Innovation and NSF: Perspectives on ERC Innovation Ecosystems

Breakout #1: ERC Biennial Meeting (ILOs and SPIs)

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Directorate of Engineering (ENG)

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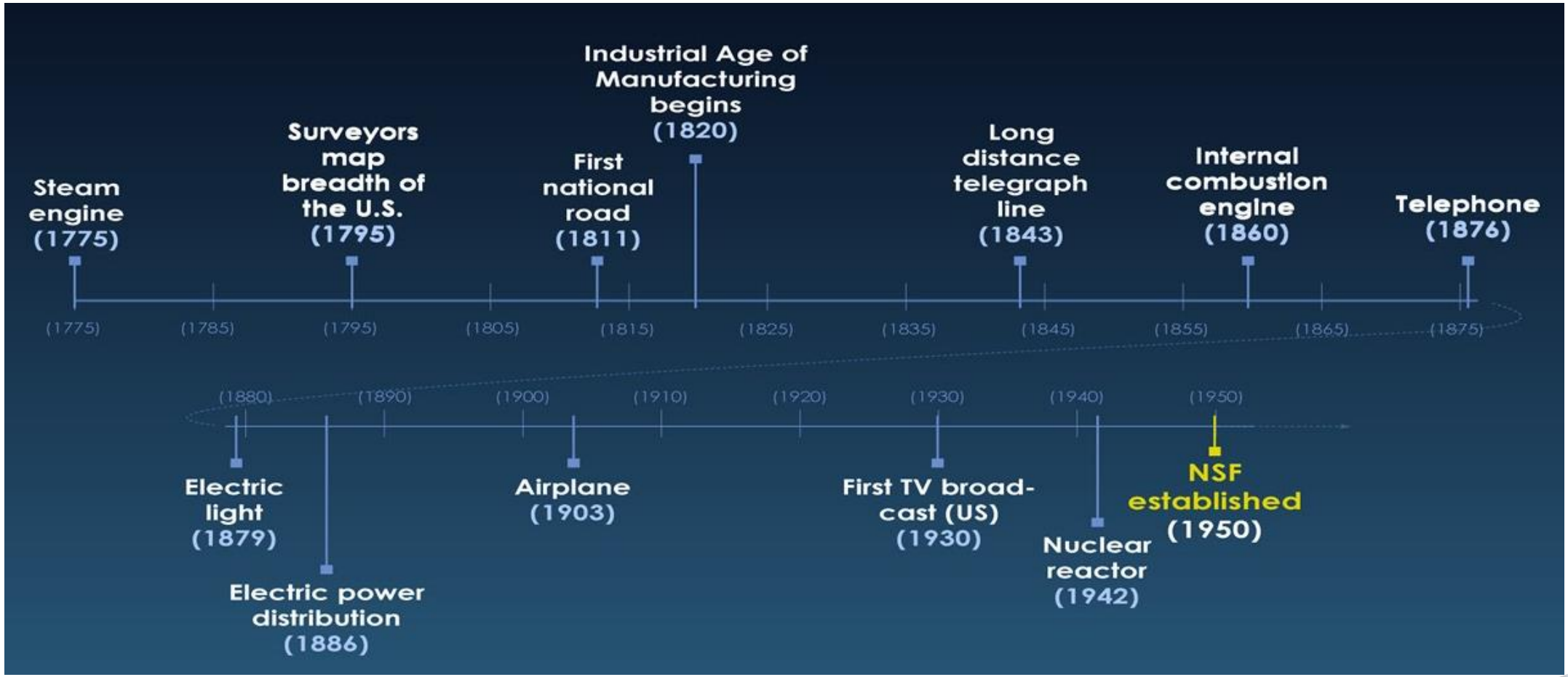
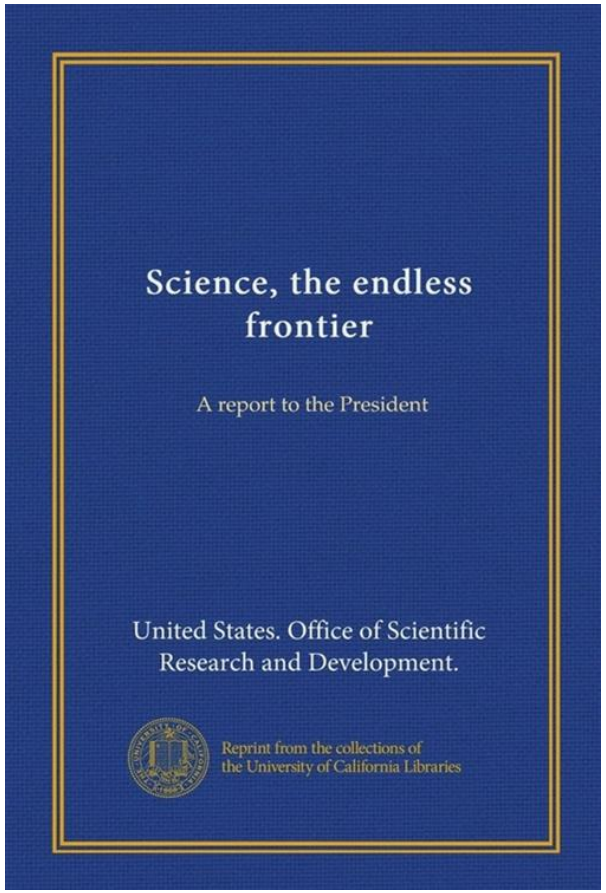
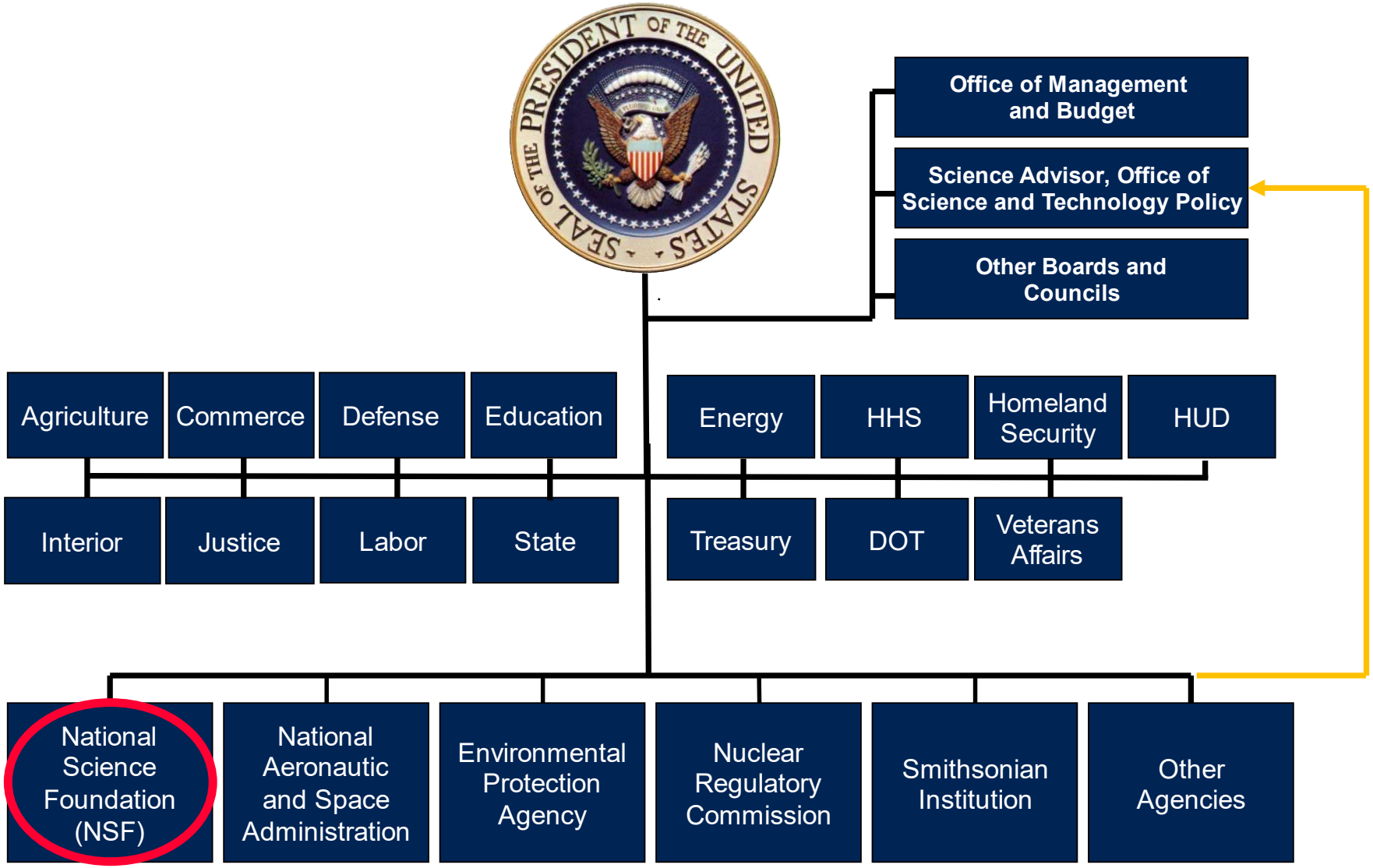
Milestones in US Engineering — Achievements

