



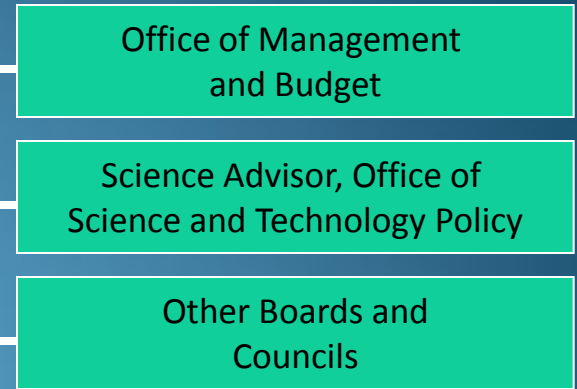
NSF Funding Opportunities in Energy - Some Things Worth Knowing

George J. Antos
National Science Foundation

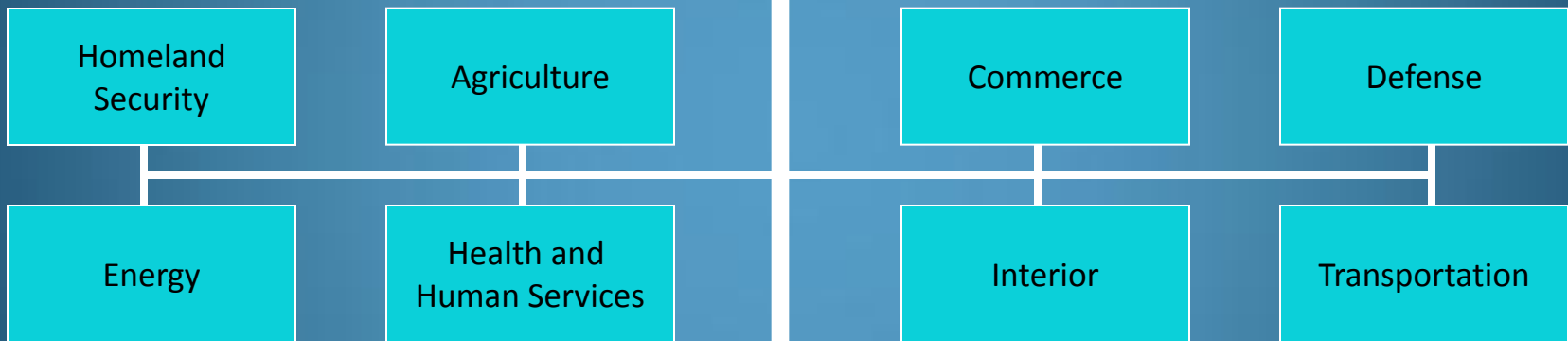
Oklahoma EPSCoR NSF Grants Workshop
Norman, OK
April 30, 2010



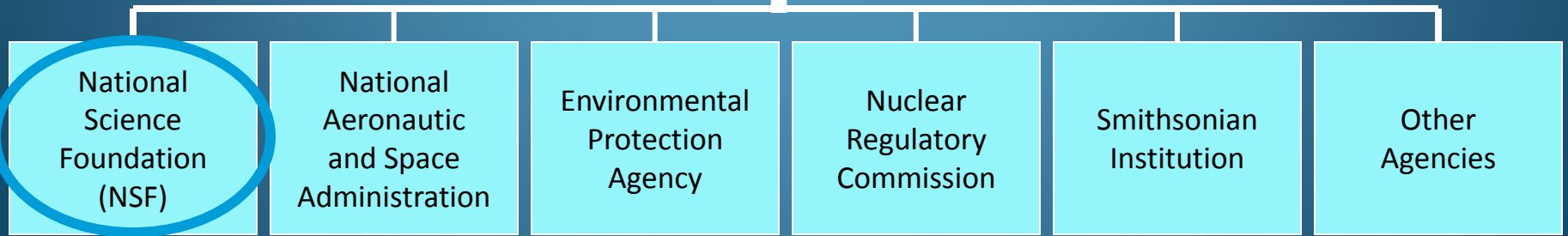
Staff Offices



Major Departments



Independent Agencies





Vision: Advancing discovery, innovation, and education beyond the frontiers of current knowledge, and empowering future generations in science and engineering.

Mission: To promote the progress of science; to **advance the national health, prosperity, and welfare**; to secure the national defense (NSF Act of 1950)



