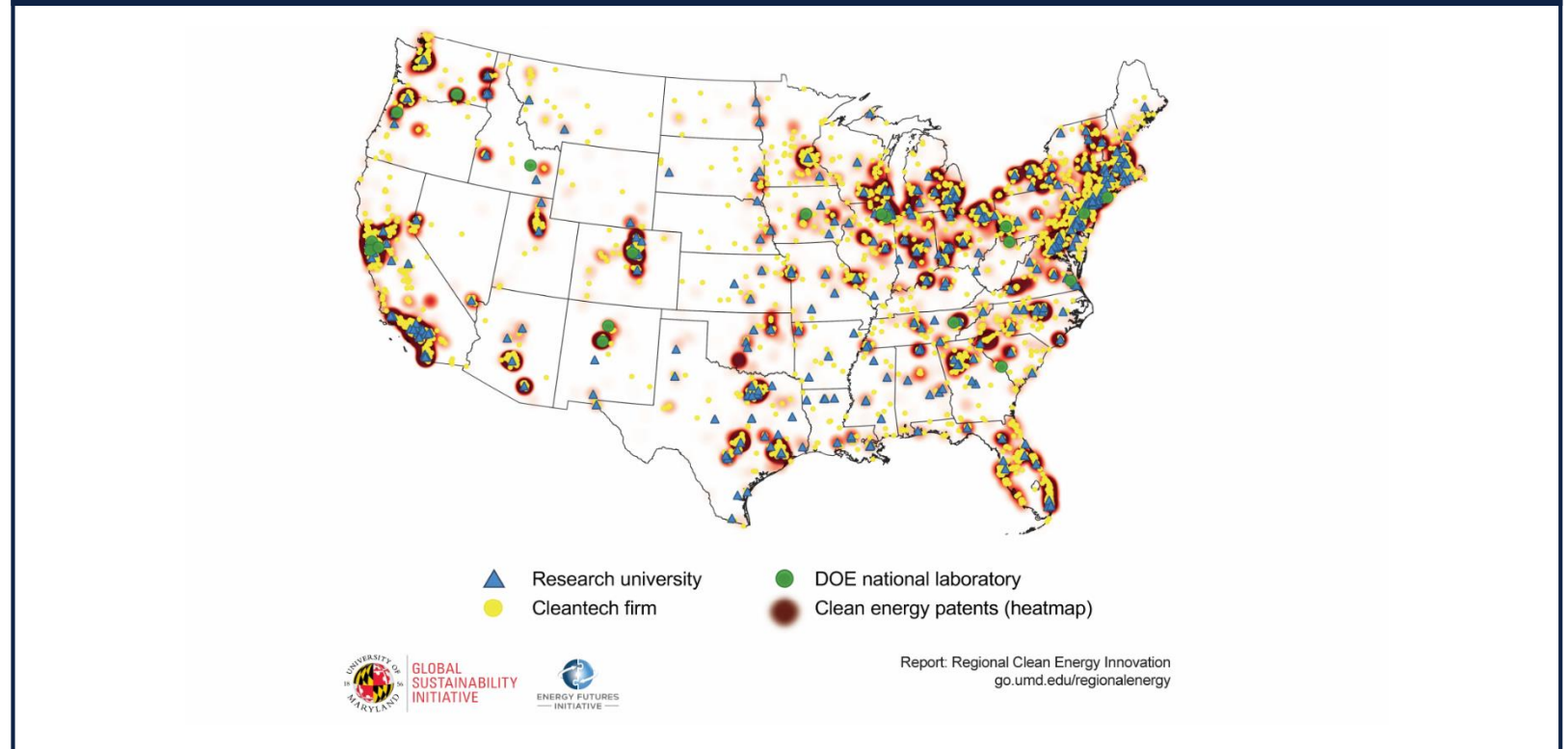
Expand user facilities and manufacturing assistance through Labs, Manufacturing USA, etc.

