

## DIRECTORATE FOR ENGINEERING (ENG)

**\$876,330,000**  
**+\$50,160,000 / 6.1%**

### ENG Funding (Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate	
				Amount	Percent
Chemical, Bioengineering, Environmental, and Transport Systems (CBET)	\$158.82	\$171.45	\$179.40	\$7.95	4.6%
Civil, Mechanical, and Manufacturing Innovation (CMMI)	189.62	203.58	217.06	13.48	6.6%
Electrical, Communications, and Cyber Systems (ECCS)	97.54	106.73	114.30	7.57	7.1%
Engineering Education and Centers (EEC)	125.76	120.00	123.27	3.27	2.7%
Industrial Innovation and Partnerships (IIP)	162.65	193.41	210.30	16.89	8.7%
<i>SBIR/STTR</i>	<i>126.47</i>	<i>152.76</i>	<i>165.20</i>	<i>12.44</i>	<i>8.1%</i>
Emerging Frontiers in Research and Innovation (EFRI)	28.95	31.00	32.00	1.00	3.2%
<b>Total, ENG</b>	<b>\$763.33</b>	<b>\$826.17</b>	<b>\$876.33</b>	<b>\$50.16</b>	<b>6.1%</b>

Totals may not add due to rounding.

### About ENG

The Directorate for Engineering (ENG) is a global leader in identifying and catalyzing fundamental engineering research, innovation, and education. To achieve this vision, the directorate leads in frontier engineering research, cultivates an innovation ecosystem, develops the next-generation engineer, and demonstrates organizational excellence.

Since its inception, ENG has provided substantial support for frontier research and education across all fields of engineering. Directorate-funded basic and use-inspired research, combined with the creativity of well-educated engineers and the resources of state-of-the-art facilities, have fueled many important innovations that in turn have stimulated economic growth and improved the health and quality of life for all Americans.

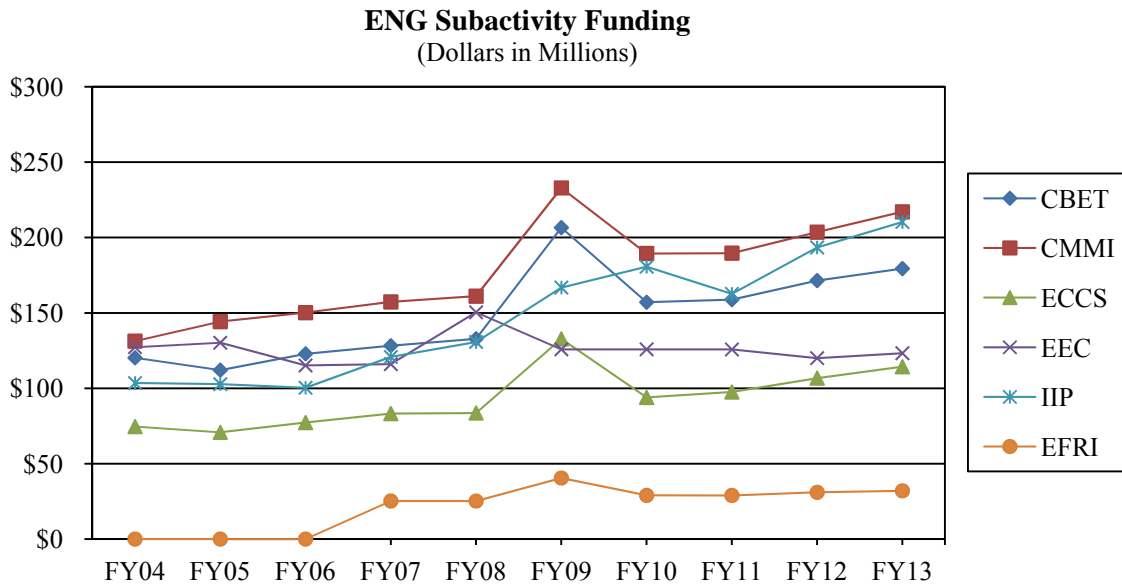
Many ENG programs and activities support national priorities and contribute to solutions to grand challenges. ENG is central to the OneNSF investments which are designed to create the knowledge and innovations required for these areas. These investments include Cyber-Enabled Materials, Manufacturing, and Smart-Systems (CEMMSS); Innovation Corps (I-Corps); Science, Engineering, and Education for Sustainability (SEES); and the Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21)

- ENG will be a major contributor in the CEMMSS OneNSF investment through interdisciplinary research in breakthrough materials and materials design, advanced manufacturing techniques and processes, and smart systems research, including robotics.
- The ENG role in SEES will continue with significant emphasis on sustainable research networks and investments in sustainable chemistry. Through coordination with all other NSF directorates,

especially the Directorate for Social, Behavioral, and Economic Sciences (SBE), ENG will be able to tackle the human dimensions of sustainability in the engineered or “built” environment.

- ENG leads the Foundation in strategic research investments focusing on innovations in manufacturing, in all its dimensions (advanced manufacturing, nanomanufacturing, and transformative technologies for traditional manufacturing).
- The ENG investment in CIF21 will build upon the directorate’s support of groundbreaking work in cyber–physical systems, engineering modeling and simulation, smart networks, and sensors.

ENG provides about 35 percent of the federal funding for basic research in engineering at academic institutions.



FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

### FY 2013 Summary by Division

- The FY 2013 Request for the Division of Chemical, Bioengineering, Environmental, and Transport Systems (CBET) will promote research and education for sustainability in the areas of water, climate, clean energy, and sustainable chemistry contributing to the NSF-wide SEES investment. CBET’s request will bolster CEMMSS support through investment in robotics with research to assist those with physical disabilities or cognitive impairment. CBET will also enhance support for early-career researchers and support a Science and Technology Center (STC) from the Class of 2010.
- The FY 2013 Request for the Division of Civil, Mechanical, and Manufacturing Innovation (CMMI) will enable contributions to the CEMMSS OneNSF investment through research and education in advanced manufacturing, interdisciplinary research in advanced materials and manufacturing processes, as well as materials design, robotics, and cyber–physical system approaches to capitalize on interdisciplinary research opportunities arising in cyber-enabled smart manufacturing systems. CIF21 support will focus on research and education on computational-based approaches for engineering design, analysis, and predictive modeling, particularly under high degrees of uncertainty. CMMI’s contribution to the SEES portfolio will include research for resilient and sustainable

buildings and infrastructure, disaster-resilient systems, energy systems manufacturing, and energy-efficient materials and processes.