Strategic Goals

Discovery

Learning

**Research
Infrastructure**

Stewardship

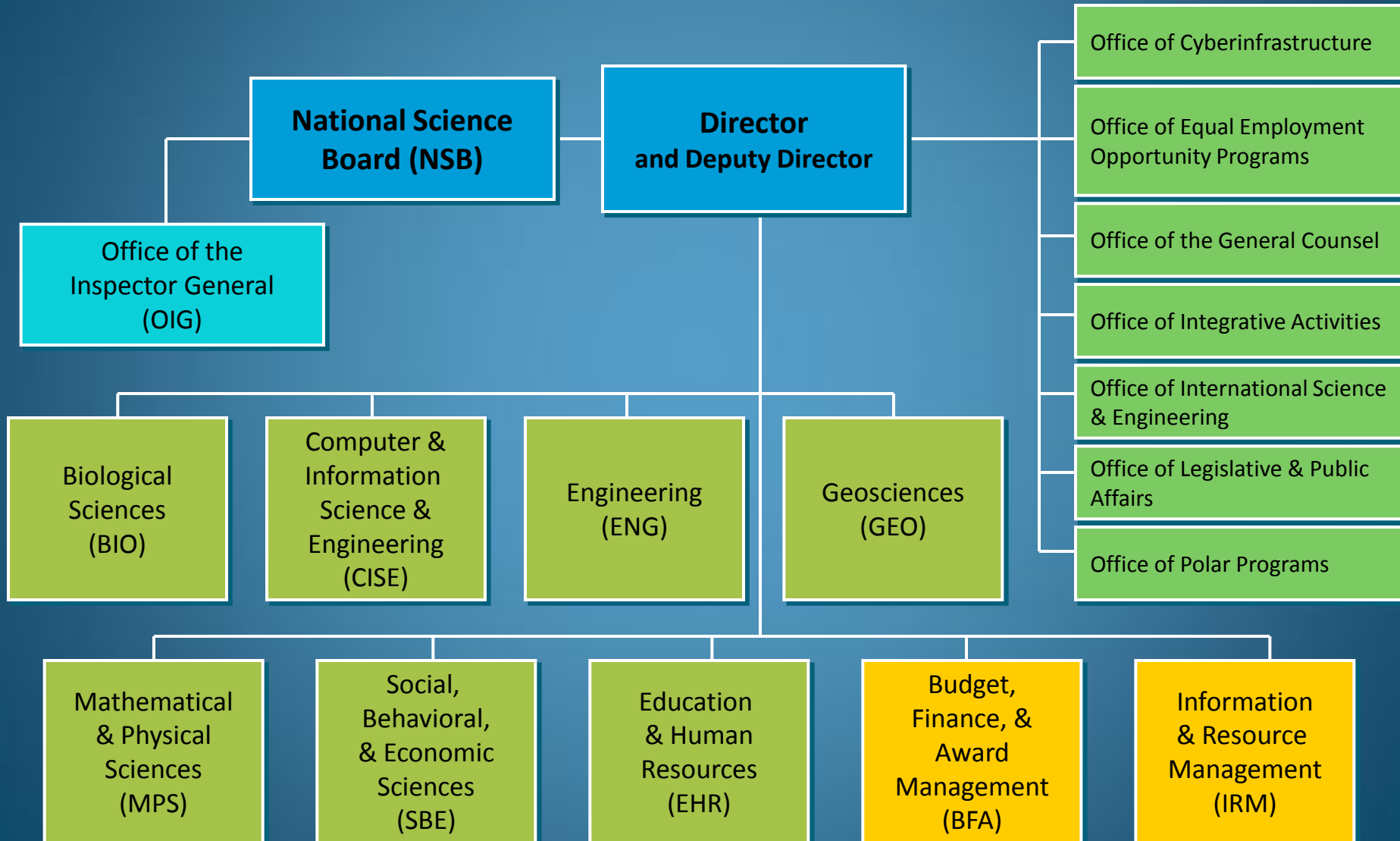
Cross-Cutting Objectives

To Inspire and Transform

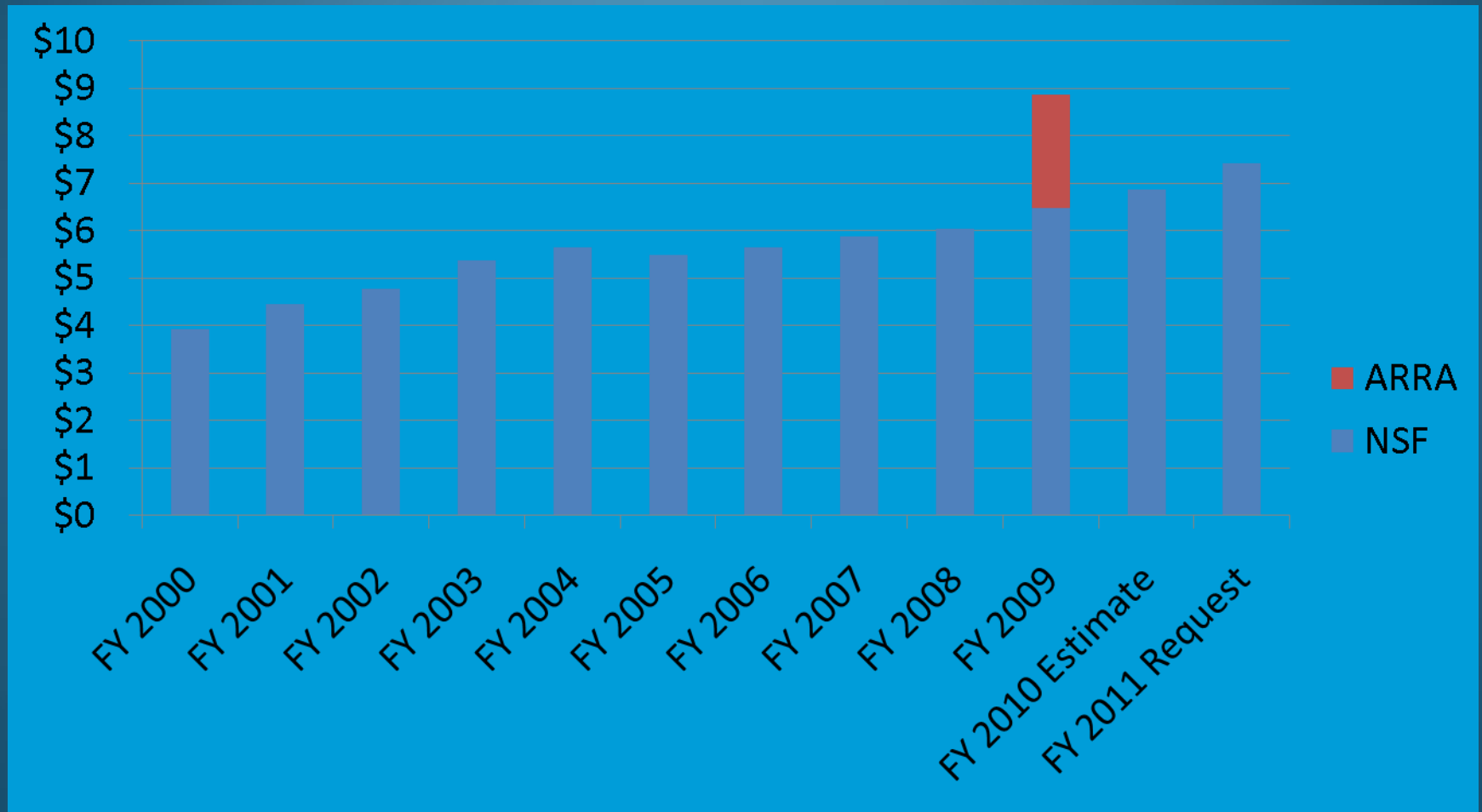
To Grow and Develop

Investment Priorities (by Strategic Goal)

