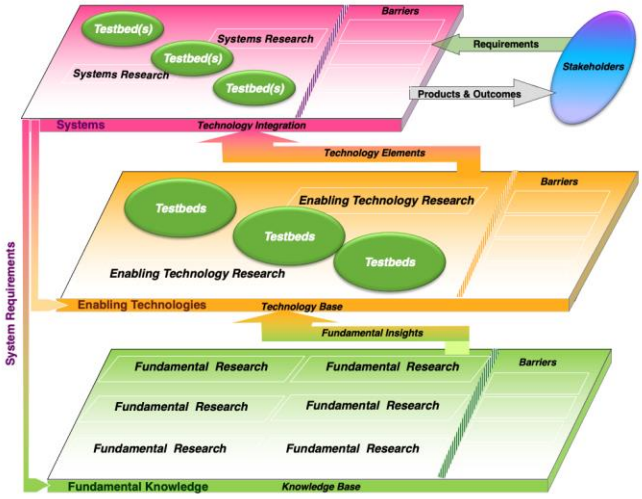
WHERE DISCOVERIES BEGIN

Engineering Research Centers

Linking Discovery to Innovation



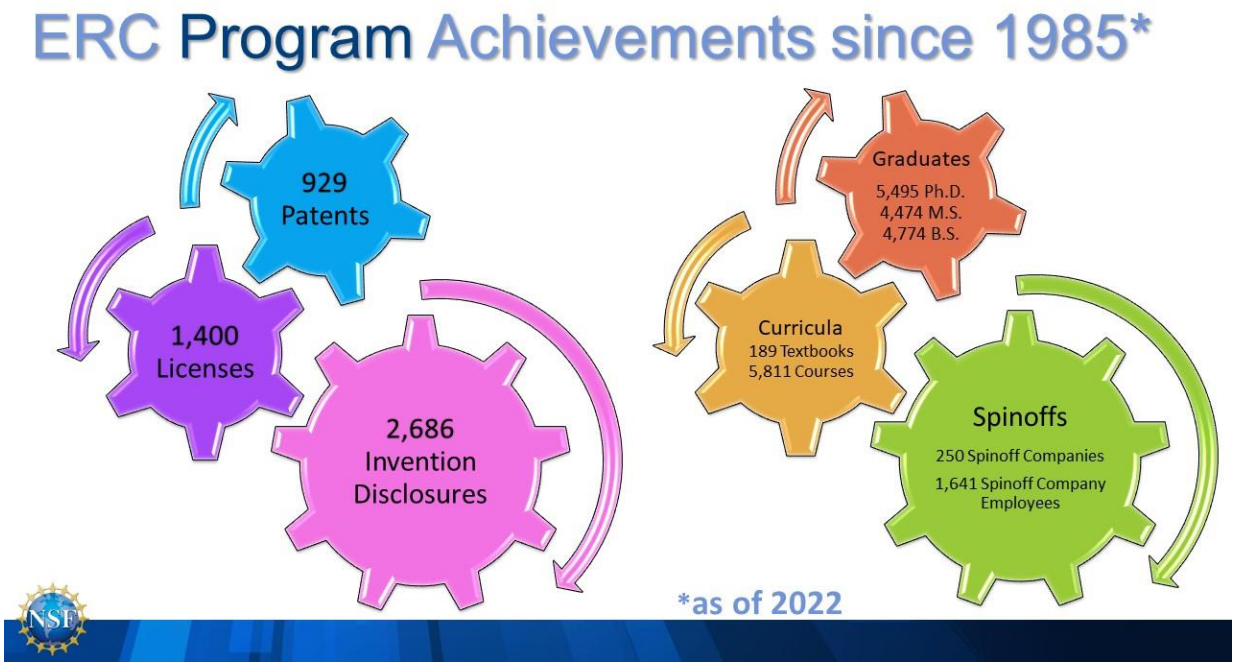
ERC

NSF's Engineering Research Centers: Linking Discovery to Innovation

Driving the discovery, dissemination, and deployment of transformational knowledge and technologies and a diverse new generation of graduates in service to industry and the Nation

The National Science Foundation's Engineering Research Centers (ERC) program has been called "among the brightest jewels in the crown of NSF."[1] Since the first ERCs were founded in 1985, these pioneering organizations have pushed the boundaries of knowledge across a broad spectrum of technology fields while transferring a continuous stream of cutting-edge technologies to their industrial partners. They have produced a wide range of engineered systems and other technologies aimed at spawning whole new industries or radically transforming the product lines, processes, and practices of current industries. At the same time, they have produced a new generation of engineering graduates who are highly innovative, diverse, globally engaged, and effective as technology leaders in industry.