Policymakers should heed six strategic principles to manage the growing clean energy RD&D portfolio (5/6)

Principle 5:

Partner with state and local governments to support regional energy innovation

Map of clean energy innovation activity across the United States
(Source: Energy Futures Initiative, University of Maryland)

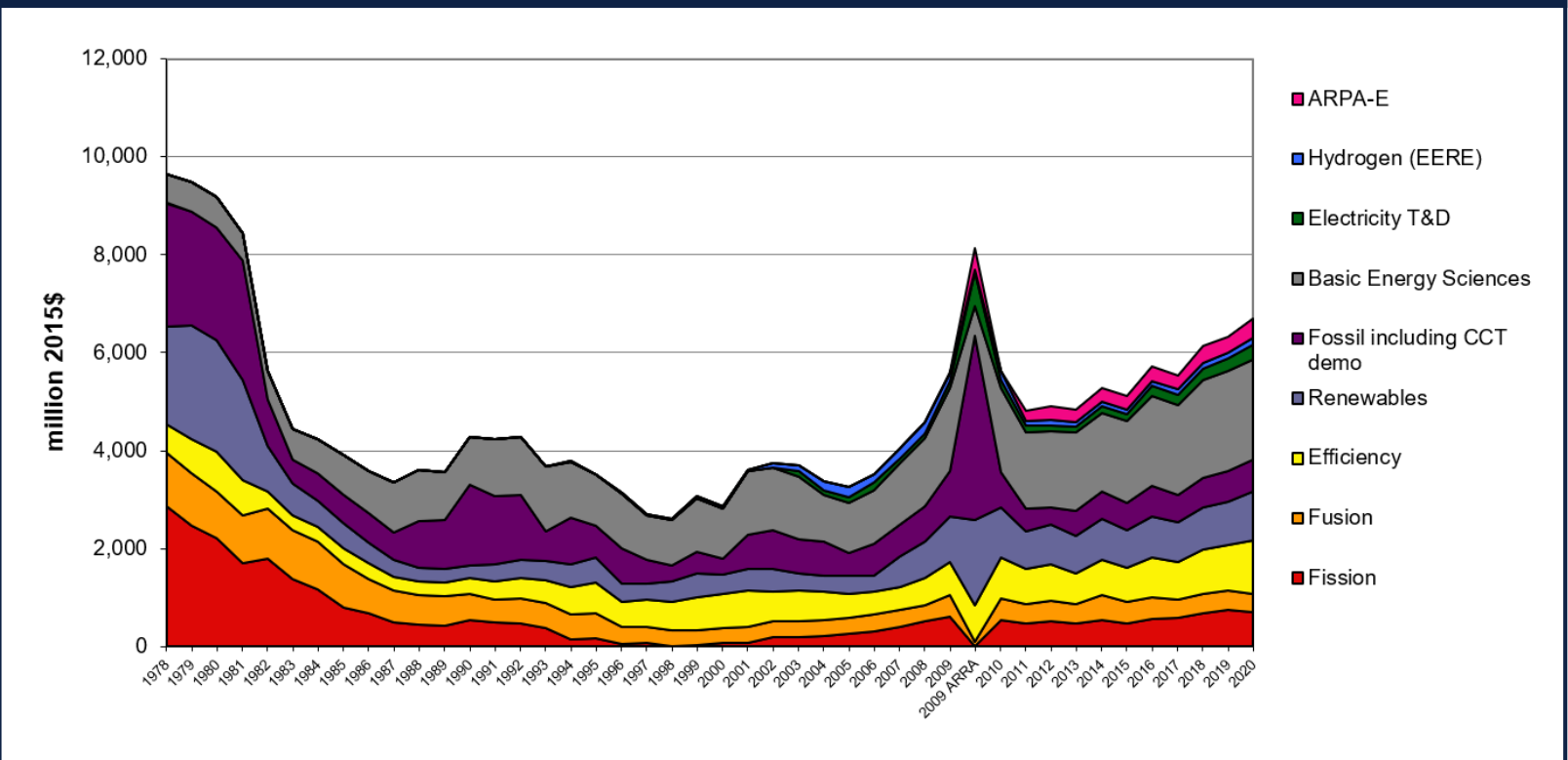


Policymakers should heed six strategic principles to manage the growing clean energy RD&D portfolio (6/6)

Principle 6:

Set predictable long-term funding targets, while adapting to new data

Historical volatility of DOE energy RD&D spending from FY 1978–2018
(Source: Harvard Belfer Center)



To jumpstart the national mission, the 117th Congress and next administration should take three immediate steps in 2021 (1/3)

Immediate action #1:

