

**INNOVATIONS AT THE NEXUS OF FOOD, ENERGY
AND WATER SYSTEMS (INFEWS)**

\$15,000,000
- \$18,540,000 / -55.3%

INFEWS Funding
(Dollars in Millions)

	FY 2018 Actual	FY 2019 (TBD)	FY 2020 Request
EHR	\$11.40	-	-
ENG	6.73	-	5.00
GEO	7.00	-	8.00
MPS	0.01	-	-
SBE	2.50	-	2.00
OISE	0.90	-	-
IA	5.00	-	-
Total	\$33.54	-	\$15.00

Overview

Humanity is reliant upon the natural and physical systems of the Earth for provision of food, energy, and water (FEW) resources. With world population projected to increase to nine billion (U.S. population reaching 400 million) by 2050 and urban populations expected to double, there are expected to be major increases in demand for FEW resources. NSF support of basic research in the science and engineering disciplines is needed to understand the interdependent and interconnected FEW systems and could lead to an integrated model useful not only for scientific understanding, but also informed decision-making. The INFEWS investment area enables interagency cooperation on pressing sustainability issues facing the Nation—understanding interactions across the FEW nexus, how it is likely to affect our water resources, and how we can proactively plan for its consequences.

Understanding the food, energy, and water nexus—its complex, coupled processes and systems function—is a grand research challenge. There is also a critical need for research to enable new technologies that will enhance the productivity of the system and subsystems, minimize overall usage of FEW resources, and define new means for socially and technologically adapting to future variability and demands. Investigations of this complex system will produce discoveries that would not emerge from research on food or energy or water systems alone; research into the interactions among these components and the context(s) of the problem(s) they pose at the FEW nexus will produce new knowledge and technologies. These multifaceted interactions are impacted on the one hand by fundamental laws governing various physical, chemical, and biological processes, and on the other hand by the social, behavioral, and economic decisions made by individuals, organizations, and governments.

NSF has invested in discovery research at a disciplinary level, as well as cross-cutting research through programs such as Water, Sustainability and Climate; Dynamics of Coupled Natural and Human Systems; Sustainable Chemistry, Engineering and Materials; Cyber Innovation for Sustainability Science and Engineering; Interdisciplinary Research in Hazards and Disasters; and Basic Research to Enable Agricultural Development.

Building on prior investments, NSF launched INFEWS in FY 2016 to support fundamental scientific and engineering research for new technologies, design concepts, and development of solutions that address the complexity of the food, energy, and water nexus and its subsystems. The desired endpoint is to improve understanding of the interdependencies of the FEW systems, within a disciplinary and transdisciplinary context.

Under INFEWS, NSF partners with the United States Department of Agriculture National Institute of Food and Agriculture (USDA/NIFA) to combine resources to identify and fund high-impact projects that support their respective missions and foster collaboration between agencies and the investigators they support. In addition, NSF and USDA/NIFA promote international cooperation that links scientists and engineers from a range of disciplines and organizations to solve the significant global challenges at the nexus of FEW systems.

NSF plans to end formal investment in INFEWS at the end of FY 2020, and thus will undertake planning and strategizing exercises internally and in consultation with other federal agencies to determine which aspects of INFEWS should be supported through core programs and which aspects may become part of a different investment area or scientific thrust for the Foundation beyond FY 2020.

Goals

1. Significantly advance our understanding of the food-energy-water system through quantitative and computational modeling, including support for advanced relevant cyberinfrastructure;
2. Develop real-time, cyber-enabled interfaces that improve understanding of the behavior of FEW systems and increase decision support capability;
3. Enable research that will lead to innovative solutions to critical FEW system problems; and
4. Grow the scientific workforce capable of studying and managing the FEW system, through education and other professional development.

In FY 2016-2018, NSF issued solicitations to support research to advance all four goals of INFEWS. Two examples of funded research are: one research project examines approaches to managing food, energy, and water systems under stress in California; another project is conducting an analysis of interventions and the impacts of conservation on reducing household food, energy and water consumption.

In FY 2016-2017, NSF issued Dear Colleague Letters (DCLs) to support research activities in nitrogen, phosphorus, and water in the context of INFEWS. Research supported by these DCLs is advancing knowledge of the nitrogen and phosphorus cycles; the production and use of fertilizers for food production; and the detection, separation, and reclamation/recycling of nitrogen- and phosphorus-containing species in and from complex aqueous environments. One research project team is developing receptors to detect and measure nitrogen/phosphorous to improve accuracy and to inform decisions on fertilizer use and wastewater treatment. This project also provides undergraduate and graduate training and internship opportunities within the agricultural industry. Another project is providing information critical to restoring floodplain ecosystems in ways that maximize water quality improvements for nitrogen and phosphorous.

In FY 2019, NSF is in the process of reviewing and awarding grants from the FY 2018 solicitation as well as providing continuing support for ongoing projects. Also, in FY 2019, the INFEWS working group continues to coordinate with intra-agency, inter-agency, and international partners to identify and promote additional opportunities to support FEW- related research.

FY 2020 Investments

In FY 2020, NSF will continue to support ongoing awards made under the final INFEWS solicitation issued in March 2018. This funding will further INFEWS and NSF Strategic Plan objectives by continuing to build interdisciplinary and convergent research and innovation capabilities. Other activities contributing to INFEWS in FY 2020 will include ENG support for research related to the soil microbiome.