The ERCs pursue research across almost the entire spectrum of technology fields, from advanced manufacturing to biotechnology and health care, to energy and infrastructure, to microelectronics and information technology. Working in concert with their industry partners, over the past three-plus decades their discoveries have led to such innovations as portable and implantable defibrillators, revolutionary new techniques in biotechnology including gene editing, the MPEG video encoding system, super-high-density data recording, satellite-based internet, 3D ultrasound, robotic surgery, reconfigurable manufacturing, new types of X-rays and lasers, a retinal prosthesis, holographic 3D video, and many more. A 2010 study of the impacts of ERC-generated technologies found that the economic value of products and processes deriving from the ERCs was already in the high tens of billions of dollars, with some centers having had a transformational impact on their field of engineering and technology.



Some of the many achievements of the ERC Program since 1985, as of 2022 are shown in this diagram.

On the cover: NSF History Mural, https://www.nsf.gov/about/history/history-wall.jsp

[1] Former NSF Director Arden L. Bement, Jr., in *Engineering Research Centers: 2005-2006 Program Report*, p. 3.

Note: The starting year for each ERC is shown in parentheses. The seven ERCs that graduated from the NSF ERC program support in 2022 are listed below.

RECENTLY GRADUATED ERCs GRADUATING in 2022

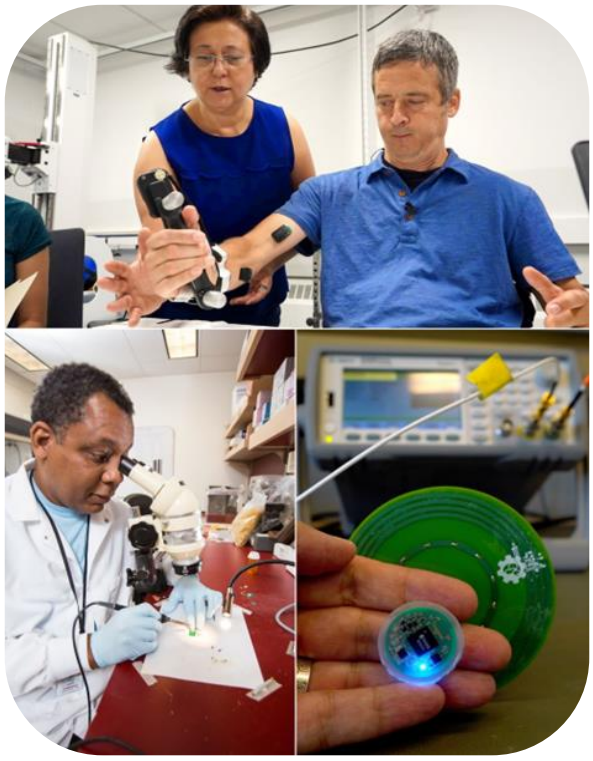
ASSIST: Advanced Self-Powered Systems of Integrated Sensors and Technologies (2012)

North Carolina State University, Florida International University, Penn State University, University of Michigan, University of North Carolina, University of Virginia. C2C: C RAM, CCRCB

Research focuses on creating self-powered sensing, computing, and communication systems to enable data-driven insights for a smart and healthy world developed for healthcare with fundamental advances in energy harvesting and low-power electronics, with a focus on usability.

https://assistcenter.org/

CURENT: Center for Ultra-wide Area Resilient Electric Energy Transmission Networks (2011)



CNT: NSF Engineering Research Center for Neurotechnology (2011)

University of Washington, San Diego State University, Massachusetts Institute of Technology

Developing innovative neural devices and methods for directing engineered neuroplasticity in the brain and spinal cord, which will improve sensory and motor function for people with spinal cord injury, stroke and other neurological disorders.

https://centerforneurotech.uw.edu/

University of Tennessee-Knoxville, Northeastern University, Rensselaer Polytechnic University, and Tuskegee University

Building a more reliable, secure transmission system that uses renewable energy sources. ***CURENT*** *is jointly funded by NSF and the Department of Energy.*

https://curent.utk.edu/

NASCENT: Nanomanufacturing Systems for Mobile Computing and Mobile Energy Technologies (2012)