- The FY 2013 Request for the Division of Electrical, Communications, and Cyber Systems (ECCS) will enable contributions to the CIF21 portfolio through support for research and education in advanced devices and systems directed towards computing, data storage, networking, and data management. The ECCS investment in the Enhanced Access to the Radio Spectrum (EARS) activity will support research on more efficient radio spectrum use and greatly improved low power energy-conserving device technologies. The division will also provide support for CEMMSS related work in the areas of robotics, smart health research, and cyber-physical systems in the area of integration of intelligent decision-making algorithms and hardware into physical systems. ECCS will also enhance support for early-career researchers and support an STC.
- The FY 2013 Request for the Division of Engineering Education and Centers (EEC) will maintain the existing portfolio of Engineering Research Centers (ERC) and provide planned growth supplements to the first class of Nanosystems Engineering Research Centers (NERCs) established in FY 2012. This investment will transition the nano-devices created at graduating Nanoscale Science and Engineering Centers (NSECs) to the systems level and commercialization. EEC will enhance support for early-career researchers and for activities that facilitate alternative pathways to engineering careers, especially for non-traditional engineering students such as veterans.
- The FY 2013 Request for the Division of Industrial Innovation & Partnerships (IIP) reflects its commitment to enhancing the Nation's innovation ecosystem. Through programs for Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR), IIP will continue to support technological breakthroughs that benefit society. Through the I-Corps, Partnerships for Innovation (PFI), and other activities, the division will enable academic researchers to begin translation of fundamental research discoveries, encourage academia and industry to collaborate (especially regionally), and prepare students to be entrepreneurial leaders in innovation.
- The FY 2013 Request for the Office of Emerging Frontiers in Research & Innovation (EFRI) will provide support for 15 interdisciplinary teams to pursue cutting-edge research with the potential for transformative impacts on national needs and grand challenges.

**Major Investments**

**ENG Major Investments**

(Dollars in Millions)

Area of Investment	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate	
				Amount	Percent
Advanced Manufacturing	\$40.36	\$48.42	\$68.42	\$20.00	41.3%
BioMaPS	-	3.31	5.00	1.69	51.1%
CAREER	57.16	50.34	52.78	2.44	4.8%
CEMMSS	-	56.00	110.42	54.42	97.2%
CIF21	-	5.00	11.00	6.00	120.0%
Clean Energy Technology	115.50	121.80	128.00	6.20	5.1%
E <sup>2</sup>	-	-	1.00	1.00	N/A
EARS	-	4.00	14.00	10.00	250.0%
I-Corps	0.45	2.50	6.00	3.50	140.0%
INSPIRE	-	-	6.00	6.00	N/A
NRI	-	8.33	10.00	1.67	20.0%
SEES	3.28	19.25	20.00	0.75	3.9%
SaTC	-	3.25	4.25	1.00	30.8%
NNI	181.59	166.37	174.37	8.00	4.8%

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

- ENG will strategically invest additional funds across the directorate in advanced manufacturing to support innovations in multi-scale modeling for simulation-based design and manufacturing across the supply chain, nanomanufacturing, innovative materials and manufacturing processes, energy systems manufacturing, and complex engineering systems design and manufacturing. The directorate will support industry–university partnerships and anticipates that at least one of the new NERCs will be in the area of advanced manufacturing. ENG’s FY 2013 Request for Advanced Manufacturing is \$68.42 million.
- ENG will invest \$5.0 million in Research at the Interface of the Biological, Mathematical, Physical Sciences, and Engineering (BioMaPS) through the clean energy and advanced manufacturing activities as well as the core programs. Funding for this activity will be directed to CBET, CMMI, and ECCS.
- ENG’s CAREER funding of \$52.78 million will make approximately 125 awards in FY 2013 to support young investigators who exemplify the role of teacher–scholar through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations.
- ENG support of \$110.42 million for CEMMSS will build upon existing frontier research and advance connections between robotics and manufacturing; materials and manufacturing; cyber–physical systems and robotics; robotics and the biological aspects of engineering. Activities that bring together potentially all of these research areas will be critical if this ambitious program is to succeed.

- ENG funding of \$11.0 million in the CIF21 OneNSF investment will focus on three components: data-enabled science, new computational infrastructure, and access and connections to cyberinfrastructure facilities. Funding will be directed to CBET, CMMI, and ECCS.
- ENG support of \$128.0 million for clean energy will enhance research and innovations in smart grid technologies, solar energy technologies, biofuels and bioenergy, wind energy generation, and renewable energy storage. The ENG clean energy investment will be strategically divided among all divisions.
- Initial funding of \$1.0 million will support engineering contributions to the Expeditions in Education (E<sup>2</sup>) OneNSF investment area.
- EARS support of \$14.0 million represents a significant increase in FY 2013. The recent NSF supported workshop, *Enhanced Access to the Radio Spectrum: A Path Forward*, outlines the need for research on new and innovative ways to use the spectrum more efficiently. In partnership with Directorate for Computer and Information Sciences and Engineering (CISE) and the Directorate for Mathematical and Physical Sciences (MPS), ENG ECCS will initiate support for the basic research that underpins this effort.
- ENG investment in the NSF I-Corps program of \$6.0 million will seek to identify NSF-funded researchers who will receive additional support – in the forms of mentoring and funding – to accelerate innovation that can attract subsequent third-party investment.
- ENG participation in INSPIRE (Integrated NSF Support Promoting Interdisciplinary Research and Education) will strengthen ENG's long-standing support for interdisciplinary, potentially transformative research by complementing existing efforts, such as EFRI, with a suite of new, highly creative Foundation-wide activities and funding opportunities. ENG's FY 2013 Request for INSPIRE is \$6.0 million.
- ENG support of the National Robotics Initiative (NRI) will fund research on assistive mechanisms for those with physical disabilities and cognitive impairment as well as the elderly; on systems integration that enables ubiquitous, advanced robotics to be realized; and on next-generation robotics for manufacturing, healthcare and rehabilitation, surveillance and security, education and training, and transportation. This \$10.0 million investment will be directed to CBET, CMMI, and ECCS. NRI is a cross-agency initiative involving NSF's CISE and ENG directorates along with external partners the National Aeronautics and Space Administration (NASA), the National Institutes of Health (NIH), and the U.S. Department of Agriculture (USDA).
- ENG will support the NSF-wide SEES investment by funding activities across the directorate that will lay the foundation for technologies to mitigate, and adapt to, environmental change that threatens sustainability. The greatest share of funding will be directed to CBET, CMMI, and ECCS, for investments in Sustainability Research Networks and Sustainable Chemistry research. ENG's FY 2013 Request for SEES is \$20.0 million.
- ENG support of \$4.25 million for the Secure and Trustworthy Cyberspace (SaTC) activity will focus on the engineering aspects of the Networking and Information Technology Research and Development (NITRD) Strategic Plan for the Federal Cybersecurity Research and Development Program (released December 2011). NITRD's research thrusts cover a set of interrelated priorities for U.S. government agencies that conduct or sponsor research and development in cybersecurity.