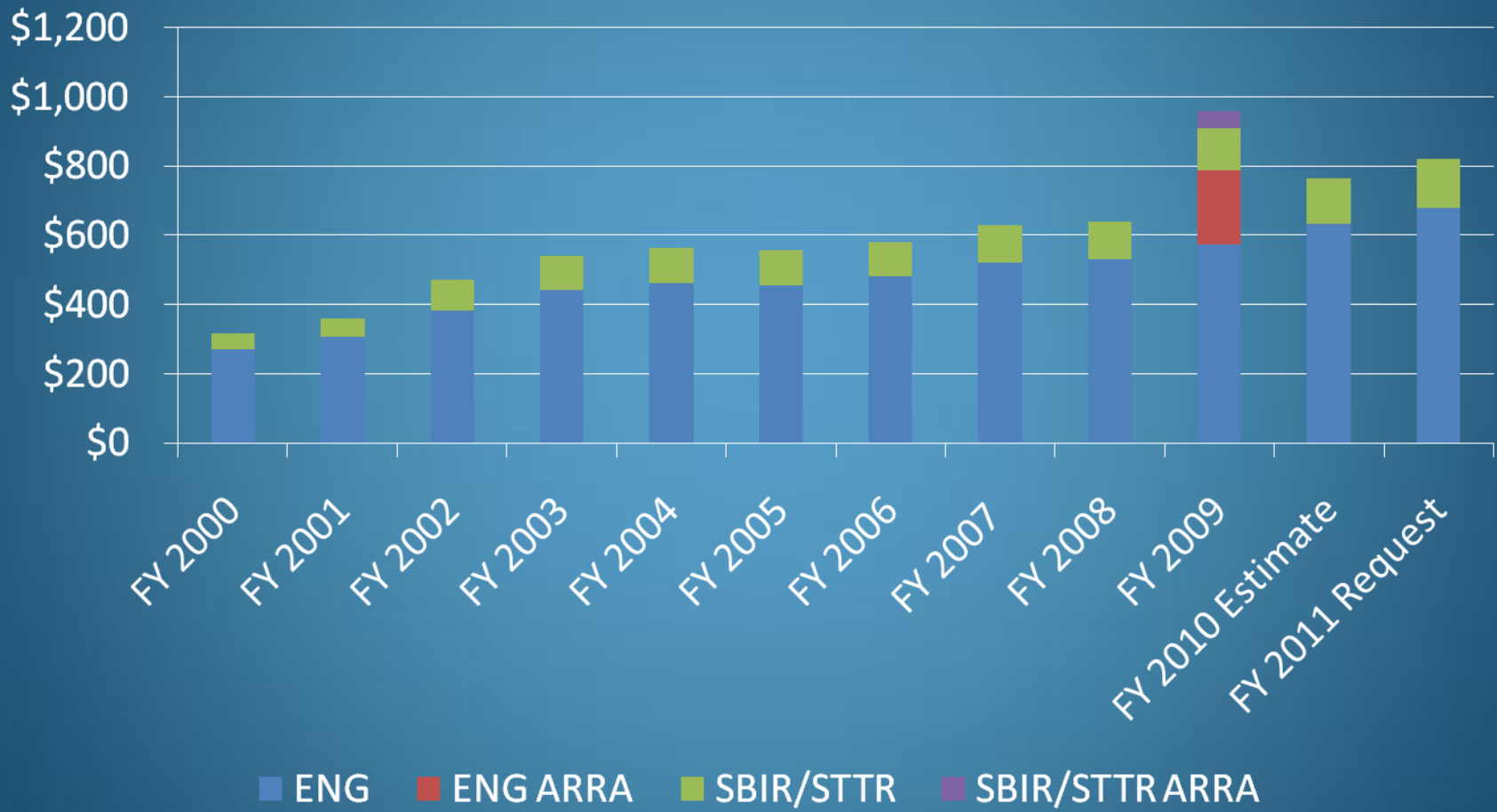
National Science Foundation



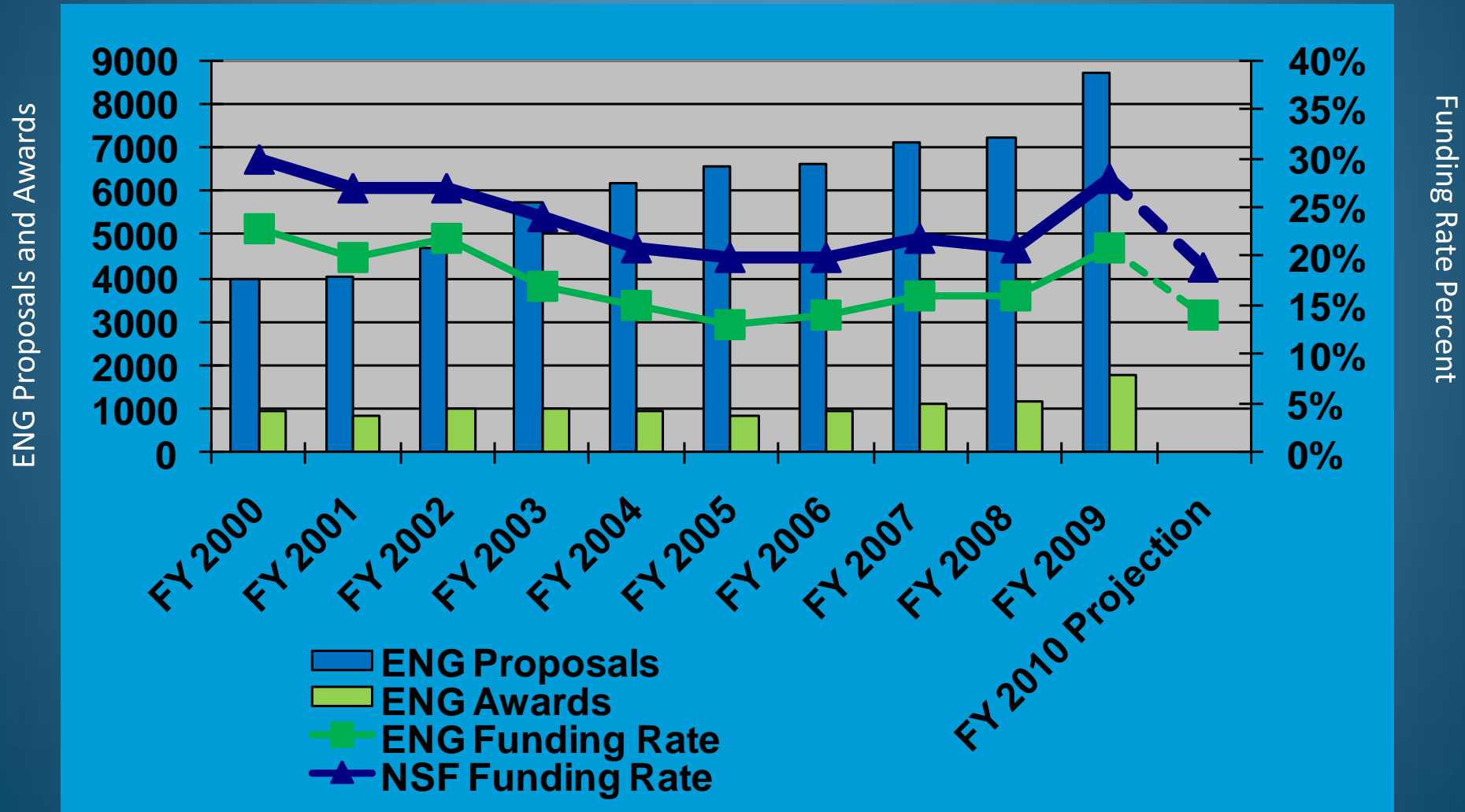
NSF Budget (\$B)