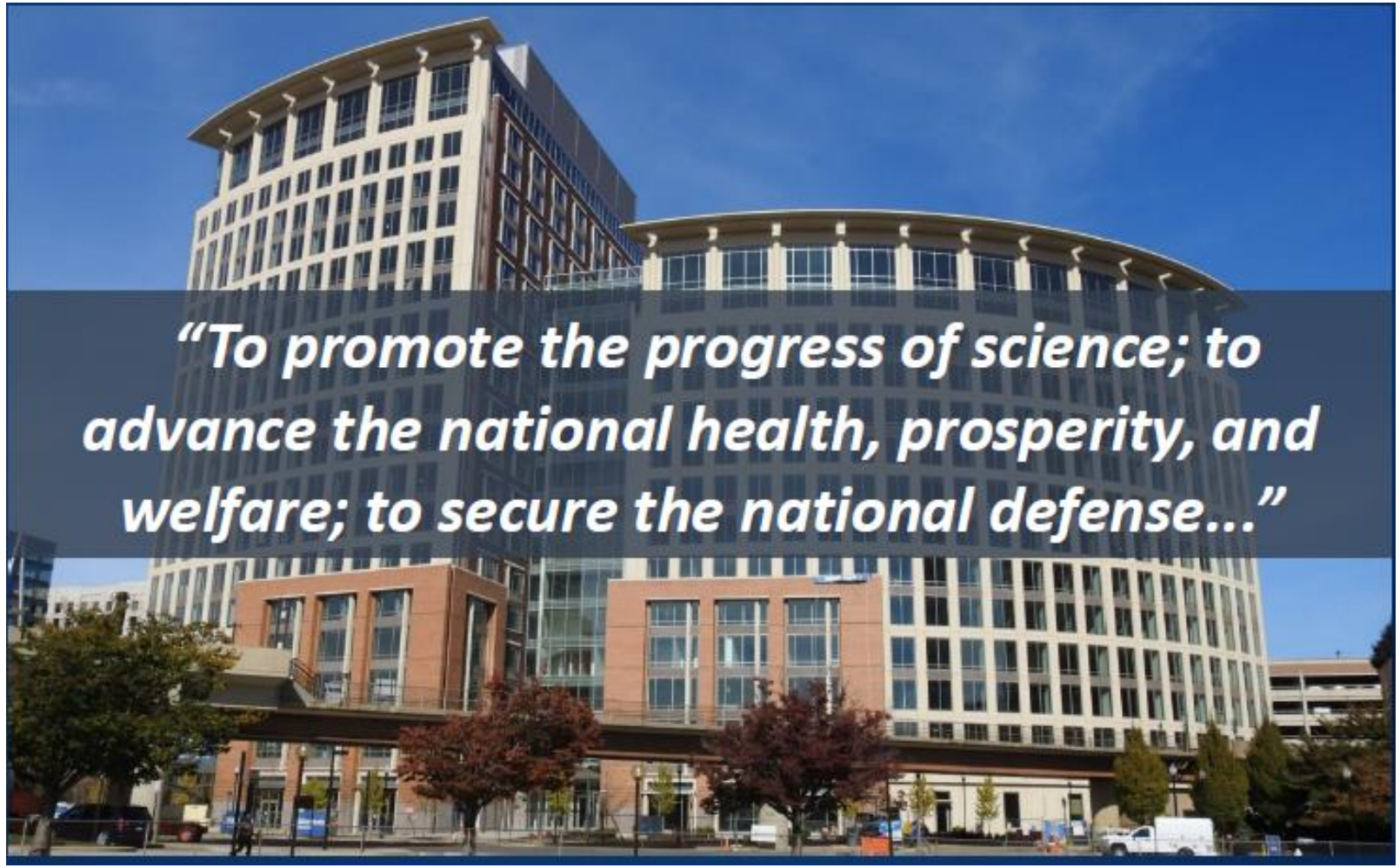




Science offers a largely unexplored hinterland for the pioneer who has the tools for his task. The rewards of such exploration both for the Nation and the individual are great. Scientific progress is one essential key to our security as a nation, to our better health, to more jobs, to a higher standard of living, and to our cultural progress.


Office of Management and Budget
Science Advisor, Office of Science and Technology Policy
Other Boards and Councils
Agriculture
Commerce
Defense
Education
Energy
HHS
Homeland Security
HUD
Interior
Justice
Labor
State
Treasury
DOT
Veterans Affairs
National Science Foundation (NSF)
National Aeronautic and Space Administration
Environmental Protection Agency
Nuclear Regulatory Commission
Smithsonian Institution
Other Agencies

National Science Foundation Mission



NSF's Eight Research Directorates

TECHNOLOGY, INNOVATION AND PARTNERSHIPS (TIP)

NSF Engineering

MISSION

To transform our world for a better tomorrow by driving discovery, inspiring innovation, enriching education, and accelerating access

VISION

NSF Engineering will be a global leader in identifying and catalyzing fundamental engineering research, innovation, and education.

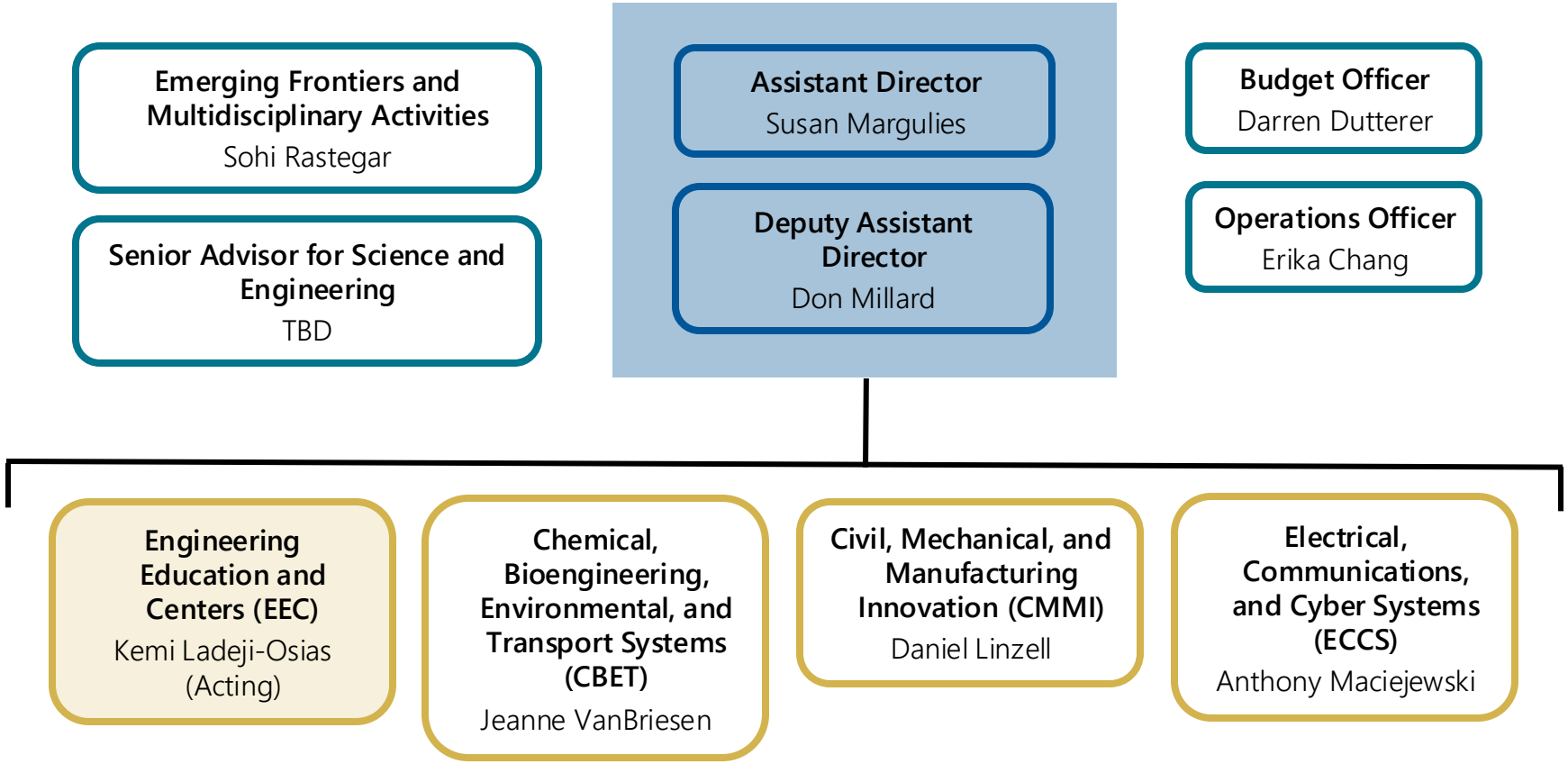
GOALS

Propel
U.S. leadership in transformational engineering approaches to problems with societal impact

Expand
opportunities for people

Catalyze
purposeful partnerships

NSF Directorate for Engineering



Division of Engineering Education and Centers (EEC)

We invest in the creation of 21st century engineers and discovery of technologies through transformational center-based research, as well as research in education, workforce development and broadening participation in engineering.