- The directorate will continue supporting the National Nanotechnology Initiative (NNI), with additional funding directed towards the NNI Signature Initiatives: Nanoelectronics for 2020 and Beyond; Sustainable Nanomanufacturing – Creating the Industries of the Future; and Nanotechnology for Solar Energy Collection and Conversion. ENG’s FY 2013 Request for NNI is \$174.37 million.

## ENG Funding for Centers Programs and Facilities

### ENG Funding for Centers Programs

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over	
				FY 2012 Estimate	
				Amount	Percent
<b>Centers Programs Total</b>	<b>\$97.88</b>	<b>\$99.82</b>	<b>\$93.83</b>	<b>-\$5.99</b>	<b>-6.0%</b>
Engineering Research Centers (EEC)	59.06	70.00	69.00	-1.00	-1.4%
Nanoscale Science & Engineering Centers (Multiple)	23.84	17.62	12.63	-4.99	-28.3%
Science & Technology Centers (CBET and ECCS)	12.78	10.00	10.00	-	-
Science of Learning Centers (EEC)	2.19	2.20	2.20	-	-

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- Engineering Research Centers (ERC): Support for the ERC program will decrease by \$1.0 million, to a total of \$69.0 million. Building on the long-standing ERC program model, ENG will maintain funding for the existing portfolio of ERC’s and provide planned growth supplement to the first class of three Nanosystems ERCs (NERCs) funded in FY 2012. This investment will transition the nano-devices created at graduating NSECs to the systems level and commercialization.
- Nanoscale Science and Engineering Centers (NSEC): NSEC support will be reduced by \$4.99 million, to a total of \$12.63 million as two centers receive final funding in FY 2012.
- Science and Technology Centers (STC): ENG will continue to fund two STCs in FY 2013. CBET will support the Center on Emergent Behaviors of Integrated Cellular Systems, and ECCS will support the Center for Energy Efficient Electronics Science.

### ENG Funding for Facilities

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over	
				FY 2012 Estimate	
				Amount	Percent
<b>Facilities (Total)</b>	<b>\$31.04</b>	<b>\$31.33</b>	<b>\$31.33</b>	-	-
NEES (CMMI)	20.10	20.50	20.50	-	-
NNIN (Multiple)	10.93	10.83	10.83	-	-

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

ENG will maintain operations and maintenance budgets for facilities at the FY 2012 Estimate level. Notable items include:

- Support for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) operations in FY 2013 will be maintained at \$20.50 million, equal to the FY 2012 Estimate. ENG will leverage investment in CIF21 to support NEES connections and foster data-enabled research within the earthquake engineering community. In response to recommendations by the Advisory Committee on Earthquake Hazards Reduction (ACEHR), NSF will organize a workshop to explore how NSF can better support Grants for Rapid Response Research (RAPIDs) for future events, and how the community can better organize in response to these events. NSF currently supports two studies to assess the future grand challenges in research and research infrastructure needs for earthquake engineering beyond 2014. These two studies are described in the NSF 10-071 Dear Colleague Letter, [www.nsf.gov/pubs/2010/nsf10071/nsf10071.jsp](http://www.nsf.gov/pubs/2010/nsf10071/nsf10071.jsp). These NSF sponsored studies and workshops will identify research needs that are shared with the NEHRP agencies and earthquake engineering research community.
- ENG continues support for the National Nanotechnology Infrastructure Network (NNIN) of user facilities at the FY 2012 Estimate level of \$10.83 million. FY 2013 represents year ten of this planned ten-year investment.

### Summary and Funding Profile

ENG supports investments in core research and education as well as research infrastructure such as facilities.

In FY 2013 the number of research grant proposals is expected to increase by nearly 200 compared to FY 2011. ENG expects to award approximately 1,600 research grants in FY 2013. Average annualized award size and duration are estimated to be \$122,000 and three years, respectively, in FY 2013.

In FY 2013, funding for centers accounts for over 13 percent of ENG’s non-SBIR/STTR Request.

Funding for facilities accounts for less than 5 percent of ENG’s non-SBIR/STTR FY 2013 Request.

#### ENG Funding Profile

	FY 2011 Actual Estimate	FY 2012 Estimate	FY 2013 Estimate
<b>Statistics for Competitive Awards:</b>			
Number of Proposals	12,296	12,600	12,850
Number of New Awards	2,047	2,220	2,370
Funding Rate	17%	18%	18%
<b>Statistics for Research Grants:</b>			
Number of Research Grant Proposals	9,362	9,450	9,600
Number of Research Grants	1,365	1,450	1,550
Funding Rate	15%	15%	16%
Median Annualized Award Size	\$101,955	\$102,000	\$102,000
Average Annualized Award Size	\$122,194	\$122,000	\$122,000
Average Award Duration, in years	3.0	3.0	3.0

## **Program Monitoring and Assessment**

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors (COVs) and directorate Advisory Committees. Please see this chapter for additional information.

In 2011, COVs reviewed EFRI and ECCS. The COVs presented their reports to the ENG Advisory Committee, which convened in April and October of 2011. ENG divisions are responding to and implementing recommendations from recent COVs.

In 2012, COVs will review CBET and CMMI. In 2013, COVs will review EEC and IIP.