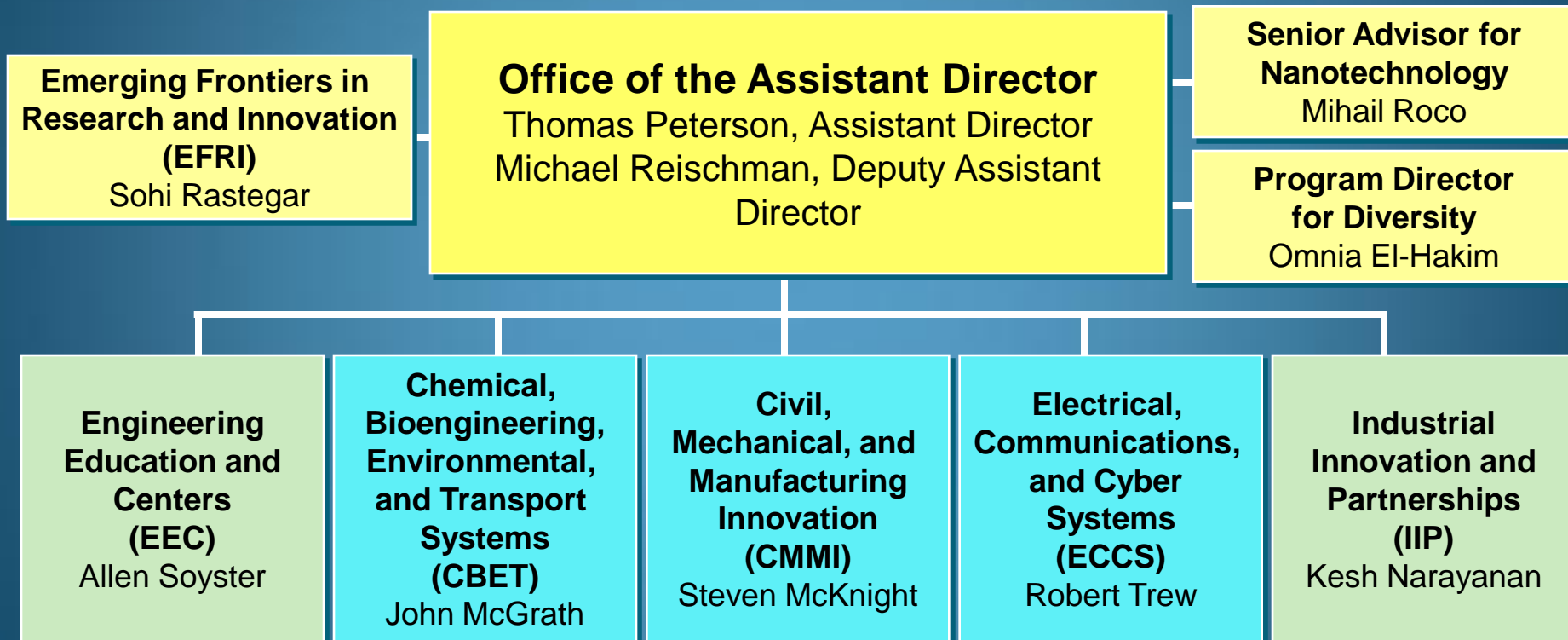
ENG and SBIR/STTR Budgets (\$M)



ENG and NSF Research Grant Proposals and Awards



NSF ENG Organization



Funding Opportunities

- Core programs
- Exploratory research
- Collaborative/interdisciplinary areas
- Crosscutting and NSF-wide programs

- Starting point for information: www.nsf.gov
- Use contact persons
- Check the site periodically for new programs

Areas of Emphasis in Engineering

- Students and young investigators
- Potentially transformative research
- Innovation (translational research)

Which Programs Directly Relate to
Energy Research?

ENG Use of ARRA Funding

- Young Investigators
 - 80 additional CAREER awards
 - 15 additional BRIGE awards
 - 16 GRF in addition to the 80 Women in Engineering (WENG) GRF Fellows funded annually by ENG
 - 1 additional IGERT in the area of energy
- Education and Workforce Development
 - 40 Postdocs in Industry
 - 17 additional REU/RET awards
 - 76 additional Education awards, including 4 for veterans/GI Bill activities
- High Risk / High Reward
 - 7 additional EFRI awards
- Translational Research
 - 257 additional small business awards (50% increase)
 - 9 additional I/UCRC awards
 - 2 additional PFI awards
 - 21 additional GOALI awards

Young Investigators

- Research Experiences for Teachers
- Research Experiences for Undergraduates
- Graduate Research Fellowships
- CAREER awards