For more info about EEC, visit:
https://www.nsf.gov/eng/eec/about.jsp

Centers & Networks (Centers)

- Discover and launch ubiquitous future technologies (ERC)
- Prepare next generation innovation leaders (ERC & IUCRC)
- Basic research of shared interest to academia and industry (IUCRC)

Engineering Education (Eng. Ed.)

- Fundamental research in the formation of engineers (RFE, RIEF)
- Translation of fundamental research into practice (RED)

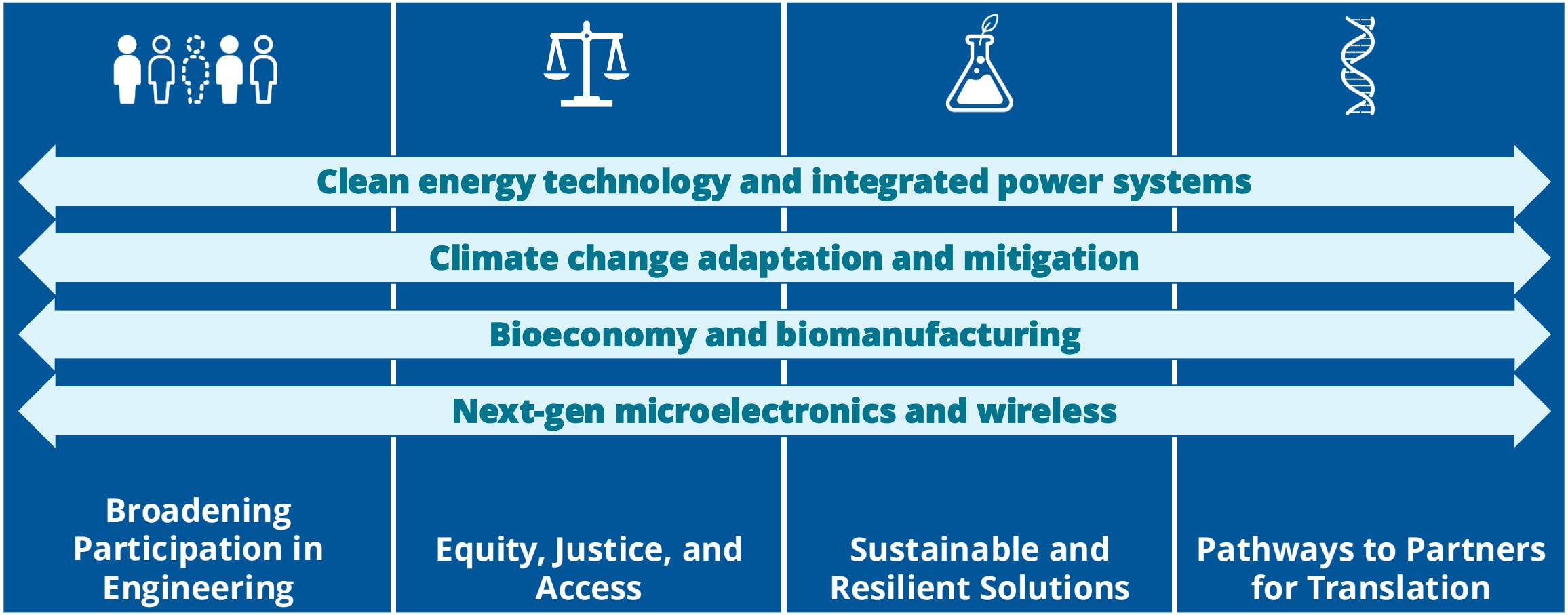
Workforce Development (WD)

- Builds human capital through research experiences - undergraduates (REU), teachers (RET), veterans (REV)
- Teach Eng., E4USA, REU/RET mega site, INTERN

Broadening Participation in Eng. (BPE)

- Improve preparation, increase participation, and ensure contributions of underrepresented groups in engineering
- NSF INCLUDES

Investing in Cross-ENG Strategic Priorities (FY24)



Coordinate — Collaborate — Co-fund

ENG Topics of Special Interest (FY24)

