

DIRECTORATE FOR ENGINEERING (ENG)

\$970,000,000

Directorate for Engineering (ENG) Funding

(Dollars in Millions)

	FY 2022 Actual ¹	FY 2023 Estimate Base	Disaster Relief Supplemental Base	FY 2023 Estimate Total	Change over		
					FY 2024 Request	FY 2023 Base Total ² Amount	Percent
Chemical, Bioeng., Environm'l & Transport Systems (CBET)	\$203.42	\$203.45	-	\$203.45	\$214.99	\$11.54	5.7%
Civil, Mechanical, & Manufacturing Innovation (CMMI)	239.28	239.30	-	239.30	252.87	13.57	5.7%
Electrical, Comms, and Cyber Systems (ECCS)	123.10	123.11	-	123.11	130.09	6.98	5.7%
Engineering Education & Centers (EEC)	132.55	134.07	-	134.07	156.23	22.16	16.5%
Emerging Frontiers & Multidisciplinary Activities (EFMA)	76.19	74.87	34.00	108.87	215.82	106.95	98.2%
Total	\$774.53	\$774.80	\$34.00	\$808.80	\$970.00	\$161.20	19.9%

¹ Excludes \$45.37 in American Rescue Plan supplemental funding.

² Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

About ENG

In FY 2024, ENG will spur engineering breakthroughs to help ensure America’s security, prosperity, health, and technological leadership in the future. ENG will invest in groundbreaking fundamental engineering research and in key Administration and NSF-wide research priorities. Substantial directorate investments—in cross NSF priority areas as well as the fourth generation of NSF Engineering Research Centers (ERCs)—will emphasize convergence research approaches to help address grand challenges and achieve societal impact. In addition, to advance U.S. global competitiveness, strategic ENG support will strengthen the engineering workforce and accelerate the translation of technological innovations.

To accelerate the translation of research results towards economic and societal benefits, ENG will build on its tradition of partnerships with industry and other government agencies and laboratories. Through the NSF-funded Engineering Research Visioning Alliance, engineers with broad perspectives identified key research directions in reports on *The Role of Engineering to Address Climate Change (2022)* and *Leveraging Biology to Power Engineering Impact (2022)*.¹ The directorate supports both direct and indirect partnerships, such as the ERC, Industry–University Cooperative Research Centers (IUCRC), Grant Opportunities for Academic Liaison with Industry (GOALI) investments. Working with the TIP directorate, ENG will spur the engineering research community to follow existing well-established pathways towards technology translation and implementation. In addition, ENG will work closely with TIP to develop new translation pathways, building on and enhancing existing successes in our center programs (ERC and IUCRC). Research results from ENG’s mid-size convergent research awards create new opportunities that are ripe for translational impact.

ENG funding in FY 2024 will help protect Americans through the continuation of its long-term support for engineering research to improve resilience to hurricanes, fires, earthquakes, and other disasters, including the Natural Hazards Engineering Research Infrastructure (NHERI). ENG will help secure and advance communications, computing, and sensing through investments in QIS-related programs for quantum technologies and systems. Other ENG-funded research will investigate methods and technologies for protecting the electric grid, understanding online influence and misinformation, detecting biological threats, and optimizing supply networks.

¹ www.ervacommunity.org/report-category/full-reports/

ENG FY 2024 investments will build future prosperity through essential contributions to research on advanced manufacturing, supply chains, biomanufacturing for health and other applications, and the circular economy; new materials and semiconductor technologies; and clean energy technologies and climate change adaptation and mitigation, including sustainable regional systems, innovations for decarbonization, and partnerships for clean energy challenges. The directorate will support advances in robotics, AI, and smart and autonomous systems. Building on prior FW-HTF research, ENG will introduce convergent research opportunities and themes on human-centered automation; behavioral, equity, economic, and regional drivers in the design and implementation of new technologies; human-machine teaming to advance understanding of the ways integrated workforce models and complement human cognitive capabilities; and other topics at the human-technology interface. ENG will also invest in disruptive technologies to advance spectrum-efficient advanced wireless systems and energy-efficient resilient microelectronics and computing. Funding across ENG will help ensure sustainable and reliable infrastructure systems through, for example, precision agriculture, complex models of food-energy-water systems, and eco-friendly disaster-resilient building materials and designs. Continued investments in partnerships and research infrastructure will provide researchers and students with access to testbeds, fabrication, and scale-up that speed technology translation.