ENG funded SRI International to evaluate the outcomes of ENG-supported Research Experiences for Undergraduates (REU) awards. In October 2010, ENG received SRI's report on the longer-term impacts of the ENG REU and other undergraduate research experiences, which was based on data collected from ENG REU students from 2006. ENG disseminated the report and received community input on how to accomplish the report's recommendations and is currently evaluating implementation strategies.

In FY 2010–2011, ENG funded the Science and Technology Policy Institute (STPI) to perform a formative assessment and evaluation of the processes by which topic areas and potentially transformative projects are selected by EFRI, and to design a protocol for future outcome evaluation of EFRI research projects. In response to this report and 2011 COV recommendations the directorate substantially revised the research topic selection process and instituted several internal process innovations in FY 2011–2012. The topic selection process frequency has been modified to every other year and external experts are being engaged in evaluating candidate topics. In order to enhance participation of underrepresented groups, the office is piloting a new opportunity to provide support to active EFRI projects for establishing summer institutes for mentored research experiences with groups including undergraduates, community college students, high school students, teachers, professors at minority serving institutions, and veterans.

In FY 2011–2012, the directorate supported two studies to assess future earthquake engineering research and research infrastructure needs. A National Research Council (NRC) committee prepared a workshop report on research grand challenges for networked earthquake engineering experimental facilities and cyberinfrastructure. To build on this work, STPI is developing potential scenarios for the future of NSF-supported earthquake engineering facilities. The Foundation is currently evaluating the NRC report and is awaiting arrival of the STPI report, expected in March 2012.

In FY 2011–2012, ENG is funding Manhattan Strategies, Inc. to evaluate the Nanotechnology Undergraduate Education (NUE) program with a final report expected September 30, 2012. This external evaluation of the 155 projects funded to date is being conducted to determine the outputs and outcomes resulting from NUE funding, the collaborating departments and colleges, the impact of the program on engineering education as reported by the funded projects, whether program outcomes have been disseminated throughout the academic community, and the level of K-12 outreach.

In addition to continuous ongoing evaluation within the ERC and Industry/University Cooperative Research Centers (I/UCRC) programs, the directorate has other plans for 2013 evaluation in development. ENG has hired a program director for evaluation and assessment who is leading a group charged with developing an overarching strategy for the directorate, which includes developing and ratifying logic models for the different engineering programs. The program director is working on pilot evaluation with selected fundamental engineering research and engineering education programs. The engineering evaluation and assessment plan will focus on immediate-, intermediate-, and long-term outcomes of



engineering investments on society. In addition, ENG is working with the Science of Science and Innovation Policy (SciSIP) program within SBE on a National Academies' study to evaluate the quality of research output and impact on society.

**Number of People Involved in ENG Activities**

	FY 2011 Actual Estimate	FY 2012 Estimate	FY 2013 Estimate
Senior Researchers	10,309	10,770	11,310
Other Professionals	1,736	1,810	1,900
Postdoctorates	485	510	540
Graduate Students	7,008	7,330	7,700
Undergraduate Students	3,354	3,500	3,680
<b>Total Number of People</b>	<b>22,892</b>	<b>23,920</b>	<b>25,130</b>



**DIVISION OF CHEMICAL, BIOENGINEERING, ENVIRONMENTAL, AND TRANSPORT SYSTEMS (CBET)** **\$179,400,000**  
**+\$7,950,000 / 4.6%**

**CBET Funding**  
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over	
				FY 2012 Estimate Amount	Percent
<b>Total, CBET</b>	<b>\$158.82</b>	<b>\$171.45</b>	<b>\$179.40</b>	<b>\$7.95</b>	<b>4.6%</b>
<b>Research</b>	<b>155.10</b>	<b>167.76</b>	<b>175.71</b>	<b>7.95</b>	<b>4.7%</b>
<i>CAREER</i>	24.45	21.55	22.59	1.04	4.8%
<i>Centers Funding (total)</i>	12.60	11.08	9.08	-2.00	-18.1%
<i>Nanoscale Science &amp; Engineering Centers</i>	4.87	6.08	4.08	-2.00	-32.9%
<i>STC for Water Purification</i>	2.68	-	-	-	N/A
<i>STC for Emergent Behavior</i>	5.05	5.00	5.00	-	-
<b>Infrastructure</b>	<b>3.72</b>	<b>3.69</b>	<b>3.69</b>	-	-
<i>Nat'l Nanotechnology Infrastructure Network</i>	3.72	3.69	3.69	-	-

CBET supports research to enhance and protect U.S. national health, energy, environment, and security. Through CBET, the physical, life, and social sciences are merged in engineering research and education, resulting in advances in the rapidly evolving fields of bioengineering and environmental engineering, and in areas that involve the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. CBET investments contribute significantly to the knowledge base and to the development of the workforce for major components of the U.S. economy, including chemicals, pharmaceuticals, medical devices, forest products, metals, petroleum, food, textiles, utilities, and microelectronics.

CBET supports research in biotechnology and the chemical, environmental, biomedical, mechanical, civil, and aerospace engineering disciplines. To serve these communities and achieve its goals, CBET has been organized into four thematic clusters each accounting for roughly 25 percent of the budget: Chemical, Biochemical, and Biotechnology Systems; Biomedical Engineering and Engineering Healthcare; Environmental Engineering and Sustainability; and Transport and Thermal Fluids Phenomena.

In general, 68 percent of the CBET portfolio is available for new research grants. The remaining 32 percent is used primarily to fund continuing grants made in previous years.

**FY 2013 Summary**

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- CAREER funding increases by \$1.04 million to a total of \$22.59 million in FY 2013. This increase is consistent with CBET's emphasis on supporting early-career researchers.
- CBET investment in SEES increases \$500,000 to a total of \$11.0 million in FY 2013 and will support the areas of water sustainability, climate engineering, and climate change mitigation and adaptation research with an emphasis in the energy area, to be supplemented by core investments in the areas of sustainable chemistry, water, energy, and the environment.