The President should launch the National Energy Innovation Mission

- Shortly after inauguration, the President should issue a **Presidential Policy Directive**
- A **White House Task Force**, chaired by the OMB director and Assistant to the President for climate change, would present a national strategy and coordinate and speed implementation
- The PPD would assign responsibilities across federal agencies and **designate the Secretary of Energy as agency lead** to provide analytical support

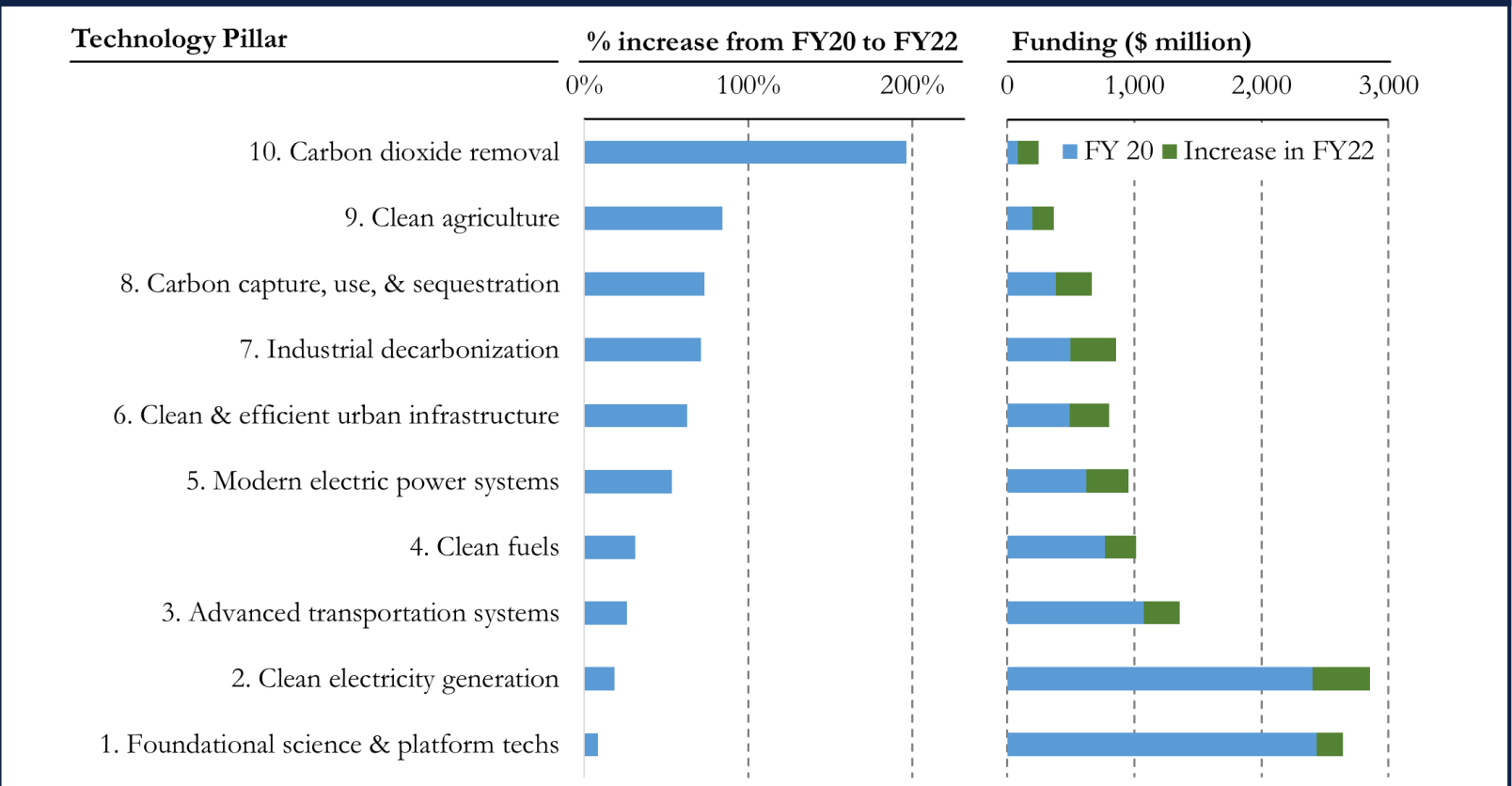


To jumpstart the national mission, the 117th Congress and next administration should take three immediate steps in 2021 (2/3)