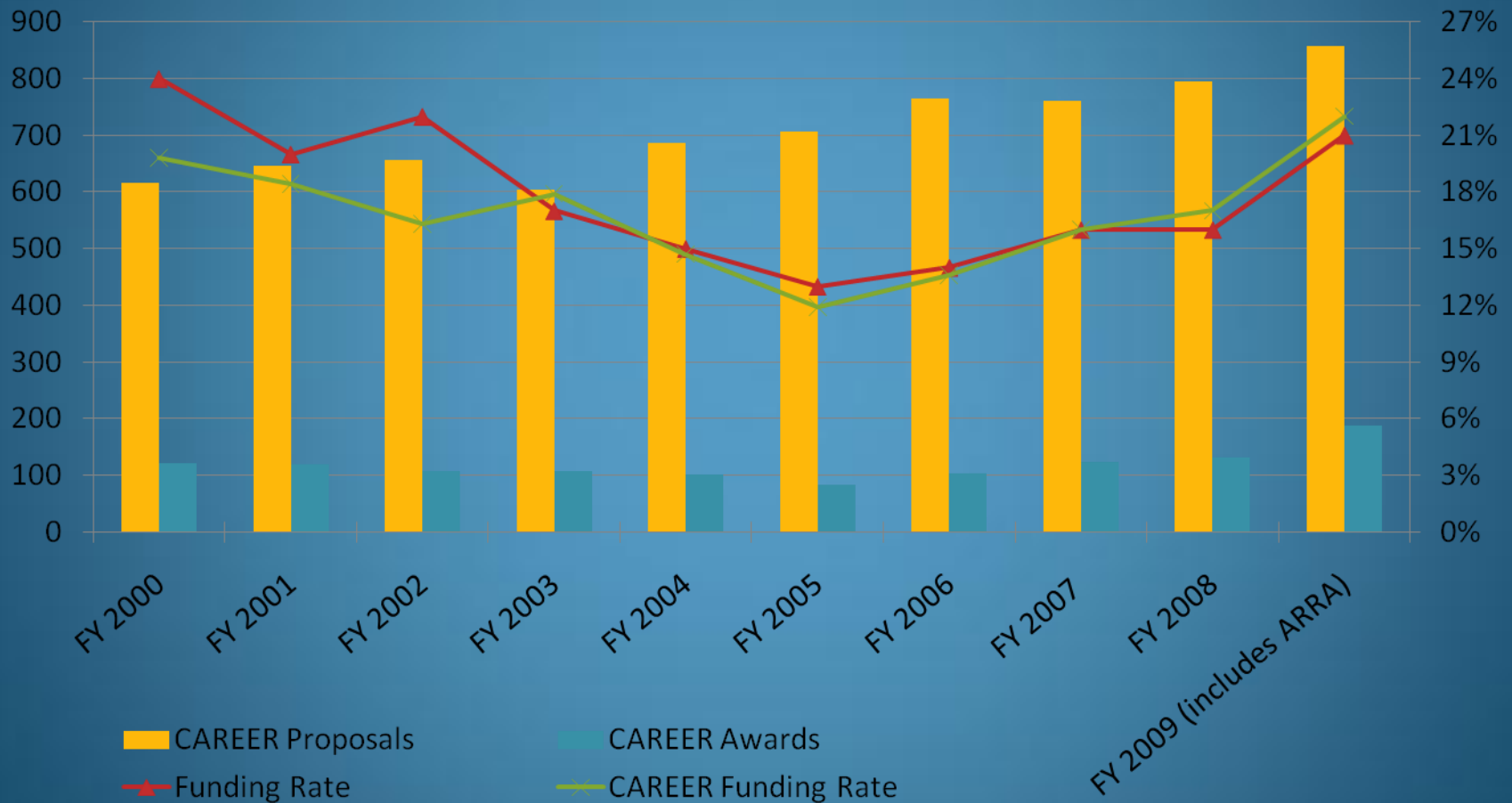
RET teachers introduce girls to infrastructure renewal concepts. *Credit: Univ. of Cincinnati College of Engineering and College of Applied Science.*



Student researchers sample contaminated sediment. *Credit: Karl Rockne, Univ. of Illinois at Chicago*

ENG CAREER

Proposals and Awards

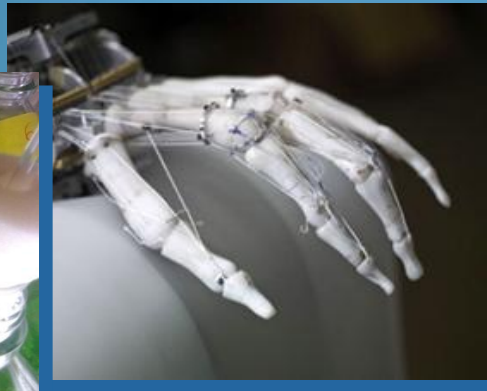


Potentially Transformative Research

- Emerging Frontiers of Research and Innovation
- Interdisciplinary research
- Disciplinary research



Growing microalgae for renewable fuel. *Credit: Phillip Savage, Univ. of Michigan*



An anatomically correct testbed hand. *Credit: Ellen Garvens, University of Washington*



Engineers examine the scoured trench behind the concrete floodwall next to the catastrophic levee breach at the west end of the Lower Ninth Ward of New Orleans. *Credit: Rune Storesund*

ENG COLLABORATIVE INVESTMENTS

Science, Engineering, and Education for Sustainable Well-Being (SEES)

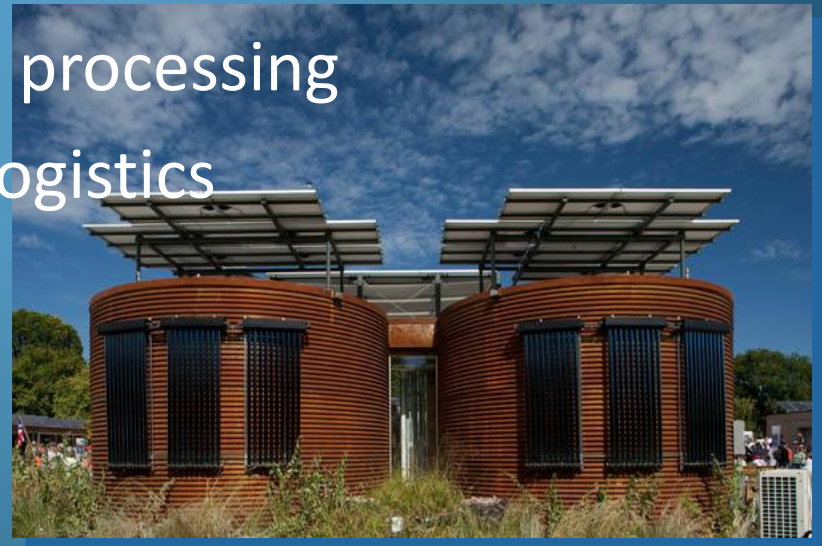
- Integrates climate and energy research and education
- Supports advances in:
 - Materials engineering and device technologies
 - Energy manufacturing, particularly from renewable sources
 - Micro-grid and smart-grid approaches to power distribution and control systems
 - Resilience and sustainability of complex, interdependent infrastructure systems