Advanced Manufacturing
NSF 24-043

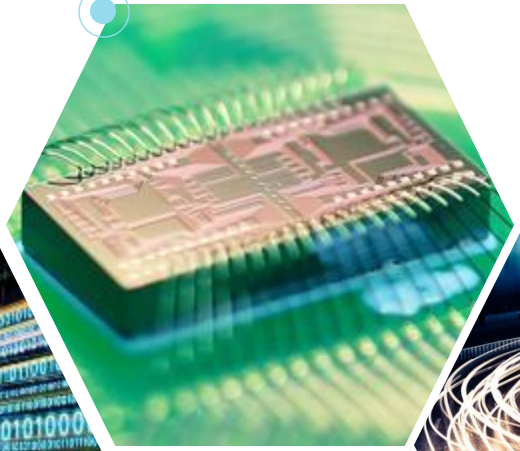
Advanced Wireless
NSF 24-041

Artificial Intelligence
NSF 24-039

Biotechnology
NSF 24-040

Quantum Information Technology
NSF 24-042

Semiconductors and Microelectronics
NSF 24-038

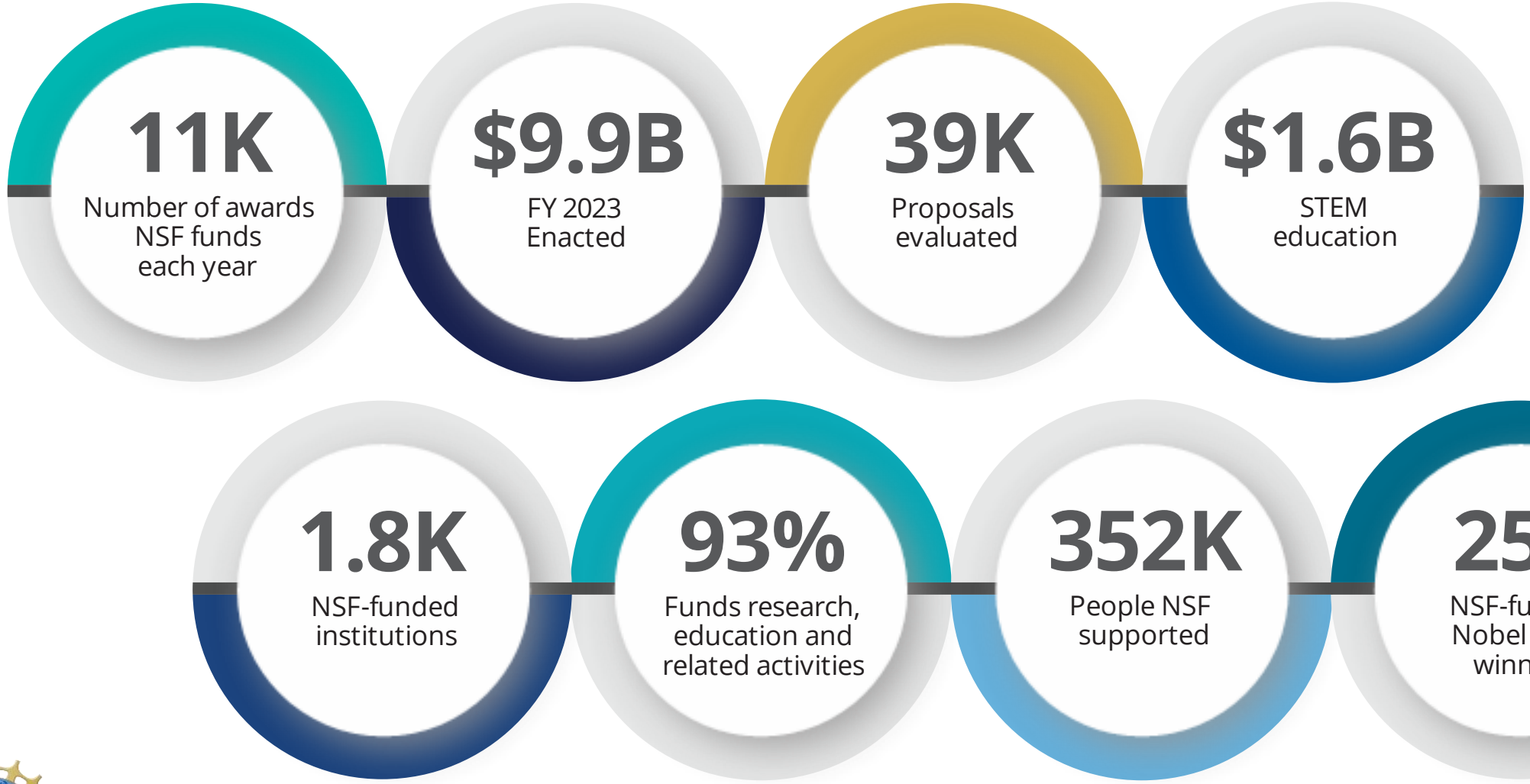


Net-Zero Climate Goals
NSF 24-045

OSTP and OMB R&D Priorities for FY 2025

- Advance trustworthy artificial intelligence (AI)
- Lead the world in maintaining global security and stability
- Tackling the climate crisis
- Achieve better health outcomes for every person
- Reduce barriers and inequities
- Bolster the R&D and industrial innovation
- Strengthen, advance, and use America's unparalleled research to achieve our Nation's great aspirations

NSF by the Numbers (FY23)



ENG by the Numbers: FY 2023

$793M
research budget

152
ENG staff

6,009
proposals

444
panels

25% competitive award funding rate

1,506
competitive awards

22,644
people

312
institutions

8,962
senior researchers

653
other professionals

377
postdoctoral associates

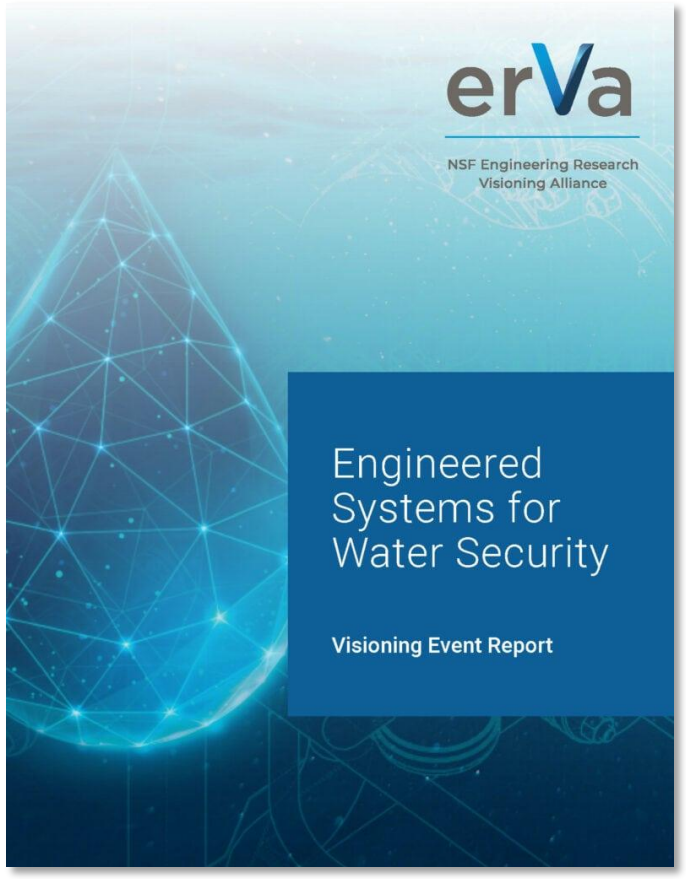
7,736
graduate students

4,916
undergraduate students

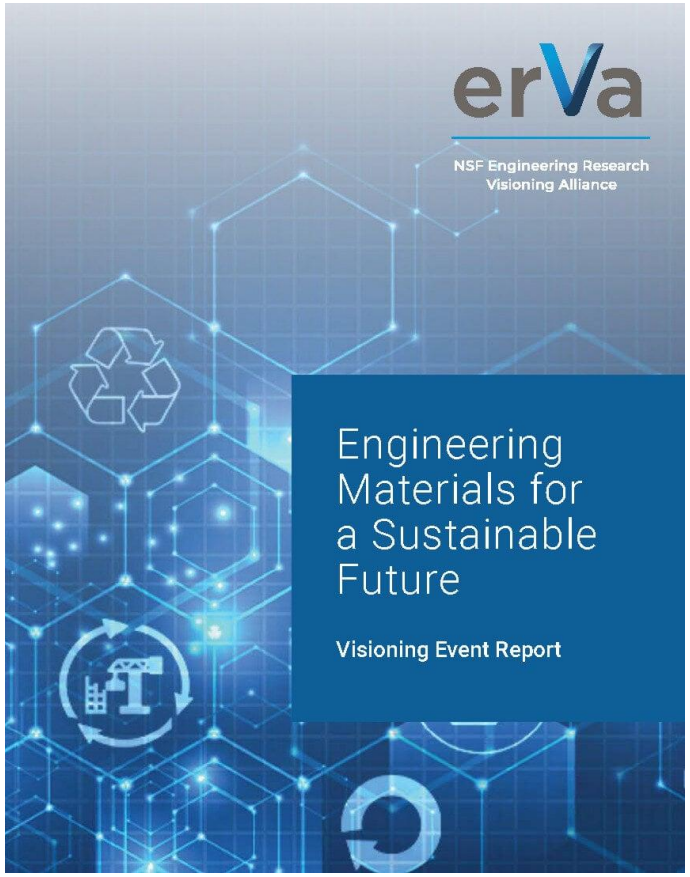
Current ENG Partnerships

BIO, CISE, EDU, GEO,
MPS, SBE, TIP, OIA, OISE

Engineering Research Visioning Alliance



July 2023



February 2024

May 2024

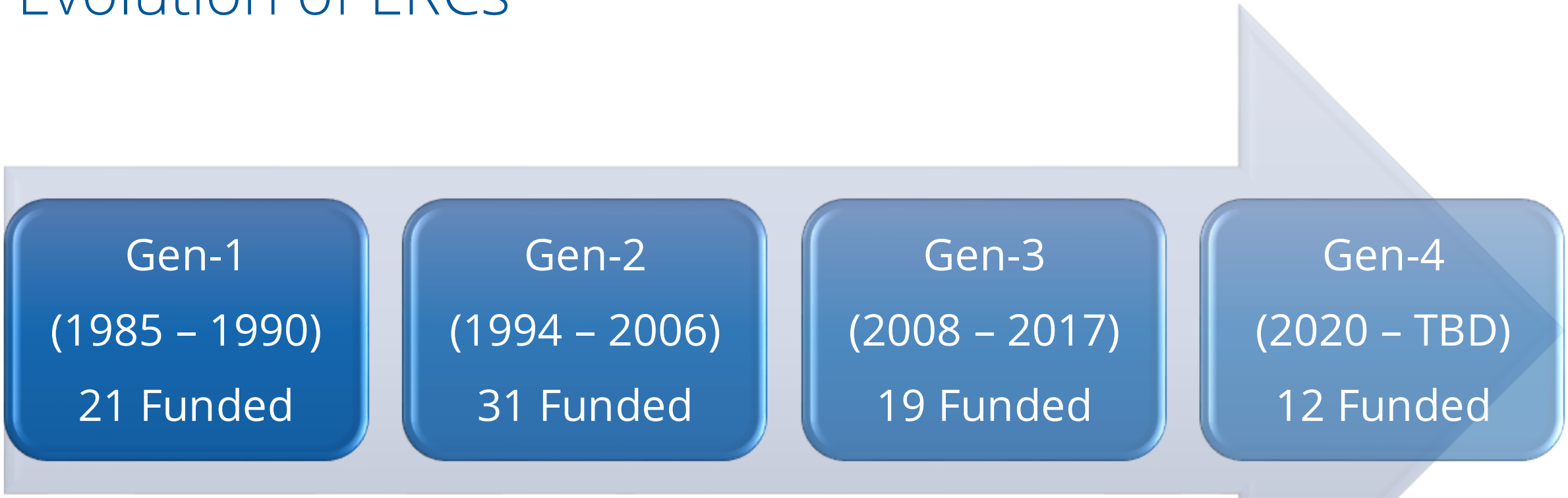
Recent workshops: Women's Health (June 5-6) & **Next-Generation Wireless** (June 13-14)

www.ervacommunity.org

NSF Centers (FY23)