Immediate action #2:

Congress should provide roughly \$12 billion in funding for energy innovation in its FY22 budget

Proposed FY22 federal clean energy RD&D budget by technology pillar



To jumpstart the national mission, the 117th Congress and next administration should take three immediate steps in 2021 (3/3)

Immediate action #3:

The United States should reassert leadership on international energy innovation

Implementation:

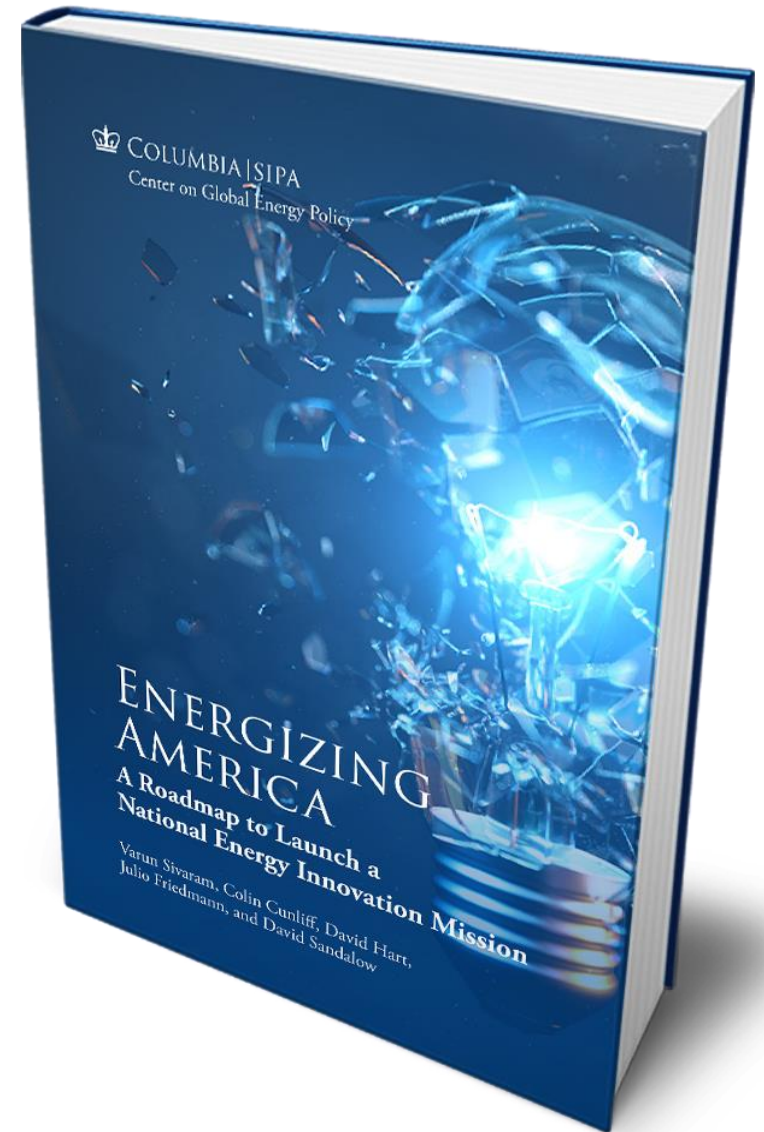
Reengage with Mission Innovation and volunteer to lead MI 2.0 Global Challenges

Pursue new bilateral RD&D collaborations and commit to ramp up funding to **\$1 billion/yr**

Inspire a race to the top:
The best way to persuade other countries to boost public RD&D funding (the goal of MI 1.0) is for the United States—the world's leading funder—to lead by example and spark a global competition

Energizing America will be out on
September 15 on Amazon

Thank You!