RE-ENERGYSE

- Collaboration with DOE to support undergraduate and graduate research in sustainable energy, including the areas of:
 - Manufacturing for energy
 - Energy-efficient materials processing
 - Energy supply chain and logistics

Cornell University home for
Solar Decathlon 2009.

*Credit: Jim Tetro, U.S. Department of
Energy Solar Decathlon*



INNOVATION THROUGH TRANSLATIONAL RESEARCH

Innovation

- Engineering Research Centers
- Industry/University Cooperative Research Centers
- Partnerships for Innovation
- Small Business Innovation Research/Small Business Technology Transfer



The leaves of *Artemisia annua*, the sweet wormwood tree, are the source of artemisinin. *Credit: Lawrence Berkeley National Laboratory*

NSF Centers as Hubs for Regional Innovation

- Engineering Research Centers
 - 10 year NSF support
 - Since 1985
 - 15 “NSF-active” currently
 - 27 of 33 “graduated” ERCs (82%) still active
- Industry/University Cooperative Research Centers
 - Based on Industry membership
 - NSF “another member”
- In BOTH CASES:
 - Multi-institutional involvement
 - Multi-Industry involvement

ERCs and I/UCRCs: Platform for Innovation and Regional Economic Development

Energy, Sustainability, and Infrastructure Sector

- ERC for Collaborative Adaptive Sensing of the Atmosphere (CASA)
University of Massachusetts, Amherst, MA (lead institution) in partnership with Colorado State University, University of Oklahoma, and University of Puerto Rico at Mayaguez
- Arizona Water Quality Center (WQC)
University of Arizona at Tucson, Arizona State University at Tempe
- Center for Fuel Cells (CFC)
University of South Carolina, University of Connecticut
- Center for Grid-Connected Advanced Power Electronic Systems (GRAPES)
University of Arkansas, University of South Carolina
- Center for Integrative Materials Joining Science for Energy Applications
Ohio State University, Colorado School of Mines, University of Wisconsin, Lehigh University.
- Center for Multiphase Transport Phenomena
Michigan State University, The University of Tulsa
- Queen's University Environmental Science and Technology Research Centre (QUESTOR)
The Queen's University of Belfast, Northern Ireland
- Silicon Solar Consortium (SiSoC) Research Center
North Carolina State University, Georgia Tech
- Center for Repair of Buildings and Bridges with Composites (RB2C)
University of Missouri at Rolla, North Carolina State University

Engineering Research Centers

- FY 2010 awards will be made in the following topic areas:
 - Complex, coupled physical civil infrastructure systems under stress
 - Energy systems for a sustainable future
 - Transformational engineered systems — open category with topic chosen by the proposing ERC team
- ~\$13M to fund 2–4 awards
- Letters of Intent due May 15, 2009; preliminary proposals due July 15, 2009; invited full proposals due May 5, 2010

ENG Contact
Lynn Preston

Industry/University Cooperative Research Center (I/UCRC) Program

- Promotes long-term partnerships among industry, academe, and government
- Centers are catalyzed by a small investment from NSF and are primarily supported by industry center members during their development and evolution
- ~\$9M for 2-8 full center awards (\$55-80K/year for up to 5 years) and 4-12 planning grant awards (\$10K for 1 year)
- Two windows per year: Letters of Intent due in Jan. and June; full proposals due in March and Sept.

Grant Opportunities for Academic Liaison with Industry (GOALI)

- Effectively promotes the transfer of knowledge between academe and industry, student education, and the exchange of culture
- Supports:
 - Faculty and students in industry (≤ 1 year)
 - Industry engineers/scientists in academe (≤ 1 year)
 - Industry-university collaborative projects (≤ 3 years)
- \$5M available for co-funding with all NSF Directorates
- Proposals accepted anytime; ~70 awards each year

Partnerships for Innovation (PFI)

- Catalyzes partnerships among colleges and universities, the private sector, and governments
- Supports one or more of the following activities:
 - research, knowledge transfer, and/or commercialization
 - workforce education and training
 - establishing the infrastructure for innovation
- \$9.5M to fund 12–15 awards each year; grants are up to \$600,000 for 2–3 years
- New solicitation in 2010

Small Business Innovation Research (SBIR) Programs

- Encourages small firms to undertake cutting-edge research with the potential for significant economic and public benefits
- Supports
 - Biotechnologies and chemical technologies
 - Education applications
 - Information and communication technologies
 - Nanotechnology, advanced materials, and manufacturing
- \$45M for 200–300 awards
- Full proposals due in June and Dec.