- Ten or more
  - AI Research Institutes (20)
  - Biology Integration Institutes (14)
  - Engineering Research Centers (17)
  - Materials Research Science and Engineering Centers (20)
  - Science and Technology Centers (14)
  - NSF Regional Innovation Engines (10), FY24
- Between 5 and 10
  - Centers for Chemical Innovation (9)
  - Quantum Leap Challenge Institutes (5)
- Fewer than 5
  - Centers for Analysis and Synthesis (2)
  - Spectrum Innovation Initiative Centers (1)

Evolution of ERCs



US Competitiveness, engineering systems, Industry collabs, integrating all students in research

Complex engineered system, discovery to testbeds, strategic plan with industry, academia & partners commit to sustainability, SWOT analysis, phase down of funding

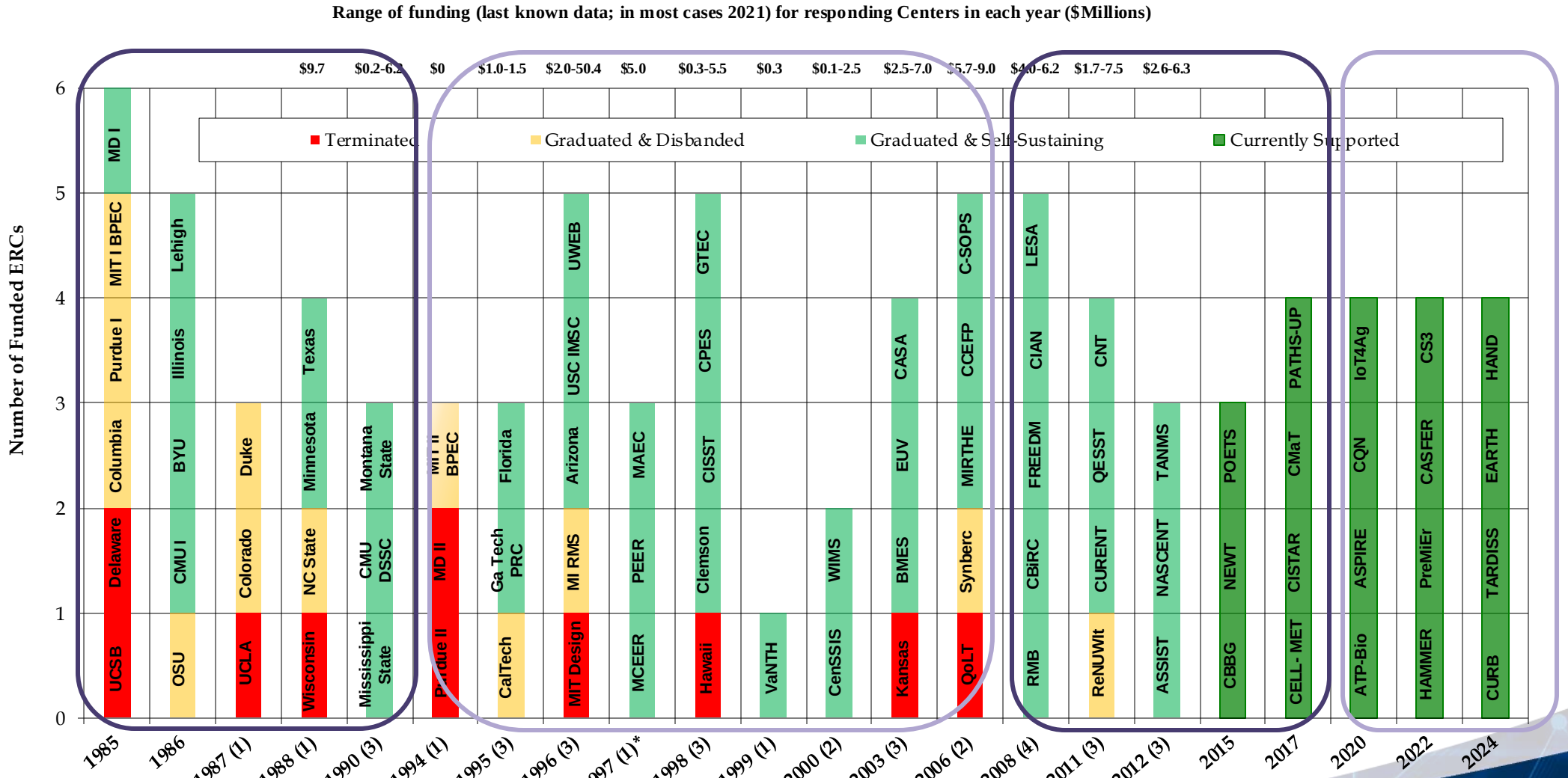
Tech transfer → culture of innovation, speed technology translation – include small biz in research, global, partnerships with Federal/State/Local government

Cross-disciplinary/sector partnerships, high-risk high-payoff ideas, societal impact, convergent approaches, engaging stakeholder communities, team science

Source: ERC History Book and ERC Associates website

Status of ERCs: 1985-2024

Currently Self-Sustaining: 42 out of 54 Graduated ERCs=78%



Three Earthquake Engineering Research Centers were funded in 1997 with funds outside of the ERC Program but were managed by the ERC Program from 1999 through their graduation from NSF support.

NSF made a change with Gen-4s to help reinforce stakeholders – what drove that decision?

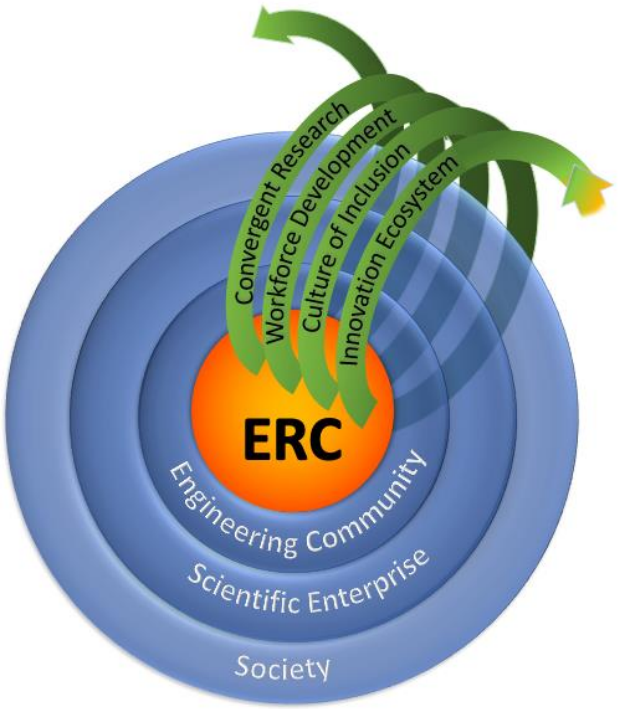
- Strategic planning for technology development is currently based around the “3-plane diagram…”. Ideally, the ERCs form productive relationships with university and industry partners such that after their 10-year NSF funding life, they “graduate” into independently funded “ERC-like” entities whose stakeholders will translate the ERC work product into useful new products and other innovations. The convergent engineering research center (CERC) model described in this report emphasizes the need for much greater collaboration between the levels and with stakeholders at all levels.

Report Recommendations

- 4-2: Future convergent engineering research centers should be encouraged to produce broadly accessible engineering prototypes, tools, data repositories, platforms, and enabling technologies that foster broad scientific, engineering, and manufacturing innovation. Such work products might form useful interim deliverables from large-scale projects.
- 4-3: The National Science Foundation should develop metrics that track the impacts of center activities, not just the outputs. Examples might include the placement of graduated students in positions of influence or evidence that intellectual value developed in the center is widely used.
- 6-3: Metrics should be minimal, essential, and aligned with center milestones and processes and should be defined in a center's strategic plan. The convergent engineering research centers should use state-of-the-art web-based collaboration platforms, such as performance dashboards, to amplify team collaboration and simplify reporting requirements.
- 6-4: Early in the life of a convergent engineering research center (CERC), performance metrics should be based on adherence to team-research and value-creation best practices. Later in the CERC's National Science Foundation funding life, metrics should be based on the CERC's impact on the economic, security, or societal domains as laid out in its strategic plan.

How does NSF view the ERCs' IE?

- NSF 24-576: Each ERC has interacting foundational components that go beyond the research project, including engineering workforce development (EWD) at all participant stages, where all participants gain mutual benefit, and value creation within an innovation ecosystem (IE) that will outlast the lifetime of the ERC.
- The Gen 4 Innovation Ecosystem is a community of like-minded stakeholders taking advantage of world-class resources proven to deliver results for individuals, teams and organizations, irrespective of geography, industry or company size.