Appendix

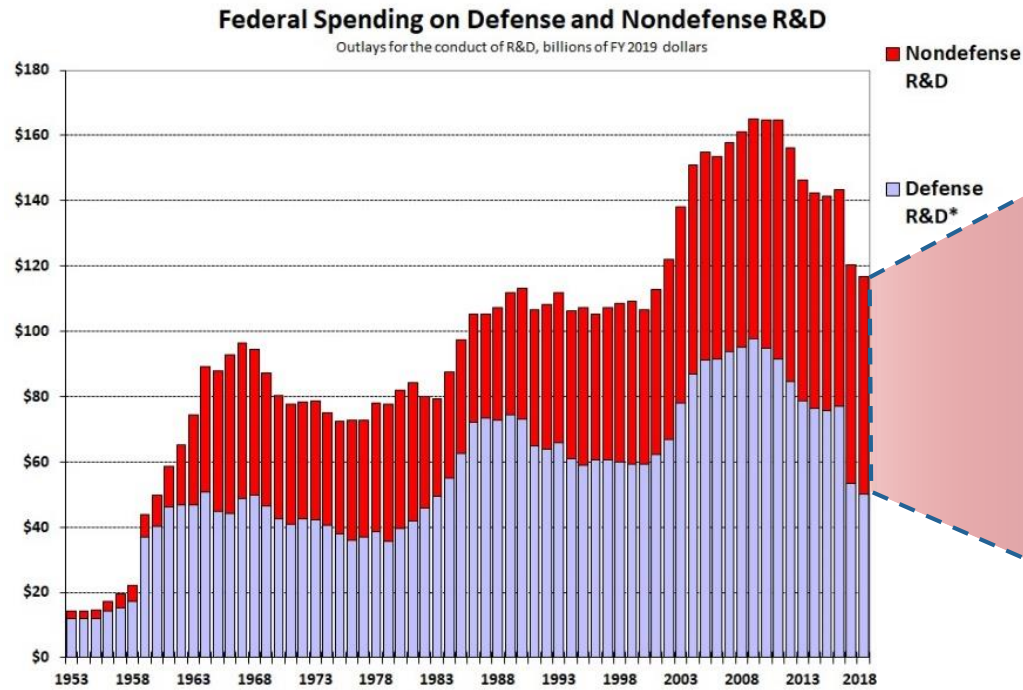


FY 2022 funding proposal by federal agency and office

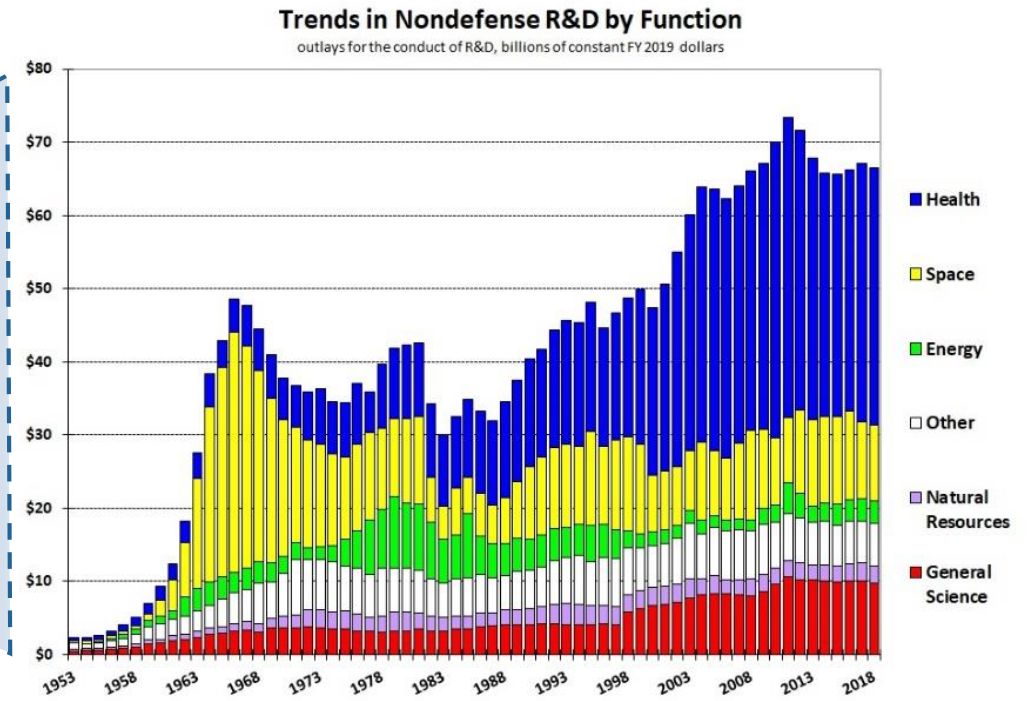
Proposed FY 2022 Funding for Clean Energy RD&D by Federal Agency and Office/Organization (\$ millions)					Proposed FY 2022 Funding for Clean Energy RD&D by Federal Agency and Office/Organization (\$ millions)					
Funding Agency	Funding Office/Organization	FY 2020 Est.	FY 2022 Proposed	% Increase	Funding Agency	Funding Office/Organization	FY 2020 Est.	FY 2022 Proposed	% Increase	
Department of Energy	Energy Efficiency and Renewable Energy (EERE)	2,228	2,682	20%	Department of Agriculture	Agriculture Advanced Research and Development Authority (AGARDA)		50		
	Vehicle Technologies Office (EERE/VTO)	396	488			Agricultural Research Service (ARS)	99	158		
	Bioenergy Technologies Office (EERE/BETO)	260	320			NIFA Agriculture and Food Research Initiative (NIFA/AFRI)	106	169		
	Hydrogen & Fuel Cell Technologies Office (EERE/FCO)	150	185			Subtotal, USDA	205	377	83%	
	Solar Energy (EERE/SETO)	280	303			Department of Defense	U.S. Army Research Laboratory (ARL)	155	202	
	Wind Energy (EERE/WETO)	104	113				U.S. Naval Research Laboratory (NRL)	97	127	
	Water Power (EERE/WPTO)	148	160				U.S. Air Force	254	332	
	Geothermal Technologies Office (EERE/GTO)	110	170				Other (Defense-Wide, DARPA, ESTCP)	298	391	
	Advanced Manufacturing Office (EERE/AMO)	350	432				Subtotal, DOD	804	1,053	31%
	Building Technologies Office (EERE/BTO)	230	301		NASA		339	394	16%	
	Office of Carbon Management (CM)*	472	812	72%	National Science Foundation	Biological Sciences (BIO)	54	75		
	Carbon Capture (Power and Industrial)	115	300			Computer and Information Science and Engineering (CISE)	24	34		
	Carbon Utilization	21	25			Engineering (ENG)	156	219		
	Carbon Storage	79	120			Directorate for Mathematical and Physical Sciences (MPS)	162	227		