ENG support will advance health technologies and systems through investment in fundamental research to observe nanoscale cellular processes and changes, engineering biology to reverse disease and produce therapies, and synthetic biology to advance a wide array of biotechnologies. The directorate also will support research on the transport of contaminants and pathogens in natural and built environments, methods to detect and monitor their presence, and the prevention and understanding of their impacts on the community and ecology. Engineering investments will continue advances in prosthetic and assistive technologies for veterans, senior citizens, and people with disabilities.

ENG will also emphasize support for racial equity and diversity efforts. ENG, together with other NSF directorates and offices, will invest in research, education, and workforce development that remove barriers, build capacity, and foster partnerships. ENG will continue investment in the Broadening Participation in Engineering program and the Engineering Research Initiation program, invest in mentoring and professional development activities, support collaborations with MSIs, and promote systemic changes that enhance diversity, equity, and inclusion in engineering.

While fundamental engineering research fuels U.S. technological innovation and competitiveness, ENG support for workforce development and innovation speeds and strengthens the translation of discoveries. The directorate will invest in research on engineering education, broadening participation, equity, and inclusion in engineering, as well as in student experiences with industry. ENG will maintain its commitment to talented students and faculty through programs supporting transitions between career stages and opportunities for mid-size, interdisciplinary team research. ENG investments in academic partnerships and professional development opportunities with industry will help bring new ideas from lab to market and fortify the Nation's innovation ecosystem.

Major Investments

ENG Investments

(Dollars in Millions)

Area of Investment ^{1,2}	FY 2022 Actual	FY 2023		Change over FY 2023 Estimate	
		Estimate	FY 2024 Request	Base Total ³ Amount	Percent
Advanced Manufacturing	\$129.00	\$125.00	\$184.37	\$59.37	47.5%
Advanced Wireless Research	26.00	25.00	27.75	2.75	11.0%
Artificial Intelligence	88.00	88.00	97.00	9.00	10.2%
Biotechnology	92.00	92.00	106.50	14.50	15.8%
Climate: Clean Energy Technology	150.00	193.00	229.75	36.75	19.0%
Climate: USGCRP	-	-	50.00	50.00	N/A
Improving Undergraduate STEM Ed.	-	5.00	6.65	1.65	33.0%
Microelectronics/Semiconductors	43.00	43.00	63.00	20.00	46.5%
National Nanotechnology Initiative	267.13	190.95	231.75	40.80	21.4%
Quantum Information Science	31.17	29.50	32.89	3.39	11.5%
Secure & Trustworthy Cyberspace	3.25	3.25	3.25	-	-

¹ Major investments may have funding overlap and thus should not be summed.

² This table reflects this directorate's support for selected areas of investment. In other directorate/office narratives, areas of investment displayed in this table may differ and thus should not be summed across narratives.

To learn more about cross-agency themes and initiatives supported by ENG, including Advanced Wireless, Artificial Intelligence, Biotechnology, Climate, Quantum Information Science, Networking and Information Technology R&D, Secure and Trustworthy Computing, see individual narratives in the NSF-Wide Investments chapter.