- Investments for CIF21 increase by \$1.0 million, to a total of \$2.0 million and will contribute to developing a cyberinfrastructure of “Sustainable Computation” that allows the use of “expert algorithms” by multiple groups (including undergraduates and industrial practitioners), less experienced than experts, to perform calculations after minimal instruction. Existing resources (envelopes, clouds, open source modules, etc.) will be used to create this environment of learning and discovery.
- CBET funding of the National Robotics Initiative, part of the ENG CEMMSS portfolio, increases \$1.0 million to a total of \$2.0 million and will include research on assistive mechanisms for those with physical disabilities and cognitive impairment as well as the aging population, especially through the Biosensing program and the General and Age-Related Disabilities Engineering (GARDE) program.
- The division will also provide \$3.0 million in support of the national Materials Genome Initiative through a collaborative effort with MPS in Designing Materials to Revolutionize and Engineer our Future (DMREF) under the NSF-wide CEMMSS investment area.
- Support for BioMaPS – Research at the Interface of Biology, the Physical Sciences, and Engineering – is requested at \$3.0 million in FY 2013 and will include research on nanoscale biosensing, neuro-engineering, and cellular biomechanics, as well as metabolic engineering and engineering aspects of synthetic biology.
- STC funding remains at \$5.0 million, equivalent with FY 2012 to continue support for the STC on Emergent Behavior of Integrated Cellular Systems, led by the Massachusetts Institute of Technology.
- CBET support for the NSEC program will be reduced by \$2.0 million, to a total of \$4.08 million, as two centers supported by the division receive final funding in FY 2012.

#### **Infrastructure**

- ENG continues support for the National Nanotechnology Infrastructure Network (NNIN) of user facilities at the FY 2012 Estimate level. FY 2013 represents year ten of this planned ten-year investment.

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

**\$217,060,000**  
**+\$13,480,000 /6.6%**

**CMMI Funding**  
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over	
				FY 2012 Estimate Amount	Percent
<b>Total, CMMI</b>	<b>\$189.62</b>	<b>\$203.58</b>	<b>\$217.06</b>	<b>\$13.48</b>	<b>6.6%</b>
<b>Research</b>	<b>167.60</b>	<b>181.18</b>	<b>194.66</b>	<b>13.48</b>	<b>7.4%</b>
<i>CAREER</i>	19.07	16.76	17.58	0.82	4.9%
<i>Centers Funding (total)</i>	5.48	5.48	3.49	-1.99	-36.3%
<i>Nanoscale Science &amp; Engineering Centers</i>	5.48	5.48	3.49	-1.99	-36.3%
<b>Infrastructure</b>	<b>22.02</b>	<b>22.40</b>	<b>22.40</b>	-	-
<i>Nat'l Nanotechnology Infrastructure Network</i>	1.92	1.90	1.90	-	-
<i>Network for Earthquake Engineering Simulation</i>	20.10	20.50	20.50	-	-

CMMI funds fundamental research in support of the Foundation’s strategic goals directed at advances in the disciplines of civil, mechanical, industrial, systems, and manufacturing engineering, and materials design. In addition, the division has a focus on the reduction of risks and damage resulting from earthquakes and other hazards and disasters. CMMI encourages discovery enabled by the use of cross-cutting technologies such as adaptive systems, nanotechnology, and high-performance computational modeling and simulation. The division promotes cross-disciplinary research partnerships at the intersections of traditional research disciplines to advance transformative research results that promote innovative manufacturing technology; enable the design and analysis of complex engineering systems; enhance the sustainability and resiliency of the Nation’s infrastructure (for example, buildings, transportation, and communication networks); help protect the Nation from extreme events; and apply engineering principles to improve the Nation’s service enterprise systems such as healthcare.

In general, 74 percent of the CMMI portfolio is available for new research grants. The remaining 26 percent is used primarily available for continuing grants made in previous years.

**FY 2013 Summary**

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- CAREER funding increases by \$820,000, to a total of \$17.58 million, in FY 2013. This increase is consistent with CMMI’s emphasis on supporting early-career researchers.
- Fundamental basic, core research in support of advanced manufacturing will be \$50.0 million in FY 2013 as part of the NSF-wide CEMMSS activity. Areas of continued emphasis include nanomanufacturing, manufacturing enterprise systems and operations research, smart manufacturing, and design and manufacturing of complex engineered systems.
- Research to support the National Robotics Initiative will be funded at \$5.0 million with advances helping to ensure continued U.S. leadership in the robotics field.
- The division will also provide \$10.0 million in support of the national Materials Genome Initiative through the DMREF effort under the NSF-wide CEMMSS investment area.

- Investments in SEES, requested at \$4.75 million in FY 2013 and an increase of \$500,000, will continue to support research for resilient and sustainable infrastructure, disaster-resilient systems, energy manufacturing, and energy-efficient materials and processes.
- Support for CIF21 increases by \$2.0 million, to a total of \$5.0 million in FY 2013. CMMI will contribute to this OneNSF investment by supporting research on computational-based approaches for engineering design, analysis, and predictive modeling particularly under high degrees of uncertainty. Efforts will support research in the areas of data-enabled science and engineering, with emphasis on complex systems design and analysis and methods to utilize disparate and distributed data sets for CMMI relevant research. Linkages between these CEMMS-related research programs and elements of the CIF21 activity will be strengthened as researchers make greater use of modeling and simulation and data enabled capabilities made possible by CIF21 investments.
- CMMI support for the NSEC program will be reduced by \$1.99 million, to a total of \$3.49 million, as two centers supported by the division receive final funding in FY 2012.

### **Infrastructure**

- Support for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) operations in FY 2013 will be maintained at \$20.50 million, equal to FY 2012. ENG will leverage investment in CIF21 to support NEES connections and foster data-enabled research within the earthquake engineering community. In response to recommendations by the Advisory Committee on Earthquake Hazards Reduction (ACEHR), NSF will organize a workshop to explore how NSF can better support RAPIDs for future events, and how the community can better organize in response to these events. NSF currently supports two studies to assess the future grand challenges in research and research infrastructure needs for earthquake engineering beyond 2014. These two studies are described in the NSF 10-071 Dear Colleague Letter, [www.nsf.gov/pubs/2010/nsf10071/nsf10071.jsp](http://www.nsf.gov/pubs/2010/nsf10071/nsf10071.jsp). These NSF sponsored studies and workshops will identify research needs that are shared with the NEHRP agencies and earthquake engineering research community.
- ENG continues support for the National Nanotechnology Infrastructure Network (NNIN) of user facilities at the FY 2012 Estimate level. FY 2013 represents year ten of this planned ten-year investment.