	Advanced Energy Systems/Crosscutting	123	150			Other NSF	21	29		
	Negative Emissions Technologies (new office)	--	75			Subtotal, NSF	417	584	40%	
	Methane Leak Detection and Mitigation	18	22		Other (NIST, NOAA, USGS, FHWA, EPA-ORD)		169	221	31%	
	Office of Nuclear Energy (NE)	1,493	2,028	36%	Total	N/A	8,894	11,758	32%	
	Versatile Test Reactor	65	450		*This is the proposed new name for the current Office of Fossil Energy					
	Reactor Concepts RD&D	102	163		FY 2020 funding levels for non-DOE programs are estimates of the portion of funding that goes to clean energy / clean agriculture. Agency and Office totals include estimates of program direction and RD&D facilities (not shown in the table) and may be greater than the sum of RD&D programs.					
	Fuel Cycle R&D	305	255							
	Advanced Reactor Research, Development, and Demonstration	330	520							
	Office of Electricity (OE)	190	520	174%						
	Office of Science (SC)	2,151	2,572	20%						
	Advanced Scientific Computing Research (SC/ASCR)	173	200							
	Biological and Environmental Research (SC/BER)	451	523							
	Basic Energy Sciences (SC/BES)	661	766							
Fusion Energy Sciences (SC/FES)	671	740								
Advanced Research Projects Agency-Energy (ARPA-E)	425	516	21%							
Subtotal, DOE	6,959	9,130	31%							

Previous federal innovation missions have shaped the U.S. economy and left important lessons for planning the next one

U.S. historical federal funding for R&D (Source: AAAS)



*Beginning in FY 2017, a new official definition of R&D has been adopted by federal agencies. Late-stage development, testing, and ev primarily within the Defense Department, are no longer counted as R&D.
Source: OMB Historical Tables in Budget of the United States Government



Source: OMB Historical Tables in Budget of the United States Government FY 2020. Some Energy programs shifted to General Science beginning in FY 1998.
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