- **Advanced Manufacturing:** With ENG leadership, NSF investments accelerate advances in manufacturing materials, technologies, and systems to create products and processes with higher performance, greater sustainability, and new capabilities, as well as prepare our manufacturing workforce. The Future Manufacturing program catalyzes new manufacturing capabilities that do not exist today. For more information, see the Advanced Manufacturing narrative in the NSF-Wide Investments chapter.
- **Clean Energy Technology:** With ENG leadership, NSF enables new understanding and innovations to support energy efficiency, enhance sustainability, adapt to and mitigate climate change, spawn new industries, and support translation and partnerships for innovation, as well as education and workforce development. For more information, see the Climate: Clean Energy Technology narrative in the NSF-Wide Investments chapter.
- **Microelectronics/Semiconductors:** With ENG leadership, NSF enables new paradigms in microelectronics and semiconductor capabilities. Activities advance materials, devices, circuits, architectures, and related software and applications. NSF invests in secure, sustainable, high-performance semiconductors; microelectronic device integration; R&D ecosystems; and workforce development. For more information, see the Microelectronics/Semiconductors narrative in the NSF-Wide Investments chapter.
- **National Nanotechnology Initiative:** With ENG leadership, NSF invests in the understanding, organization, manipulation, and control of matter at the atomic, molecular, and supramolecular levels in the size range of about 1 nanometer to 100 nanometers. An increased focus will be on nanotechnology as a foundation for other emerging technologies, as well as for mitigating climate

change and supporting vaccine development. For more information, see the NNI narrative in the NSF-Wide Investments chapter.

Centers Programs

ENG Funding for Centers Programs

(Dollars in Millions)

	FY 2023 Estimate		FY 2024 Request	Change over FY 2023 Estimate	
	FY 2022 Actual	Base Total ¹		Base Total ¹	
				Amount	Percent
AI Research Institutes (Multiple)	\$1.00	\$2.00	\$4.00	\$2.00	100.0%
Engineering Research Centers (EEC)	70.47	68.70	86.09	17.39	25.3%
STC: Sci. & Tech. for Phosphorus Sustainability Ctr. (CBET)	5.00	5.00	5.00	-	-
STC: Ctr. for Engineering Mechanobiology (CMMI)	5.00	5.00	5.00	-	-
Total	\$81.47	\$80.70	\$100.09	\$19.39	24.0%

¹ Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

People Numbers and Funding Profiles

For Organization detail on the People Numbers and Funding Profile tables, please see the Technical Information chapter.

DIVISION OF CHEMICAL, BIOENGINEERING, ENVIRONMENTAL, AND TRANSPORT SYSTEMS (CBET)

CBET Funding
(Dollars in Millions)

	FY 2022	FY 2023	FY 2024	Change over	
	Actual ¹	Estimate Base		FY 2023 Base Total ²	Amount
Total	\$203.42	\$203.45	\$214.99	11.54	5.7%
Research	198.73	198.26	209.80	11.54	5.8%
Education	1.01	1.50	1.50	-	-
Infrastructure	3.68	3.69	3.69	-	-

¹ Excludes funding provided by the American Rescue Plan supplemental appropriation.

² Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

CBET supports research and education to enhance and protect national health, energy, food, water, environment, manufacturing, and security, by investing in areas involving the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. Through CBET, the physical, chemical, and biological sciences are integrated in engineering research and education, leading to advances in biotechnology, bioengineering, biomanufacturing, advanced materials, environmental engineering, climate adaptation and mitigation, and sustainable clean energy. In general, about 84 percent of the division portfolio is available to support new research grants. The remaining 16 percent supports research grants made in prior years.

DIVISION OF CIVIL, MECHANICAL, AND MANUFACTURING INNOVATION (CMMI)

CMMI Funding
(Dollars in Millions)

	FY 2022	FY 2023	FY 2024	Change over	
	Actual ¹	Estimate Base		FY 2023 Base Total ²	Amount
Total	\$239.28	\$239.30	\$252.87	13.57	5.7%
Research	218.74	221.65	229.62	7.97	3.6%
Education	2.56	2.95	2.95	-	-
Infrastructure	17.98	14.70	20.30	5.60	38.1%

¹ Excludes funding provided by the American Rescue Plan supplemental appropriation.

² Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

CMMI funds fundamental research and education that advances civil, design, mechanical, industrial, systems, manufacturing, and materials engineering. In addition, the division has a focus on the reduction of risks and damage resulting from earthquakes, wind, and other hazards on the built environment and in the context of a socio-technical system. CMMI encourages discoveries enabled by cross-cutting technologies such as adaptive systems, artificial intelligence, robotics, nanotechnology, and high-performance computational modeling and simulation. In general, about 75 percent of the division portfolio is available to support new research grants. The remaining 25 percent supports research grants made in prior years.

