CLEAN ENERGY TECHNOLOGY

Clean Energy Technology Funding[1]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request[2]
BIO	$55.00	-	$57.48
CISE	39.50	-	42.63
ENG	193.00	-	201.69
MPS	123.83	-	129.40
TIP	53.07	-	69.32
OISE	7.50	-	-
Total	**$471.90**	**-**	**$500.52**

[1] Funding displayed may have overlap with other topics and programs.

[2] Other Climate investments of $152.30 million in the FY 2025 Request, outside the CET and USGCRP defined crosscuts, are not captured here.

Overview

Energy is essential, and our future as a people and a Nation depends on our leadership in the transition to clean energy. That leadership depends on winning the research, innovation, and education race to transform the energy sector and ensuring the global competitiveness of our energy workforce. NSF will advance the clean energy future through investments in foundational research to transform energy systems and the industries that depend on them; innovation and translation to move discoveries to the market and society; and education and workforce development, with a focus on preparing for the energy jobs of the future. Clean energy investments complement and align with NSF investments to support research and innovation necessary to achieve the Nation's Net-Zero Goals by 2050.

To achieve a carbon-neutral and sustainable economy, critical technological advances are needed to maximize access and utilization of renewable energy, enable grid security and storage, and electrify manufacturing, transportation, and chemical processing. Industrial and manufacturing processes are difficult to decarbonize, and their energy transition is key to meeting Net-Zero Goals while expanding economic prosperity and U.S. leadership. Also, attracting, educating, training, and reskilling/upskilling diverse workers, from K-12 to college and industry, across the Nation, is key for developing and maintaining a manufacturing workforce of the future.

The use of hydrogen, fusion, and renewable energy (such as solar, wind, geothermal, hydro, tidal and biomass) is enabled by new discoveries, new technologies and the translation of those discoveries and technologies to practical solutions (for example, energy conversion technologies like fuel cells, and energy distribution technologies like the smart grid). Advances in plasma science, thermoelectrics, catalysis, and semiconductors provide new opportunities for energy system transformations for Net-Zero Goals. Integration of advances in biotechnology and bio-inspired systems into energy research will propel discovery and applications that create new industries. Leveraging artificial intelligence and optimization across energy systems will shape the energy sector of the future. Advances in designing

the next generation of computing systems will enable novel ways to not only dramatically increase energy efficiency but also incorporate clean energy technologies in the entire computing lifecycle. NSF's investments across these research areas, from clean energy sources to clean energy uses (transportation, industry, cyberinfrastructure), will support U.S. leadership in the transition to clean energy and meeting our Net-Zero Goals.

NSF's clean energy investments span longstanding programs as well as focused solicitations. Research funding opportunities in clean energy enable partnerships of investigators in the economic and social sciences, education research, biological sciences, physical sciences, computing and information sciences, and engineering disciplines to build fundamental knowledge and overcome technological barriers. NSF continues to make long-term investments in multidisciplinary research centers through the Centers for Chemical Innovation, Expeditions in Computing, Engineering Research Centers, and Industry-University Cooperative Research Centers programs, and the National AI Research Institutes. The NSF Regional Innovation Engines support use-inspired and translational research in this topic space, among others, giving rise to new regional innovation ecosystems throughout the U.S. NSF also supports research infrastructure such as the Grid-Connected Testing Infrastructure for Networked Control of Distributed Energy Resources (DERConnect).

As indicated in the National Academies of Sciences, Engineering, and Medicine reports on *Accelerating Decarbonization of the U.S. Energy System* (2021)[1] and (2023)[2] and *The Future of Electric Power in the United States,*[3] in White House documents on *Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050,*[4] and *U.S. Innovation to meet 2050 Climate Goals,*[5] bold and decisive action is urgently required to address the need for clean energy. That action includes research and translation of that research to implementation.

New resources are necessary to both initiate and accelerate new discoveries and insights, and to develop translation pathways from exploratory concepts to engineered solutions to technological deployments. NSF-funded workshops, on topics ranging from electrochemical energy storage[6] to a zero-carbon power grid,[7] have identified new research directions that can help meet this global challenge.