Stakeholders - faculty, students, industry partners, state and local governments, regulatory agencies, anyone impacted by proposed technology, etc.

Expectations: ERC Innovation Ecosystem

- Form strategic partnerships with core industrial/practitioner stakeholders
- Speed the translation of research into new processes and products as guided by the logic model
- Engage all stakeholders
- Follow best practices to optimize utilization of ERC's knowledge/ technology advances
- Foster entrepreneurial culture by engaging ERC students in all phases of the innovation process

Strategic Partner and Innovation (SPI) Director

- Create the strategic plan for nurturing the ERC's innovation ecosystem, in concert with the Center Director. Under that umbrella, the SPI Director defines the organization, reporting structure, and processes needed to complete the following three functions:
  a) Manage industry partner relations
  b) Nurture innovation ecosystem
  c) Engage stakeholders
- SPI Director is on the ERC Leadership team
- Define for each functional group: How often the group meets, Do they provide SWOT analysis
- Provide input to strategic planning and project selection/evaluation

Gen-4 Innovation Ecosystem

Industry Management

- Set vision and strategic plan for industry
- Market ERC to industry across the IAB value chain
- Develops and finalizes cross-university membership agreement and IP policy
- Finalizes Industry partner membership agreement and seals the deal to collect fees
- Develops ERC technology sector value chain

Innovation

- Manages the translational research process
- Develops partnerships with state and local government agencies and VCs to accelerate innovation
- Integrates innovation ecosystem program with ERC's education program and strategic vision for diversity and a culture of inclusion

Gen-4 Innovation Ecosystem

Stakeholder engagement

- Engaging advocacy groups;
- Forming innovation partnerships
- Seeking membership partners who facilitate tech diffusion
- Bringing on individual consultants
- Creating associate membership category
- Formalization mechanisms
  - How often do they interact with the ERC Team?
  - What is the nature of the interaction?
  - Do/should they generate a SWOT?
  - Do/should they generate a report?

Suggested Process for Identifying Relevant Entities

A. What entities impact available funding?
   - Commercial funding
   - Government funding
   - Institutional, NGOs and charities

B. What entities or groups comprise the end-user community?

C. What entities or groups are impacted by the technology?
   - Is it a net positive impact
   - Is it a net negative impact

D. What entities provide the governing frameworks that define the interactions among A, B, and C above?
   - Policy, Regulatory agencies, Laws reflecting social desires, Tax incentives, Established customs, Etc.

Evolution of the ERCs' IE?

- Proposal Stage
  - How well does the proposal describe a plan to build a network of trusted partners for innovation capacity?
  - How appropriate is the proposed structure and processes for value creation to move from ideation to implementation?
- Site Visit
  - How well does the proposal describe a plan to build a network of trusted partners for innovation capacity?
  - Comment on the proposed structure and processes for value creation to move from ideation to implementation.
  - How well does the proposal plan for innovation infrastructure including input from stakeholders at the appropriate levels?
  - Is there an appropriate strategy for engaging all relevant stakeholders? Why or why not?

	High-Quality Innovation Ecosystem (Years 1-5)	Low-Quality Innovation Ecosystem
Innovation Ecosystem	The IE Construct is forming with member firms/practitioners, role for translational research, and involvement of other partners devoted to innovation and entrepreneurship	No understanding of an innovation ecosystem, ERC has only a traditional industrial membership construct
Pathways to Innovation	Plans in place for fostering the creation of societal value from innovation that benefit society in a sustainable fashion; effective engagement of stakeholder groups across value chain	Limited plans for technological or social innovation aligned with ERC vision
Membership	Growing or stable group of members across sectors and throughout the value chain appropriate for systems vision; key players have joined by the third year or are in the process of joining	Membership promise of proposal not fulfilled, many of those committed or promising to commit did not sign up, significant numbers of firms/agency are leaving, and /or major firms across the value chain are missing
Partnerships	Partnerships across stakeholder groups are beginning to achieve integration across Center activities	Partners only on a project-by-project basis, no collective, collaborative partnership
Entrepreneurship	State or local government, or other innovation/entrepreneurship partners effectively engaged to help speed the innovation process	Little or no engagement with innovation partners; neither they nor the ERC understand their role
Membership Fees	Provide discretionary funds, and commensurate with typical investments in academic R&D for the sectors represented by the firms involved; sound basis for self-sufficiency	Low
Translational Research	Translational research is underway with small member or non-member firms if member firms do not license the ERC's IP, sound conflict of interest policy	Partnerships with small firms in translational research dropped or not well understood
Technology Transfer	Knowledge and technology transfer are starting to impact industry/practitioner members through sponsored projects and other teams	Little knowledge or technology transfer has occurred, the center has had little impact on industry/practitioner members

IE Focus during Site Visits

- Alignment with and contributions to the ERC mission (and institution)
- Industrial partner participation in directed research projects
- IPP memberships and number of associated projects
- Federal laboratory partnerships
- Collaborations with non-US based scientists and engineers
- Expanded network of stakeholders/collaborators and level of engagement
- Student training and involvement

Accomplishments – FY23

Thank you!

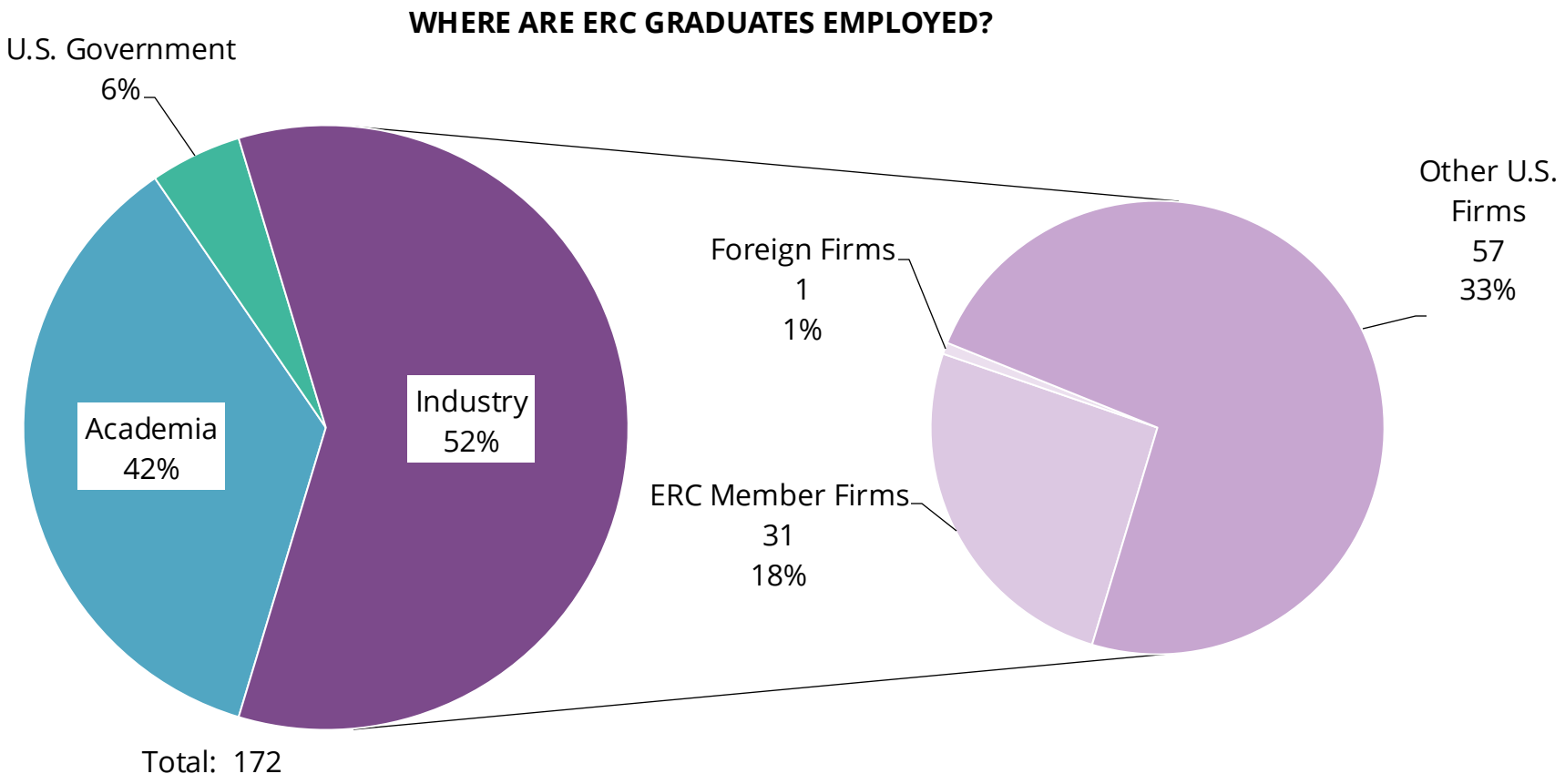
The next few slides would not have been possible without you.