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

**\$114,300,000**  
**+\$7,570,000 / 7.1%**

**ECCS Funding**  
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over	
				FY 2012 Estimate Amount	Percent
<b>Total, ECCS</b>	<b>\$97.54</b>	<b>\$106.73</b>	<b>\$114.30</b>	<b>\$7.57</b>	<b>7.1%</b>
<b>Research</b>	<b>92.25</b>	<b>101.49</b>	<b>109.06</b>	<b>7.57</b>	<b>7.5%</b>
<i>CAREER</i>	<i>13.64</i>	<i>12.03</i>	<i>12.61</i>	<i>0.58</i>	<i>4.8%</i>
<i>Centers Funding (total)</i>	<i>8.56</i>	<i>8.54</i>	<i>7.54</i>	<i>-1.00</i>	<i>-11.7%</i>
<i>Nanoscale Science &amp; Engineering Centers</i>	<i>3.51</i>	<i>3.54</i>	<i>2.54</i>	<i>-1.00</i>	<i>-28.2%</i>
<i>STC for Efficient Electronics</i>	<i>5.05</i>	<i>5.00</i>	<i>5.00</i>	-	-
<b>Infrastructure</b>	<b>5.29</b>	<b>5.24</b>	<b>5.24</b>	-	-
<i>Nat'l Nanotechnology Infrastructure Network</i>	<i>5.29</i>	<i>5.24</i>	<i>5.24</i>	-	-

ECCS addresses fundamental research issues underlying electronic and photonic devices and component technologies, radio frequency through terahertz (THz) circuit integration, nanoelectronics, bioelectronics, energy (including alternate energy sources), power, smart-grid, controls, computation, networking, communications, control, sensing, robotics, and cyber-physical technologies. The division supports fundamental research of novel electronic and photonic devices, the integration of these devices into circuit and system environments, and the networking of intelligent systems at multiple scales for applications in energy, healthcare, disaster mitigation, telecommunications, environment, manufacturing, and other systems-related areas. ECCS research and education investments emphasize interdisciplinary collaboration and the convergence of technologies to take on major technological challenges for the next generation of innovative devices and systems.

In general, 64 percent of the ECCS portfolio is available for new research grants. The remaining 36 percent is used primarily for continuing grants made in previous years.

**FY 2013 Summary**

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- CAREER funding increases by \$580,000, to a total of \$12.61 million in FY 2013. This increase is consistent with ECCS’s emphasis on supporting early-career researchers.
- ECCS will increase support for the NSF-wide CIF21 activity by \$2.0 million to a total of \$3.0 million through support for research in advanced devices and systems directed towards computing, data storage, networking, and data management.
- The division’s investment in the NRI (\$3.0 million) is part of the NSF-wide CEMMSS portfolio and will support the integration of electronic, mechanical, computing, sensing devices and systems, controls, and intelligent systems that enable ubiquitous, advanced robotics to be realized.
- In an ongoing collaboration with CISE, the division will increase support for research on cyber-physical systems (CPS) by \$4.0 million, to a total of \$8.0 million. The ECCS investment is part of the NSF-wide CEMMSS portfolio and will be directed towards the integration of intelligent decision-making algorithms and hardware into physical systems.

- ECCS support for CEMMSS-related smart systems research (\$6.0 million), will include smart health research at the interface of biological and electronic systems and will focus on low cost electronic devices and circuits that can be fabricated on soft, flexible substrates, and areas such as distributed and ubiquitous computing and communications technologies to greatly expand the capability of current systems.
- The ECCS investment in EARS will increase by \$10.0 million, to a total of \$14.0 million and will support research on more efficient radio spectrum use and greatly improved low power, energy-conserving device technologies. Increased emphasis will be directed towards research of novel high linearity transistors, devices and circuits that will permit more efficient spectrum use, as well as research into new modulation techniques, circuits, and communications systems. Extension of the radio spectrum to bandwidth rich higher frequencies will be enabled with research of new types of transistors, electronic devices, and circuits that can operate at mm-wave and THz frequencies with enhanced efficiency. Research on novel integrated antenna technologies and investigations of electromagnetic propagation in lossy media will be increased.
- ECCS funding of \$5.0 million in FY 2013 supports the STC for Energy Efficient Electronics Science led by the University of California at Berkeley and awarded in FY 2010.
- ECCS support for the NSEC program will be reduced by \$1.0 million, to a total of \$2.54 million, as two centers supported by the division receive final funding in FY 2012.

**Infrastructure**

- The division continues support of \$5.24 million for NNIN user facilities. FY 2013 represents year ten of this planned ten-year investment.



**DIVISION OF ENGINEERING EDUCATION  
AND CENTERS (EEC)**

**\$123,270,000  
+\$3,270,000 / 2.7%**

**EEC Funding**  
(Dollars in Millions)

	FY 2011	FY 2012	FY 2013	Change Over	
	Actual	Estimate	Request	FY 2012 Estimate Amount	Percent
<b>Total, EEC</b>	<b>\$125.76</b>	<b>\$120.00</b>	<b>\$123.27</b>	<b>\$3.27</b>	<b>2.7%</b>
<b>Research</b>	<b>71.23</b>	<b>74.72</b>	<b>73.72</b>	<b>-1.00</b>	<b>-1.3%</b>
<i>Centers Funding (total)</i>	71.23	74.72	73.72	-1.00	-1.3%
<i>Engineering Research Centers</i>	59.06	70.00	69.00	-1.00	-1.4%
<i>Nanoscale Science &amp; Engineering Centers</i>	9.98	2.52	2.52	-	-
<i>Science of Learning Center</i>	2.19	2.20	2.20	-	-
<b>Education</b>	<b>54.53</b>	<b>45.28</b>	<b>49.55</b>	<b>4.27</b>	<b>9.4%</b>

EEC integrates disciplinary basic research and education conducted in other divisions of ENG and across NSF, into strategic frameworks critical to addressing societal grand challenges and to promoting innovation. Research included in the EEC portfolio spans both the physical and life sciences and engineering, from nanostructured materials to new device concepts, subsystems, and systems. Applications range across a wide spectrum, including energy, medicine, telecommunications, nanoelectronics, manufacturing, civil infrastructure, the environment, computer networks, cyber security, and others. Also included are formal scholarly studies in engineering education and on how people learn.