Goals

Clean Energy Technology investments at NSF are designed to identify and support transformative research to advance U.S. leadership in the clean energy transition and meet the U.S. Net Zero objectives for 2030 and beyond. Goals include:

- *Support fundamental research* in science and engineering to change paradigms and spawn innovations in clean energy supply, distribution, and use;
- *S*upport *convergent research engaging teams* of scientists and engineers to address interconnected

[1] www.nap.nationalacademies.org/catalog/25932/accelerating-decarbonization-of-the-us-energy-system
[2] www.nap.nationalacademies.org/catalog/25931/accelerating-decarbonization-in-the-united-states-technology-policy-and-societal
[3] www.nap.nationalacademies.org/catalog/25968/the-future-of-electric-power-in-the-united-states
[4] www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf
[5] www.whitehouse.gov/wp-content/uploads/2022/11/U.S.-Innovation-to-Meet-2050-Climate-Goals.pdf
[6] www.nsf.gov/awardsearch/showAward?AWD_ID=1942226
[7] www.nsf.gov/awardsearch/showAward?AWD_ID=2218933

problems inspired by the need to reshape the energy sector and related emerging industries;
- *Develop energy research infrastructure*, as well as the associated computing and communications infrastructure, necessary to generate fundamental knowledge and technologies for clean energy;
- *Translate innovations* through unique funding opportunities and partnerships that foster co-design, co-creation, piloting, prototyping and testbeds*;* and
- *Develop the clean energy workforce of the future* by attracting, inspiring, educating, training, and reskilling/upskilling individuals, representing the full spectrum of diverse talent in the U.S., from K-12 to college and industry.

FY 2025 Investments

The cross-NSF investments in Clean Energy Technology in FY 2025 support high-risk, high-reward research ideas across the science and engineering spectrum that create broad new understanding and innovations to support energy efficiency, enhance sustainability, support net-zero solutions for decarbonization, adapt to and mitigate climate change, spawn new industries and transform existing industries, and support translation and partnerships for innovation, as well as education and workforce development.

Fundamental and Convergent Research:
NSF will invest in fundamental, convergent clean-energy technology research to support: improvements in generation, capture, conversion, storage, and distribution of electricity and fuels; advancements in renewable clean-energy sources, including off-shore wind, hydrogen and fuel cells; development of new net-zero fuels and chemicals; more efficient energy usage; as well as research related to reimagined infrastructure and systems, such as industrial heat, decarbonization technologies, and interconnected natural, human-built, and social systems. NSF will invest in research related to behavioral economic, equity and regional drivers in design and implementation of clean energy technologies and net-zero solutions, as well as the human-technology interface. NSF will also invest in collaboration activities to advance grand challenges in clean energy frontiers.

Energy Research Infrastructure:
Investments in energy research infrastructure will allow for the creation of more energy-efficient energy systems, from capture and generation to distribution, for industry, transportation, buildings, and other uses. Investments in computing and communication research infrastructure will enable the creation of more efficient and sustainable hardware, software, and systems for computing and communication—a significant and growing component of U.S. electricity consumption. Energy research infrastructure investments will also afford piloting and prototyping of research-based solutions.

Innovation and Translation:
NSF accelerates the translation of research results to the market and society, catalyzing a broad spectrum of advanced energy technologies and systems. NSF speeds translation of fundamental discoveries in clean energy into technologies and systems through its Centers for Chemical Innovation, Expeditions in Computing, Engineering Research Centers, Materials Research Science and Engineering Centers, Materials Innovation Platforms, Industry-University Cooperative Research Centers, and the National AI Research Institutes; as well as through the NSF Lab-to-Market Platform comprising, I-Corps™, and the Small Business Innovation Research and Small Business Technology Transfer programs. In FY 2025, NSF will continue investments in Biofoundries as part of the set of

programs that fosters innovation and translation of biobased clean energy technologies. In addition, NSF partners and coordinates with federally supported Manufacturing USA Institutes, and with other agencies such as the Department of Energy and the Department of Defense to transition fundamental clean energy technology research further towards application.

Education and Workforce Development:

To prepare a diverse clean energy workforce across the Nation, NSF invests in the Advanced Technological Education, NSF Research Traineeship, Faculty Early Career Development, Research Experiences for Undergraduates Sites and Supplements, and Research Experiences for Teachers in Engineering and Computer Science programs, as well as clean energy technology education in research projects and education research and development projects. Support for NSF Non-Academic Research Internships for Graduate Students and Experiential Learning for Emerging and Novel Technologies provides students with relevant experience beyond academia, including in government and industry settings. The Innovative Technology Experiences for Students and Teachers program provides support for projects that involve K-12 students in innovative use of technologies, including those related to clean energy. In addition, NSF has a suite of programs that support the underlying knowledge STEM education and workforce development from preK-12 to professional learning and in both formal and informal contexts.