ERC Products of Innovation, FY 1985–2023*

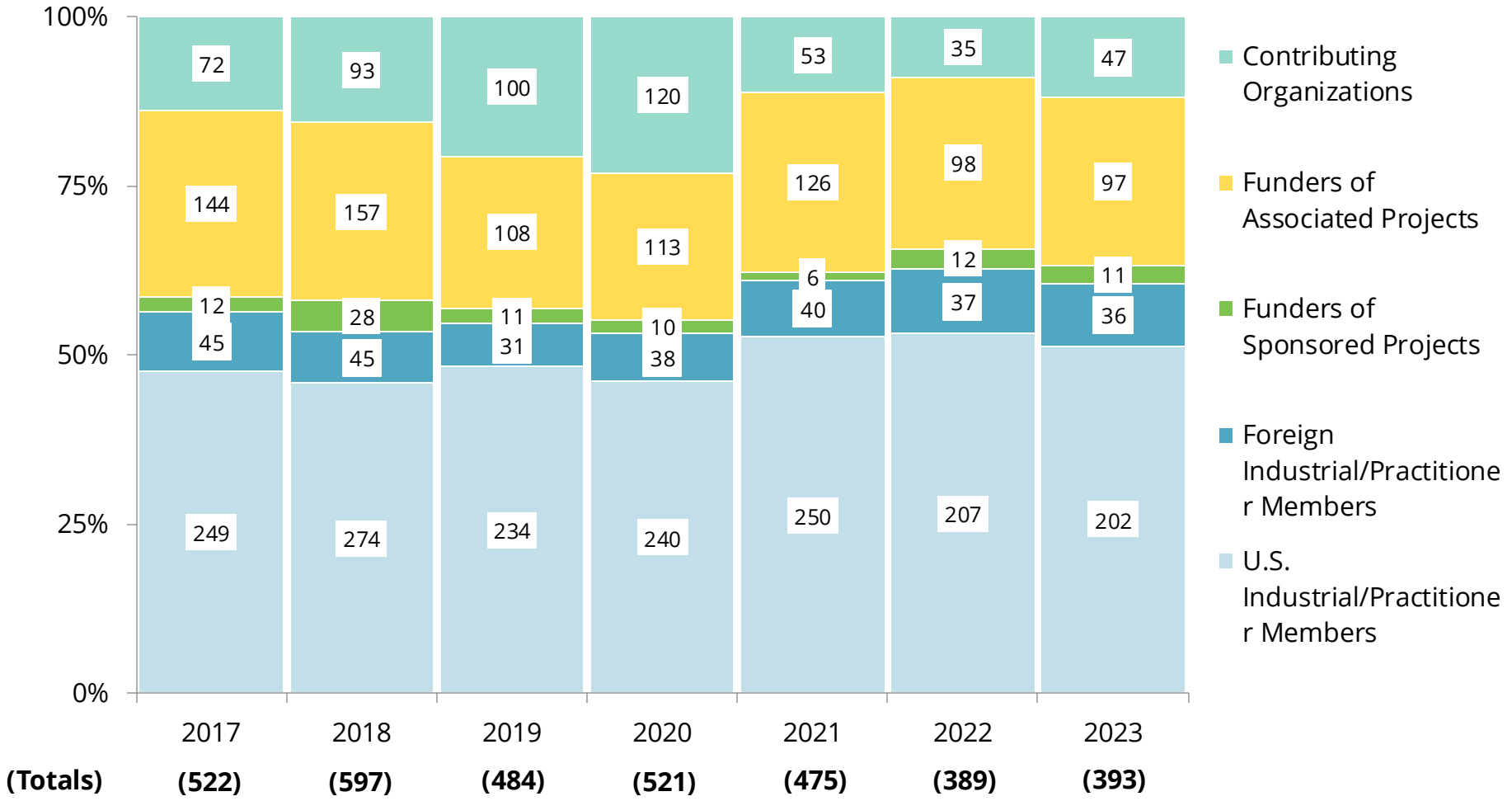
	FY 2023 (18 ERCs)		FY 2018–2022 Annualized		FY 1985–2023 (73 ERCs)
Intellectual Property Transaction	***Total***	***Per Center***	***Total***	***Per Center***	***Total***
Inventions Disclosed	84	5	57	3	2,770
Patent Applications Filed (Provisional and Full)	88	5	79	5	2,498
Patents Awarded	26	1	19	1	955
Licenses Issued	1	< 1	9	1	1,401
Economic Development	***Total***	***Per Center***	***Total***	***Per Center***	***Total***
Spinoff Companies	3	< 1	7	< 1	253
Spinoff Employees	3	< 1	49	3	1,644