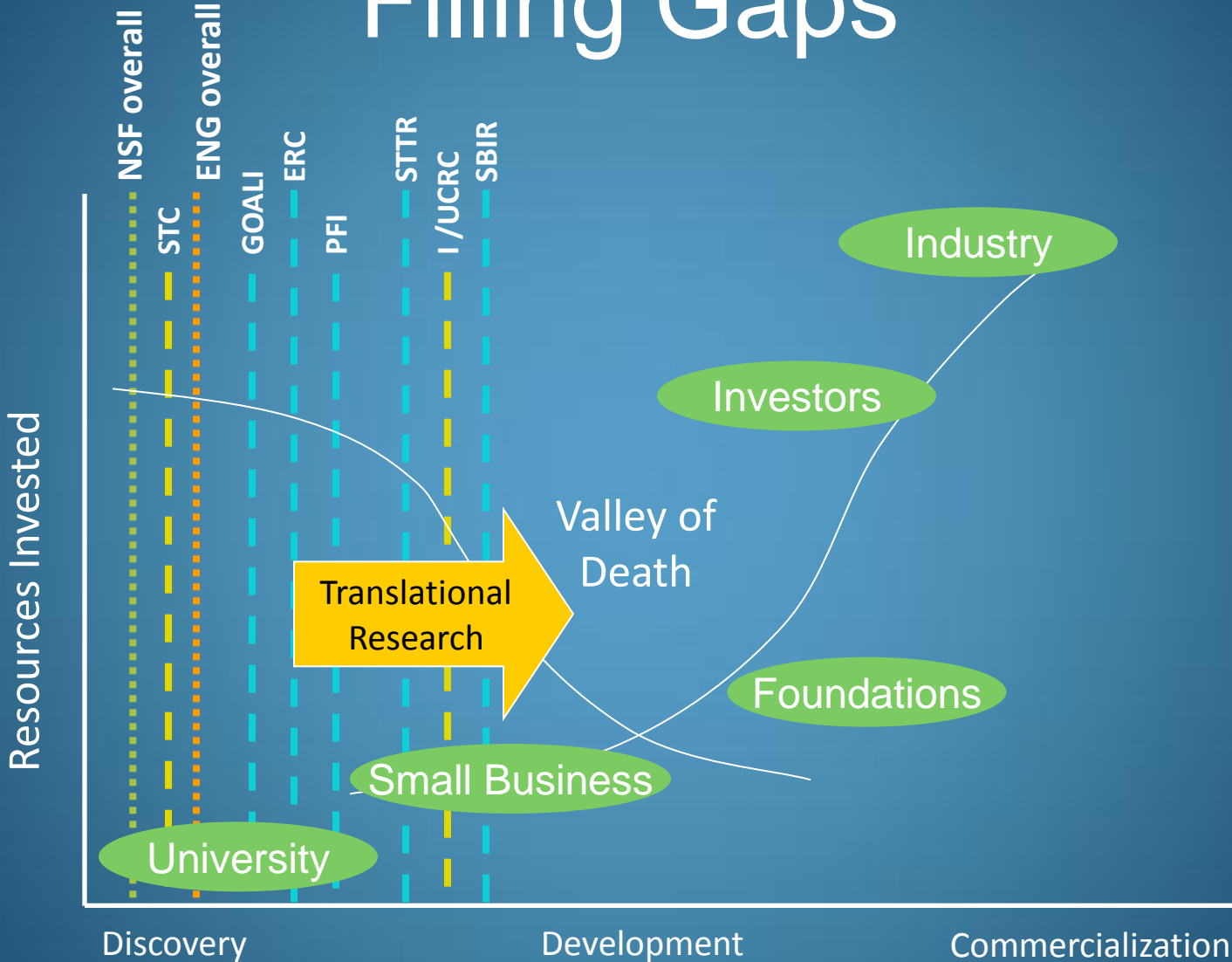
Small Business Technology Transfer (STTR) Programs

- Encourages small firms to undertake cutting-edge research with the potential for significant economic and public benefits
- Enables university researchers to spin off commercially promising ideas while remaining employed primarily at the research institution
- Supports multi-functional materials
- \$5M for ~35 awards
- New solicitation in late summer 2010

NSF Programs for Translational Research

- Science and Technology Centers (STC)
- Engineering Research Centers (ERC)
- Materials Research Science and Engineering Centers (MRSEC)
- Grant Opportunities for Academic Liaison with Industry (GOALI)
- Industry/University Cooperative Research Centers (I/UCRC)
- Partnerships for Innovation (PFI)
- Small Business Technology Transfer (STTR)
- Small Business Innovation Research (SBIR)
- Nanoscale Science and Engineering Center (NSEC)
- Nanoscale Interdisciplinary Research Teams (NIRT)
- Emerging Frontiers of Research and Innovation (EFRI)
- Other ENG programs

Filling Gaps



Funding Opportunities

- Core programs
- Exploratory research
- Collaborative/interdisciplinary areas
- Crosscutting and NSF-wide programs

- Starting point for information: www.nsf.gov
- Use contact persons
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Funding in Energy Programs

- Proposals must address NSF goals
 - Discovery
 - Learning
 - Research infrastructure
 - Stewardship
- Energy Funding may be found significantly in ENG and crosscutting/interdisciplinary programs
- Other Programs: MPS/CHE Catalysis



National Science Foundation | Directorate for Engineering
**Chemical, Bioengineering, Environmental,
 and Transport Systems Division (CBET)**

Deputy Division Director
Bob Wellek

Division Director
John McGrath

Senior Advisor
Marshall Lih

**Chemical, Biochemical,
 and Biotechnology
 Systems**

**Bioengineering and
 Engineering Healthcare**

**Environmental
 Engineering
 and Sustainability**

**Transport
 and
 Thermal Fluids**

**1401 - Catalysis and
 Biocatalysis**
George Antos

**5345 - Biomedical
 Engineering**
Semahat Demir

**7644 - Energy for
 Sustainability**
Greg Rorrer

**1407 - Combustion,
 Fire, & Plasma Systems**
Arvind Atreya

**1417 - Chemical and
 Biological Separations**
Rose Wesson

7236 - Biophotonics
Leon Esterowitz

**1440 - Environmental
 Engineering**
Paul Bishop

**1443 - Fluid
 Dynamics**
Henning Winter

**1403 - Process and
 Reaction Engineering**
Maria Burka

7909 - Biosensing
Alex Simonian

**1179 - Environmental
 Implications of
 Emerging Technologies**
Cindy Ekstein

**1414 - Interfacial
 Processes and
 Thermodynamics**
Bob Wellek

NOTE: Program Titles are
 arranged alphabetically
 within each cluster.