DIVISION OF ELECTRICAL, COMMUNICATIONS, AND CYBER SYSTEMS (ECCS)

ECCS Funding
(Dollars in Millions)

	FY 2022	FY 2023	FY 2024	Change over	
	Actual ¹	Estimate Base	Request	FY 2023 Base Amount	Total ² Percent
Total	\$123.10	\$123.11	\$130.09	6.98	5.7%
Research	117.09	116.87	123.85	6.98	6.0%
Education	0.57	0.90	0.90	-	-
Infrastructure	5.44	5.34	5.34	-	-

¹ Excludes funding provided by the American Rescue Plan supplemental appropriation.

² Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

ECCS supports transformative research at the nano, micro, and macro scales that fuels impacts on quantum, cyber and wireless technologies, sensing, clean energy and power systems, healthcare, transportation, robotics, advanced manufacturing, and other systems-related areas. The division's programs encompass novel electronic, photonic, quantum, and magnetic devices, including energy-efficient, sustainable and secure semiconductors and microelectronics, and the integration of these devices into circuit and system environments, intelligent systems, control, and networks. In general, about 80 percent of the division portfolio is available to support new research grants. The remaining 20 percent supports research grants made in prior years.

DIVISION OF ENGINEERING EDUCATION AND CENTERS (EEC)

EEC Funding
(Dollars in Millions)

	FY 2022	FY 2023	FY 2024	Change over	
	Actual ¹	Estimate Base	Request	FY 2023 Base Amount	Total ² Percent
Total	\$132.55	\$134.07	\$156.23	22.16	16.5%
Research	116.49	118.02	137.03	19.01	16.1%
Education	16.06	16.05	19.20	3.15	19.6%
Infrastructure	-	-	-	-	N/A

¹ Excludes funding provided by the American Rescue Plan supplemental appropriation.

² Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

EEC invests in the creation of 21st century engineers and the discovery of new technologies through engineering education research, broadening participation in engineering, research and experiential learning opportunities for students and teachers, and transformational center-based research. EEC leads the signature ERC and IUCRC programs, which impact advanced manufacturing; biotechnology and health; agriculture; energy, sustainability, and infrastructure; and microelectronics, sensing, quantum, and information technology. In general, about 22 percent of the division portfolio is available to support new research grants. The remaining 78 percent supports research grants made in prior years.

OFFICE OF EMERGING FRONTIERS AND MULTIDISCIPLINARY ACTIVITIES (EFMA)

EFMA Funding
(Dollars in Millions)

	FY 2022 Actual ¹	FY 2023 Estimate Base	Disaster Relief Supplemental Base	FY 2023 Estimate Total	FY 2024 Request	Change over FY 2023 Base Total ²	
						Amount	Percent
Total	\$76.19	\$74.87	\$34.00	\$108.87	\$215.82	106.95	98.2%
Research	76.01	73.62	33.00	106.62	214.57	107.95	101.2%
Education	-	0.15	-	0.15	0.15	-	-
Infrastructure	0.18	1.10	1.00	2.10	1.10	-1.00	-47.6%

¹ Excludes funding provided by the American Rescue Plan supplemental appropriation.

² Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

The EFMA office enables ENG to strategically pursue and support projects in important emerging areas. A central activity of EFMA is the Emerging Frontiers in Research and Innovation (EFRI) program, which funds interdisciplinary projects with potential for major impacts on national needs and/or grand challenges. EFMA also provides ENG with the necessary flexibility to invest in long-term challenges and to adapt as new challenges arise. In FY 2023, EFMA serves as steward of DRS funding for cross-NSF activities in Climate: Clean Energy Technology. In FY 2024, EFMA will invest in coordination hubs to catalyze partnerships for clean energy challenges; interdisciplinary research for extreme design in the age of climate change; and trailblazing engineering researchers for impacts on grand challenges. In general, about 83 percent of the office portfolio is available to support new research grants. The remaining 17 percent supports research grants made in prior years.