University of Texas at Austin, University of California, Berkeley, and University of New Mexico

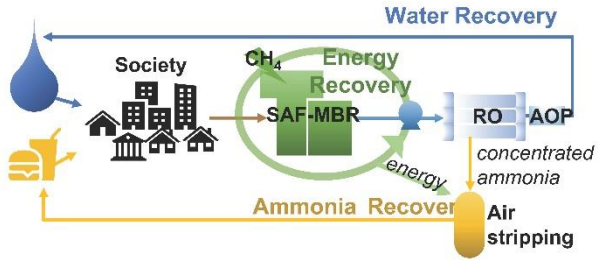
Developing high throughput, high yield, reliable, and versatile nanomanufacturing systems that will revolutionize future-generation mobile computing and energy devices.

www.nascent-erc.org/

QESST: Quantum Energy and Sustainable Solar Technologies (2011)

Arizona State University, Massachusetts Institute of Technology, University of New Mexico, University of Delaware, and California Institute of Technology. C2C: I-Form

Addressing the Terawatt Challenge by developing the photovoltaic ecosystem—the technology, innovation infrastructure, and education resources surrounding photovoltaics. The goal is to develop technologies and approaches that provide a path of continuous, cumulative improvements, providing both short-term relevance as well as a path to exceed the presently accepted commercial efficiency and cost targets. *https://qesst.org/*

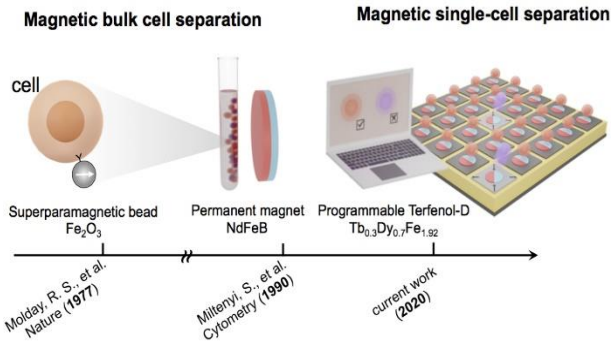


ReNUWIt: Re-Inventing America's Urban Water Infrastructure (2011)

Stanford University, New Mexico State University, University of California-Berkeley, Colorado School of Mines

Focusing on safe and sustainable urban water infrastructures enabled by technological advances in natural and engineered systems and informed by a deeper understanding of institutional frameworks.

https://renuwit.org/



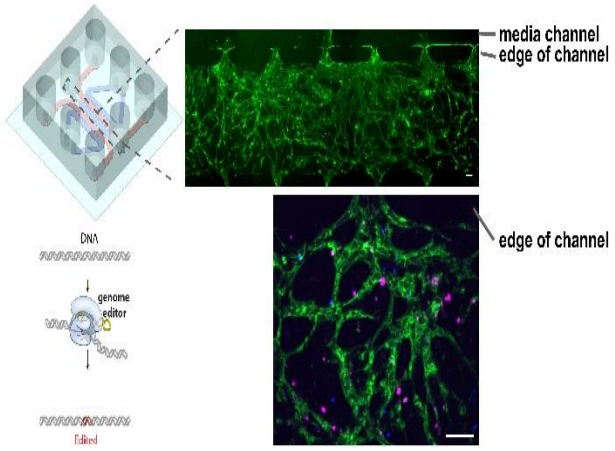
TANMS: Translational Applications of Nanoscale Multiferroic Systems (2012)

University of California-Los Angeles, California State University-Northridge, Cornell University, Northeastern University, UC-Berkeley, University of Texas-Dallas. C2C: AMBER, CNM

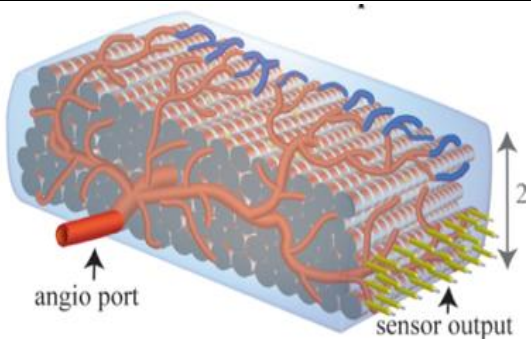
Research, technology translation, and education focused on magnetism on the small scale, using a new nanoscale multiferroic approach that couples electricity to magnetism using engineered nanoscale multiferroic elements to enable increased energy efficiency, reduced physical size, and increased power output in consumer electronics.