The complex, integrative role of EEC requires a comprehensive infrastructure of people, equipment, and centers. Fresh, creative approaches to developing the engineering workforce are vital, as a lack of properly prepared engineers is a critical barrier to a healthy U.S. economy. EEC invests in faculty, graduate and undergraduate students, post doctoral scholars, and K-12 teachers. As nontraditional students comprise more than 70 percent of the general undergraduate population, EEC is defining unique alternative pathways for these students, especially veterans, to successfully earn degrees in engineering.

The programs in EEC are administratively managed within three categories: (1) Centers; (2) Engineering Education Research (EER); and (3) Engineering Career Development. The Centers category is comprised primarily of the signature Engineering Research Centers (ERC) program along with Nanoscale Science and Engineering Centers (NSECs) and a Science of Learning Center (SLC). They provide the framework for interdisciplinary research and education, development, and technology transfer in partnership with academia, industry, and government. The Engineering Education Research category advances new productive engineering pedagogy and learning strategies in traditional and non-traditional environments. The Engineering Career Development category includes programs such as Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET).

All programs in EEC have a significant education component, whether it is fundamental research in engineering education innovation (EER), integration of research and education (Centers), implementation strategies (EER), or human resource development (All). Thus, the emphasis on program evaluation is critical to ensure workforce development and U.S. competitiveness objectives are met. To that end, logic models with trackable indicators are being developed at this time for small-scale (projects) and large-scale (centers) programs.

In general, 20 percent of the EEC portfolio is available for new research grants. The remaining 80

percent funds continuing grants and cooperative agreements made in previous years. This high fraction of multi-year commitments is primarily a consequence of the center funding vehicle, which includes awards made as five-year cooperative agreements.

## **FY 2013 Summary**

All funding decreases/increases represent change over the FY 2012 Estimate.

### **Research**

- Support for the ERC program decreases by \$1.0 million, to a total of \$69.0 million. Building on the long-standing ERC program model, ENG will support planned growth of the first class of Nanosystems ERCs (NERCs) funded in FY 2012. This investment will transition the nano-devices and other nanotechnologies created at graduating NSECs into engineered systems and commercialization. It is expected that at least one of these new NERCs will be in the area of advanced manufacturing, and it is likely that one will be in a health-related area. The remaining portfolio of traditional Generation 3 (Gen-3) ERCs will be maintained. To encourage the customary open-topic submissions, the ERC program will defer a planned FY 2013 competition to position itself for a combined ERC and NERC competition in FY 2014.
- Funding of \$2.20 million will provide continued support for an SLC — the Center of Excellence for Learning in Education, Science, and Technology (CELEST) led by Boston University.

### **Education**

- Funding for the Engineering Education Research program totals \$11.10 million, unchanged from the FY 2012 Estimate, and will provide support in the areas of education pedagogy and learning strategies, veterans in engineering programs, alternative pathways to engineering degree attainment, virtual learning, and others. The division will also continue to support a National Innovation Education Center (\$1.0 million in FY 2013) jointly funded with EHR.
- Nanotechnology Undergraduate Education funding remains level at \$1.50 million.
- Funding for the REU sites program increases by \$750,000, to a total of \$10.0 million. Since its inception in 1988 the REU sites program has made a tremendous impact on attracting – *and retaining* – U.S. citizens, permanent residents, and U.S. nationals into all areas of engineering. Over 60 percent of these undergraduate scholars have continued their studies at the graduate level because of the interdisciplinary research experience they gained through REU. The increase will support the growing demand in sustainability, energy, manufacturing, robotics, and other areas of national need as well as directly respond to President Obama’s Jobs Council *10,000 Engineers Initiative*.
- Funding for the RET totals \$4.0 million, which is unchanged from the FY 2012 Estimate. Over the past 10 years the RET in Engineering sites program has provided K-12 teachers and community college faculty with the opportunity to gain research experience in university laboratories. The professional development gained by the participants through this unique experience has enriched their performance in the classroom and their guidance of students toward engineering, thus impacting the current anemic engineering pipeline. The increase will support these participants in areas of national need such as sustainability, energy, manufacturing, robotics, and others.
- Initial funding of \$1.0 million will support engineering contributions to the Expeditions in Education (E<sup>2</sup>) OneNSF investment area and will focus on the integration of outreach and education efforts at ENG funded centers with other NSF education efforts and will leverage the data generated by ENG centers and facilities with advancements being made in cyberlearning research.
- EEC will also provide \$1.0 million to support the directorate’s involvement in the SEES Fellows program.

**DIVISION OF INDUSTRIAL INNOVATION  
AND PARTNERSHIPS (IIP)**

**\$210,300,000**  
**+\$16,890,000 / 8.7%**

**IIP Funding**  
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over	
				FY 2012 Estimate Amount	Percent
<b>Total, IIP</b>	<b>\$162.65</b>	<b>\$193.41</b>	<b>\$210.30</b>	<b>\$16.89</b>	<b>8.7%</b>
<b>Research</b>	<b>162.65</b>	<b>193.41</b>	<b>210.30</b>	<b>16.89</b>	<b>8.7%</b>
SBIR/STTR	126.47	152.76	165.20	12.44	8.1%

IIP contributes to the NSF innovation ecosystem by: (1) supporting innovation research that builds on fundamental research discoveries that exhibit potential for societal impact; (2) encouraging research partnerships between academia and industry; and (3) offering hands-on experience in the innovation process to entrepreneurs and future innovators.

IIP is home to two federal small business research programs, the Small Business Innovation Research (SBIR) program and the Small Business Technology Transfer (STTR) program. These programs support innovation research that leverages academic research findings and builds partnerships between academia, small business, and large industry with the goal of achieving commercialization of new products, processes, or services. Technology topics draw upon the breadth of NSF scientific and engineering research disciplines and are aligned along national and societal priorities.