** Does not include centers from the Earthquake Technology Sector*

ERC Graduate Employment (18 Centers), FY 2023

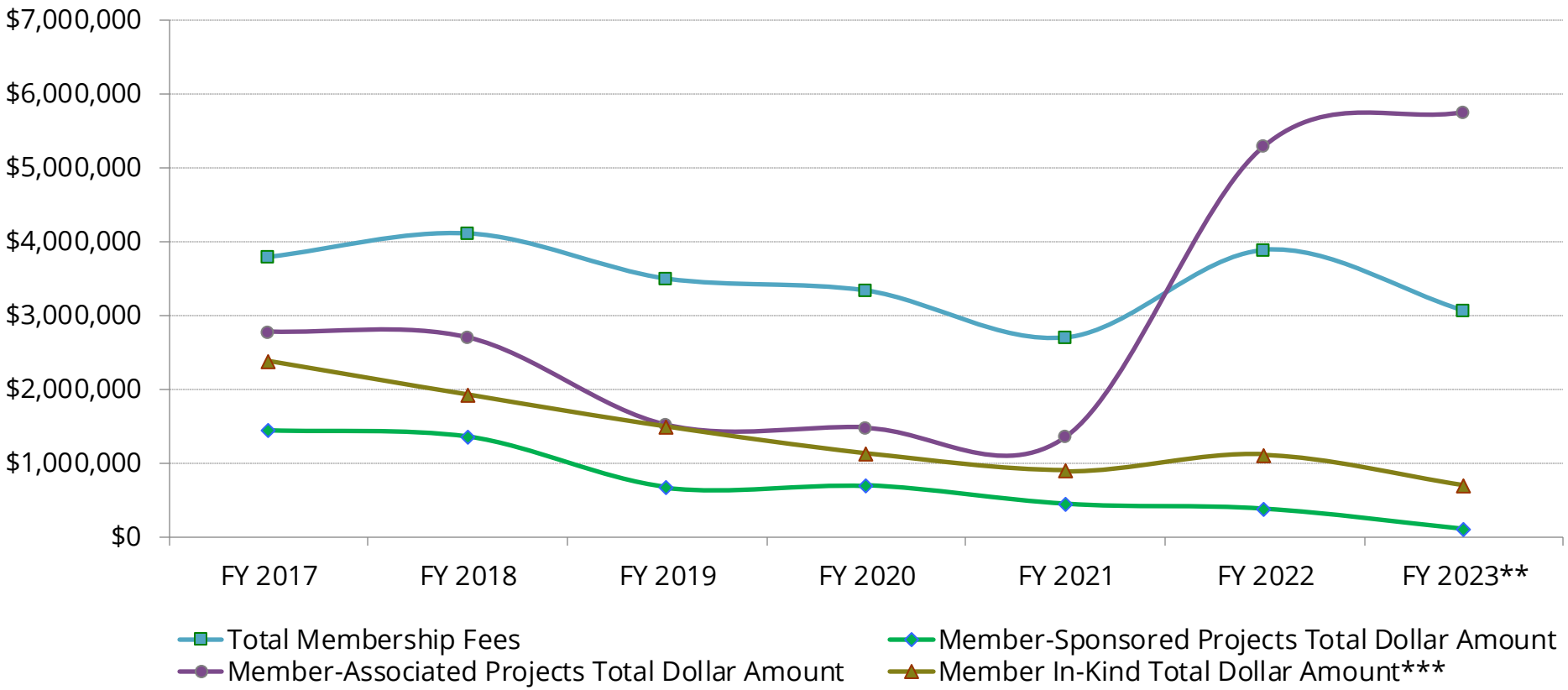


ERC Industrial/Practitioner Members and Supporting Organizations, FY 2017–2023*



** Does not include centers from the Earthquake Technology Sector*

Industrial/Practitioner Member Support by Year, FY 2017–2023*

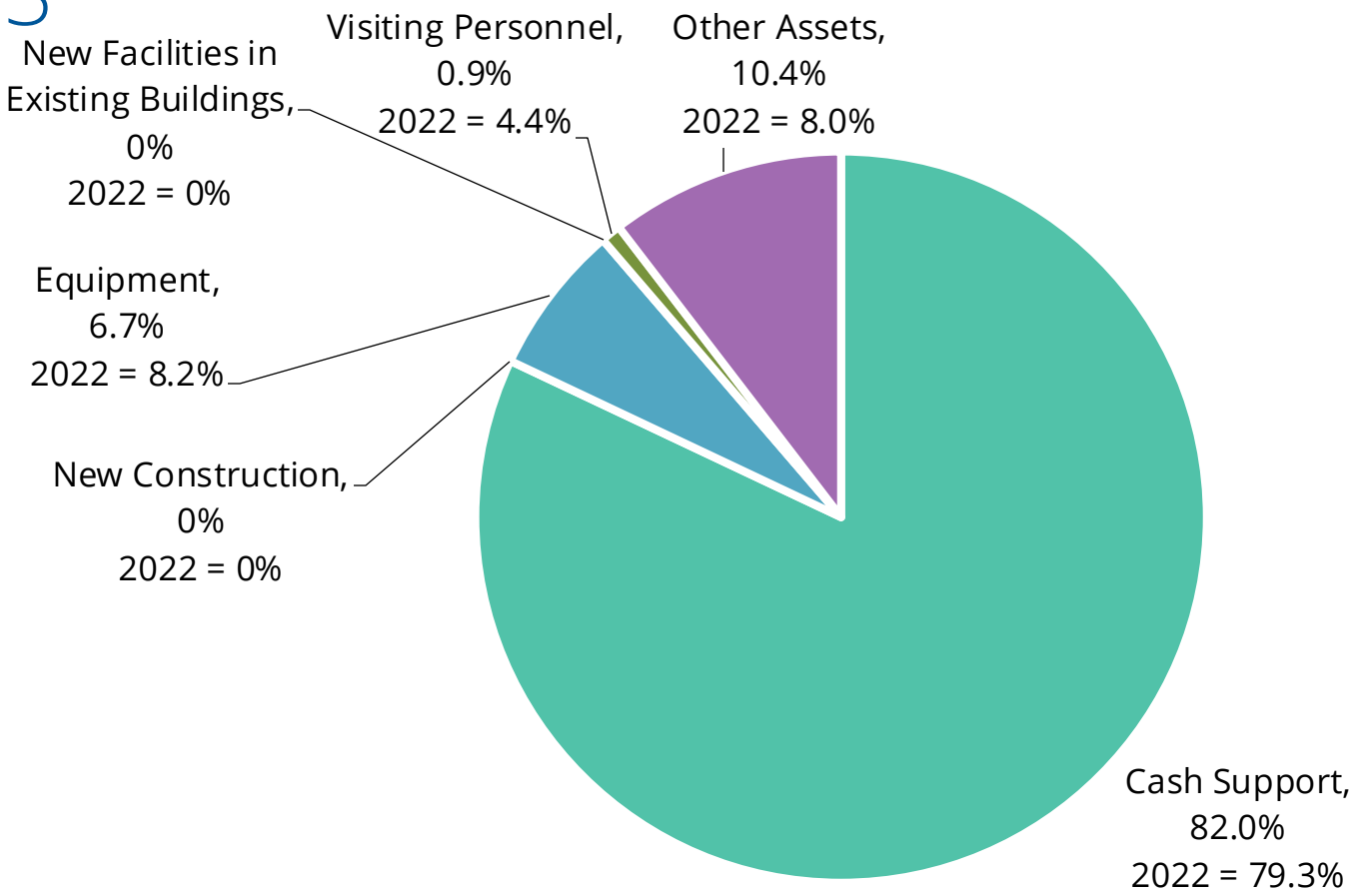


** Does not include centers from the Earthquake Technology Sector*

*** Support received by the end of the current reporting year. Includes data for centers that have entered partial data during a no-cost extension (NCE)*

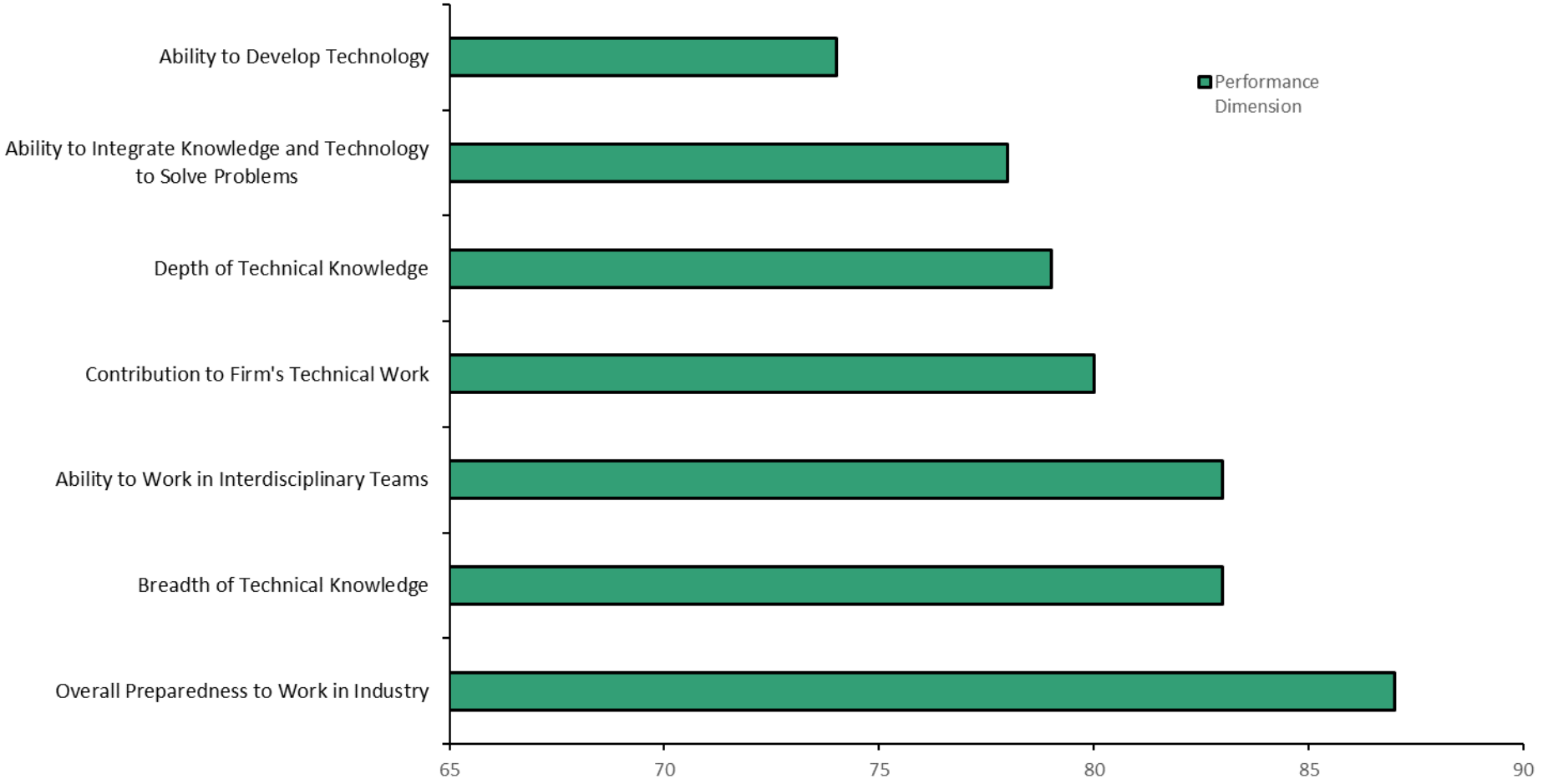
**** Data for this line are from the In-Kind Support reported in the Organizations section*

Industrial/Practitioner New Support to 18 ERCs, FY 2023



Total value of support: $3.9 million

Comparisons by Member Firms of the Performance of ERC Hires vs. Non-ERC Hires*



** Percentage of industrial supervisors rating the former ERC students/graduates hired by their firms as "Better Than" or "Much Better Than" equivalent hires without ERC experience*

Volunteer to Review ENG Proposals

- Learn about leading-edge work
- Understand NSF merit review
- Network with other experts
- Serve the STEM community


NSF