www.tanms-erc.org/

ONGOING ERCs

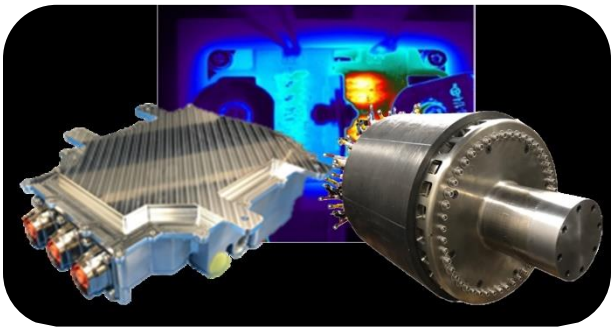


CMaT: ERC for Cell Manufacturing Technologies (2017)
Georgia Tech, University of Georgia, University of Puerto Rico -Mayagüez, University of Wisconsin-Madison. C2C: CURAM, WWIEM
Transforming the manufacture of cell-based therapeutics into a large-scale, lower-cost, reproducible, and high-quality engineered process, for broad industry and clinical use.
https://cellmanufacturingusa.org/

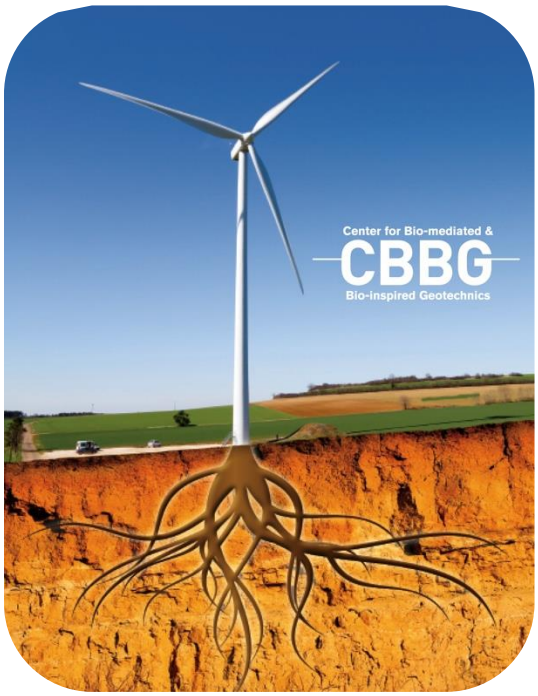


CELL-MET: Nanosystems ERC for Cellular Metamaterials (2017)
Boston University, Florida International University, University of Michigan. C2C: CURAM, WWIEM
Developing a centimeter-scale cardiac patch that includes functional vasculature and can be perfused in culture to maintain stable function.
https://www.bu.edu/cell-met/

PATHS-UP: ERC for Precise Advanced Technologies and Health Systems for Underserved Populations (2017)
Texas A&M University, Rice University, Florida International University, University of California-Los Angeles. C2C: SFNC, ISR
Changing the paradigm for the health of underserved populations by developing revolutionary and cost-effective technologies and systems at the point-of-care. https://pathsup.org/

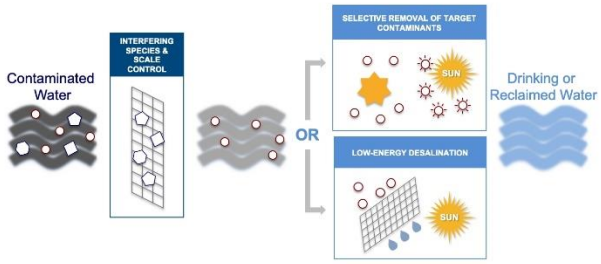


POETS: ERC for Power Optimization for Electro-Thermal Systems (2015)
University of Illinois at Urbana-Champaign, Howard University, Stanford University, University of Arkansas. C2C: RCGI
Aiming to enhance or increase the overall power density available in tightly constrained mobile environments by changing the approach to their design and operation. https://poets-erc.org/