IIP supports academic research by leveraging industrial support through three research programs: the Industry/University Cooperative Research Centers (I/UCRC) program, the Partnerships for Innovation (PFI) program, and the Grant Opportunities for Academic Liaison with Industry (GOALI) program. University grantees in these programs work closely with industry to create enabling technologies for national needs, such as managing the electrical power system, improving manufacturing and biological processing, and supporting new healthcare information and telecommunications technologies. Furthermore, these programs prepare students for innovation leadership in a globally competitive marketplace through opportunities to work closely with industry.

The division also manages the grant-making process, and is a strong intellectual contributor to the I-Corps OneNSF investment. The NSF I-Corps' purpose is to identify NSF-funded researchers who will receive additional support — in the forms of mentoring and funding — to accelerate innovation that can attract subsequent third-party funding.

In general, 90 percent of the IIP portfolio is available for new research grants. The remaining 10 percent funds continuing grants made in previous years, primarily due to the long-duration of I/UCRCs. All other programs are managed with standard grants.

**FY 2013 Summary**

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- The SBIR/STTR program increase of \$12.44 million, to a total of \$165.20 million, and is consistent with the levels specified in the SBIR/STTR Reauthorization Act of 2011 (P.L. 112-81). Increased

support for SBIR/STTR will provide an opportunity for greater collaboration with the disciplinary divisions across NSF in the spirit of bringing basic research to innovation research.

- Funding for Accelerating Innovation Research (AIR) in FY 2013 totals \$14.25 million, representing an increase of \$250,000, and will support projects that accelerate the process of innovation through the fostering of connections between an existing NSF innovation research alliance. The activity is designed to strengthen the U.S. innovation ecosystem. The increase will also allow support for the continuation and expansion of opportunities to encourage small business partnerships with ERCs. Outcomes resulting from the partnerships will be measured by the number of financial investments; additional partnerships will be collected such as strategic partnerships, people partnerships in-kind partnerships, lab sharing, and acquisitions.
- Funding for I-Corps increases by \$3.50 million, to a total of \$6.0 million, to give project team's access to resources to help determine the readiness to commercialize technology built on previously-funded or currently-funded NSF basic research projects.
- The I/UCRC program increases by \$500,000, to a total of \$10.50 million. The increased support will focus on topics related to advanced manufacturing, clean energy and cyberinfrastructure in line with NSF investments in CEMMSS, SEES and CIF21.
- Support for the PFI program component, Building Innovation Capacity (BIC), increases by \$200,000 to a total of \$8.20 million and will fund public-private partnerships composed of academic researchers and small business practitioners collaborating to further basic research toward market-accepted innovations.
- IIP Support for the GOALI program is maintained at \$6.15 million, equal to the FY 2012 Estimate. ENG's total FY 2013 Request for GOALI will be \$16.40 million.

**EMERGING FRONTIERS IN RESEARCH  
AND INNOVATION (EFRI)**

**\$32,000,000  
+\$1,000,000 / 3.2%**

**EFRI Funding**  
(Dollars in Millions)

	FY 2011	FY 2012	FY 2013	Change Over	
	Actual	Estimate	Request	FY 2012 Estimate Amount	Percent
<b>Total, EFRI</b>	<b>\$28.95</b>	<b>\$31.00</b>	<b>\$32.00</b>	<b>\$1.00</b>	<b>3.2%</b>
<b>Research</b>	<b>28.95</b>	<b>31.00</b>	<b>32.00</b>	<b>1.00</b>	<b>3.2%</b>

EFRI strategically pursues and funds projects in important emerging areas in a timely manner. Each year EFRI recommends, prioritizes, and funds interdisciplinary topics at the frontiers of engineering research and education that have the potential for transformative impacts on national needs and/or grand challenges.

Technological innovations have given rise to new industries, expanded access to quality healthcare, and fueled national prosperity even as global competition has grown. To help ensure the Nation’s continued success, EFRI will provide critical, strategic support of fundamental discovery, particularly in areas that may lead to breakthrough technologies and strengthen the economy’s technical underpinnings. EFRI will have the necessary flexibility to target long-term challenges, while retaining the ability and agility to adapt as new challenges demand.

EFRI encourages the engineering community to come forward with new and paradigm-shifting proposals at the interface of disciplines and fields in important emerging areas. Their ideas and discoveries may potentially lead to new research areas for NSF and other agencies; new industries or capabilities that result in a leadership position for the country; and/or significant progress on a recognized national need or grand challenge.

Recent EFRI topics have included areas such as sustainable energy sources; integrated systems designed to make U.S. infrastructures more resilient to disasters; advances in robotics, manufacturing healthcare; and regeneration of some of the body’s most complex tissues. In FY 2011, EFRI invested in two topic areas to use insights from biological world to inspire new engineering capabilities. These two topical areas were Engineering New Technologies Based on Multicellular and Inter-kingdom Signaling (MIKS), and Mind, Machines, and Motor Control (M3C) were the two topic areas, which were developed in close collaboration with the BIO, CISE, and SBE directorates. The results from these investigations will enable new biological energy sources and better protection for the environment, and human health, including new bionic prosthetics for amputees. In FY 2012, EFRI will invest in three topic areas, namely, Flexible Bioelectronics Systems (BioFlex); Origami Design for the Integration of Self-assembling Systems for Engineering Innovation (ODISSEI); and Photosynthesis Biorefineries (PSBR).

The Department of Energy (DOE) and the Environmental Protection Agency (EPA) have co-funded some of the current EFRI projects in sustainable energy and environmental design. The Air Force Office of Scientific Research (AFOSR) entered into a five-year Memorandum of Understanding with NSF in FY 2012 to help support projects of mutual interest related to this year’s as well as future EFRI topics.

EFRI conducted an external formative assessment of its processes and projects in 2010 and was reviewed by an external Committee of Visitors (COV) in January of 2011. Based on the COV’s recommendation, ENG will develop an outcome logic model for evaluation of EFRI and plans to conduct another external outcome evaluation of its projects funded during the first two years of EFRI’s operation (FY 2007 and

FY 2008).

In general, 96 percent of the EFRI portfolio is available for new research grants. The remaining 4 percent funds continuing grants made in previous years.

### **FY 2013 Summary**

All funding decreases/increases represent change over the FY 2012 Estimate.

#### **Research**

FY 2013 funding will provide support for one additional interdisciplinary team project, for a total of 15 projects aimed at addressing national challenges such as renewable energy or advanced manufacturing.