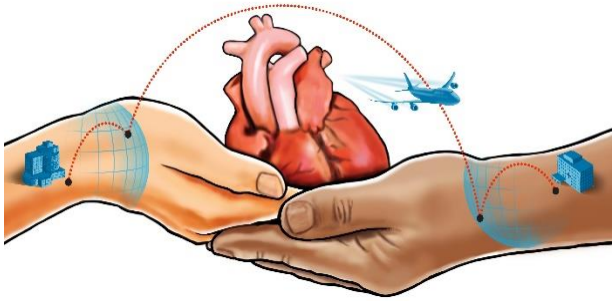
CBBG: ERC for Bio-mediated and Bio-inspired Geotechnics (2015)
Arizona State University, Georgia Tech, New Mexico State University, University of California-Davis.
C2C: iCRAG, EEM
Applying biogeotechnical techniques to create sustainable, resilient, and environmentally compatible solutions for construction, repair, and rehabilitation of civil infrastructure systems, including transportation systems, commercial, institutional, and industrial development, residential development, and resource recovery systems. CBBG also provides bio-mediated and bio-inspired solutions for remediation of soil and groundwater and for ecological restoration of degraded landscapes.
https://cbbg.engineering.asu.edu/

CISTAR: ERC for Innovative and Strategic Transformation of Alkane Resources (2017)
Purdue University, Northwestern University, University of Notre Dame, University of New Mexico, University of Texas-Austin. C2C: CINE, RCGI
The overarching goal for the Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR) is to provide a highly-trained, diverse and inclusive workforce needed to responsibly realize the potential of shale resources as well as to provide the technological innovation to create transformative engineered systems to convert light hydrocarbons into lower carbon footprint chemicals and transportation fuels, through the exploration of decarbonization of manufacturing processes, modular design, and electrification based on renewable energy sources.
https://cistar.us/



NEWT: Nanosystems ERC for Nanotechnology Enabled Water Treatment Systems (2015)
Rice University, Arizona State University, University of Texas-El Paso, Yale University
Solving fit-for-purpose water treatment needs by applying nanoscale science and engineering to protect human lives and support sustainable economic development with our technology.
https://newtcenter.org

Gen-4 ERCs

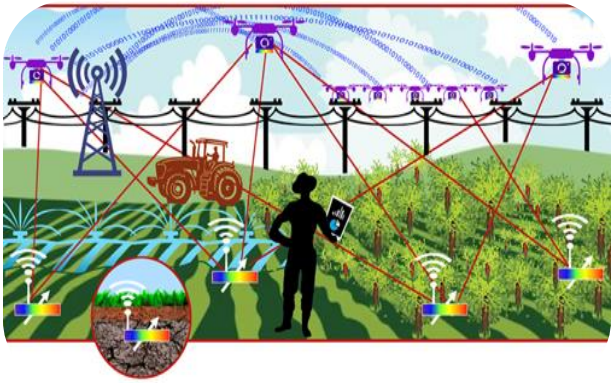


ATP-Bio: ERC for Advanced Technologies for Preservation of Biological Systems (2020)
University of Minnesota, University of California-Berkeley, University of California-Riverside, Center for Engineering in Medicine and Surgery at Massachusetts General Hospital

Aiming to "stop biological time" and radically extend the ability to bank and transport cells, aquatic embryos, tissue, skin, whole organs, microphysiological systems ("organs-on-a-chip"), and even whole organisms through a team approach to build advanced biopreservation technologies. *https://www.atp-bio.org/*

ASPIRE: Advancing Sustainability through Powered Infrastructure for Roadway Electrification (2020)
Utah State University, Purdue University, University of Colorado-Boulder, University of Texas-El Paso, University of Auckland-New Zealand

Eliminating range and charging as barriers to electric vehicle use via seamless integration of wireless and wired charging systems across all vehicle classes with power levels to achieve ubiquity. *https://aspire.usu.edu/*



IoT4Ag: ERC for the Internet of Things for Precision Agriculture (2020)
University of Pennsylvania, University of Florida, Purdue University, University of California-Merced

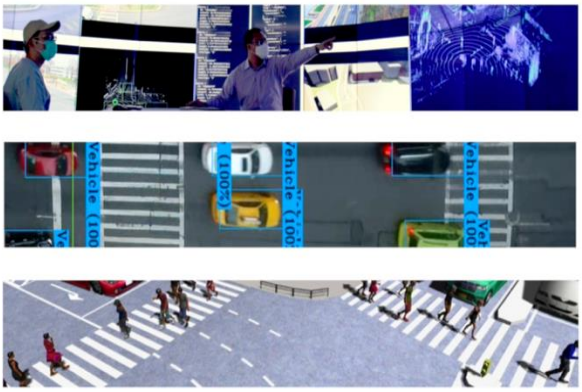
Creating and translating to practice Internet of Things (IoT) technologies for precision agriculture and aiming to train and educate a diverse workforce that will address the societal grand challenge of food, energy, and water. *https://iot4ag.us/*

CQN: ERC for Quantum Networks (2020)
University of Arizona, Harvard University, MIT, and Yale University
Developing the first quantum network in the USA enabling the foundation for a socially responsible quantum internet which will spur new technology industries and a competitive marketplace of quantum service providers and application developers for the benefit of all.
https://cqn-erc.org/

CASFER: Center for Advancing Sustainable and Distributed Fertilizer Production (2022)
Texas Tech University, Case Western Reserve University, Florida A&M University, Georgia Tech and Massachusetts Institute of Technology.
This ERC will enable resilient and sustainable food production by developing next-generation modular, distributed, and efficient technology for capturing, recycling and producing decarbonized nitrogen-based fertilizers.
https://www.casfer.us/

HAMMER: Hybrid Autonomous Manufacturing Moving from Evolution to Revolution (2022)
The Ohio State University (lead), Case Western Reserve University, North Carolina Agricultural and Technical State University, Northwestern University and the University of Tennessee, Knoxville.
This ERC will accelerate the development and deployment of intelligent, autonomous manufacturing systems, enabling mass customization in local production facilities.
https://hammer.osu.edu/

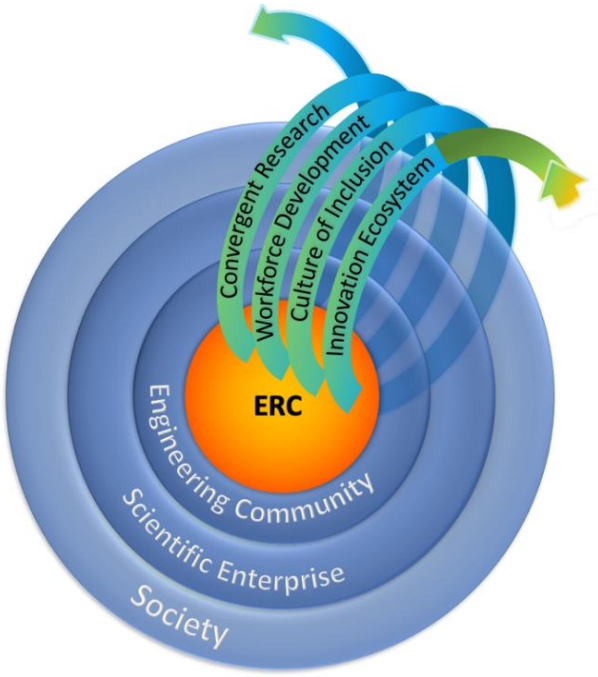
PreMiEr: Precision Microbiome Engineering (2022)
Duke University (lead), North Carolina Agricultural and Technical State University, North Carolina State University, the University of North Carolina at Chapel Hill, and the University of North Carolina at Charlotte.
This ERC will create microbiome technologies that address challenges at the interface of human health and the built environment, promoting the proliferation of beneficial microorganisms and preventing colonization by infectious agents.
https://premier-microbiome.org/



CS3: Center for Smart Streetscapes (2022)
Columbia University (lead), Florida Atlantic University, Lehman College, Rutgers University, and the University of Central Florida.
This ERC will forge livable, safe, and inclusive communities through real-time, hyperlocal technologies for streets and their surroundings.
https://cs3-erc.org/

THE ERC MODEL

NSF funds each ERC for up to 10 years. Since 1985, a total of 76 ERCs have been formed across the United States, with 15 ERCs currently in operation. Surveys of industry employers have shown that ERC graduates are viewed by 80% of their supervisors as being more productive than their peers because their ERC experience has taught them how to integrate knowledge across disciplines and manage teams to advance technology. The goal of today's ERCs is to create a culture that actively stimulates technological innovation through partnerships with all relevant stakeholders that bring collaborative, team-based *convergent* research to bear on addressing important societal needs. Given this evolving and outward-looking program, current and future ERCs are continuing to advance transformational engineered systems and to produce graduates who will be creative innovators in the global economy.



To achieve this goal, NSF's ERCs have the following four "Foundational Components":

- **Convergent Research (CR)** that has the strong potential to lead to transformative solutions or new fields of study.
- **Engineering Workforce Development (EWD)** that strengthens a robust spectrum of engineering education occurring at all levels of the Center and that provides opportunities for engagement by all ERC members including students, faculty, and external partners.
- **Diversity and a Culture of Inclusion (DCI)** within an ERC and its various teams that reflects an environment in which all members, including those from groups traditionally underrepresented in engineering, feel valued and welcomed.
- An **Innovation Ecosystem (IE)** that involves trusted partners (not only industries, but also other stakeholders) who work together to create and enhance the capacity for innovation by finding new ways to deliver value with positive societal impact. This includes implementing effective translational efforts from ideation to implementation, workforce development in support of the enterprise, and targeted efforts to attract funding and resources.

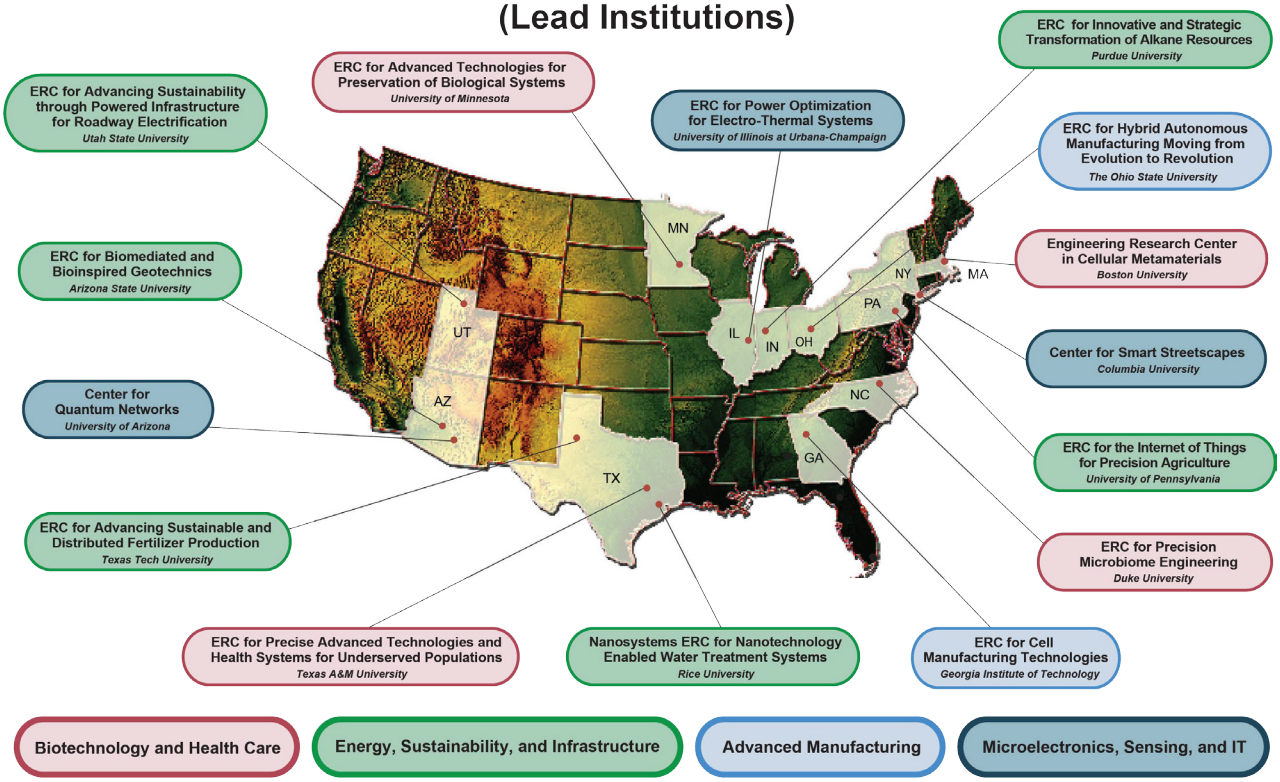
Each ERC is established as a 3-way partnership involving academe, industry, and NSF (in some cases with the participation of state, local, and/or other Federal government agencies). Total funding provided directly to each center by the ERC Program can be up to $60 million over up to 10 years.

In many ways the ERC program has redefined the concept of an academic research center, serving as a model for the development of other Centers programs in the U.S. and around the world. This history is described in the book, *Agents of Change: NSF's Engineering Research Centers* <https://erc-history.erc-assoc.org/>.

As the Director of NSF and the Assistant Director for Engineering noted in a recent report, "Today, NSF's ERC Program is stronger than ever, a testament to the power of NSF's commitment to strategic investments in the nation's science and engineering enterprise and workforce. In a world of ever-accelerating change, the ERC Program continues to be a key component of how we meet today's challenges and build a brighter tomorrow."[2]

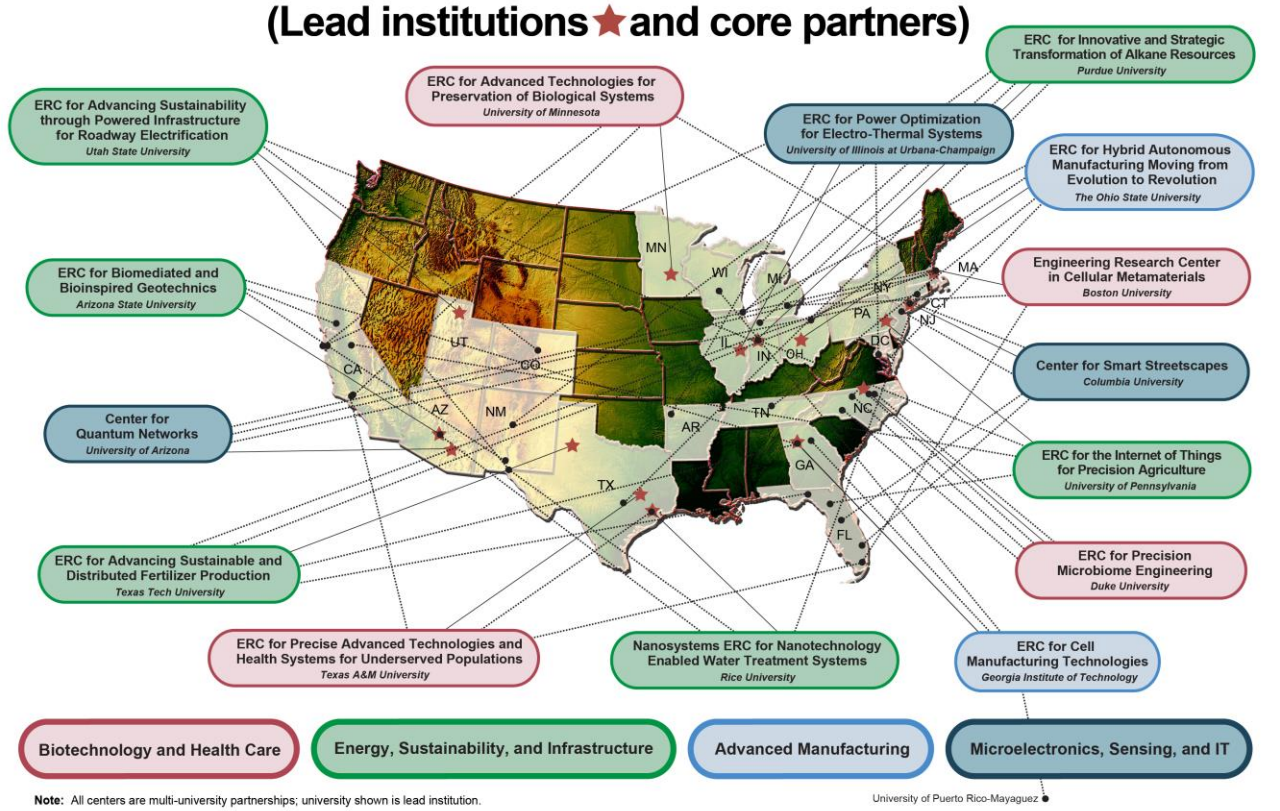
[2] NSF, 2022. *FY 2020 Engineering Research Centers Program Report*.

NSF's FY 2023 Engineering Research Centers (Lead Institutions)



Note: All centers are multi-university partnerships; university shown is lead institution.

NSF's FY 2023 Engineering Research Centers (Lead institutions ★ and core partners)



Note: All centers are multi-university partnerships; university shown is lead institution.

University of Puerto Rico-Mayaguez ●

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Below are the links to previous ERC Planning Grant workshops:

https://ercbiennial.asee.org/2018-pgw/program/
https://ercbiennial.asee.org/planning-workshop/2019-program/
https://ercbiennial.asee.org/planning-workshop/2021-program/

Engineering Education and Centers Division, Directorate for Engineering, National Science Foundation
http://www.nsf.gov/div/index.jsp?div=EEC
ERC Association: http://www.erc-assoc.org
Email: **NSFERC@nsf.gov**