**1491 - Biotechnology,
 Biochemical, and
 Biomass Engineering**
Theresa Good

**7643 - Environmental
 Sustainability**
Bruce Hamilton

**1415 - Particulate and
 Multiphase Processes**
Marc Ingber

**5342 - Research to
 Aid Persons with
 Disabilities**
Ted Conway

**Assessment & Impact
 of Research Funding
 Investments**
Peter Wu - AAAS Fellow

**1406 - Thermal
 Transport Processes**
Ted Bergman



Catalysis and Biocatalysis Program Synopsis



CONTACT: George J. Antos gantos@nsf.gov (703) 292-4997 NSF Room 565 S

SYNOPSIS:

Chemical engineering and chemistry are intertwined. Proposals which receive funding in this Program may include any number of the following broad scopes:

- ◆ Catalyst Synthesis, Characterization, Behavior and Performance.
- ◆ Kinetics and Mechanisms of Key Catalytic Reactions.
- ◆ Catalysis at Surfaces or in Reactor Process Streams.
- ◆ Synthesis and Fabrication of Component Materials and Catalyst Composites.
- ◆ Modeling and Fundamental Studies of a Catalyst or Catalytic Process.
- ◆ Catalysts and Studies for Alternative Energy Systems, such as Electro- and Photocatalysis.

Most studies will focus on the catalysis of one or more chemical reactions. The products of these catalyzed reactions may include molecules used for fuels, energy sources, feedstocks, fine chemicals, bulk chemicals and specialized materials. While **proposals will be accepted in any of the areas and with any product or feedstock in mind, national needs suggest heightened interest be given to proposals relating to processes and catalysts for conversions of biomass to fuels and chemicals, for development of alternative energy sources and for transition to green or environmentally benign products and processes.** Submissions investigating unique catalysis related to the nanoparticle state and to the bridging catalysis of biomimetism are welcome.



Typical research projects:

A - The disciplines of Catalysis and Biocatalysis

B - The applications of Catalysis and Biocatalysis to Energy issues

- ◆ Catalytic or biocatalytic conversion of biorenewables to fuels or chemicals
- ◆ Gasification studies and Fischer-Tropsch catalysis
- ◆ Catalytic conversions of fossil fuel feedstocks
- ◆ CO₂ Activation and conversion processes
- ◆ Use of Ionic Liquids as part of a Catalytic Conversion process
- ◆ Electrocatalysis materials and mechanism studies and fuel cell applications
- ◆ Photocatalysis studies and solar energy interconversions
- ◆ Biomimetic and biologically-inspired catalysts for producing fuels, chemicals and including photosynthesis biomimeticism
- ◆ Development of natural enzymes and supported enzymes for use in biomass conversion
- ◆ Environmentally beneficial or benign chemical process alternatives
- ◆ Catalytic remediation of feedstocks, process streams, products or effluents

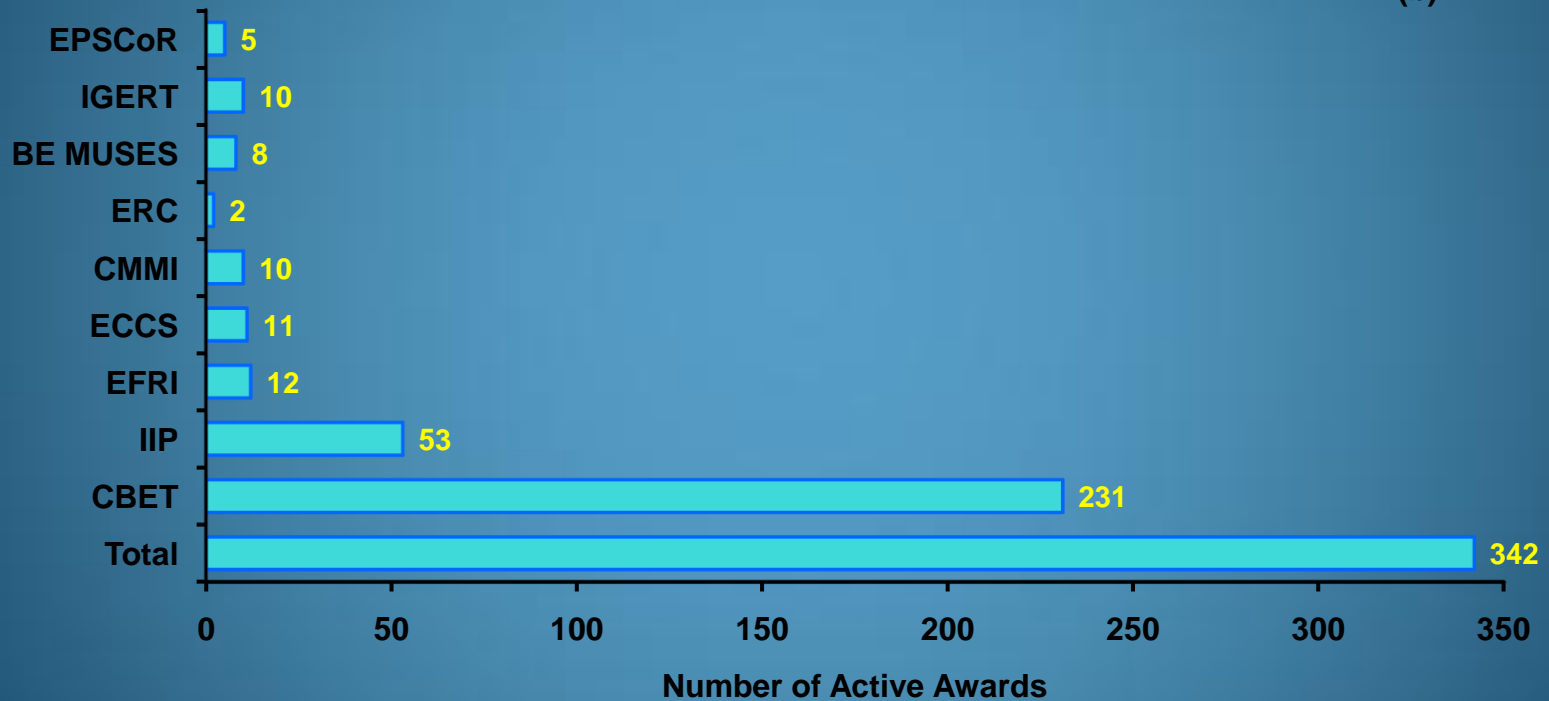
C - The applications of Catalysis and Biocatalysis to Materials

D - Combinations

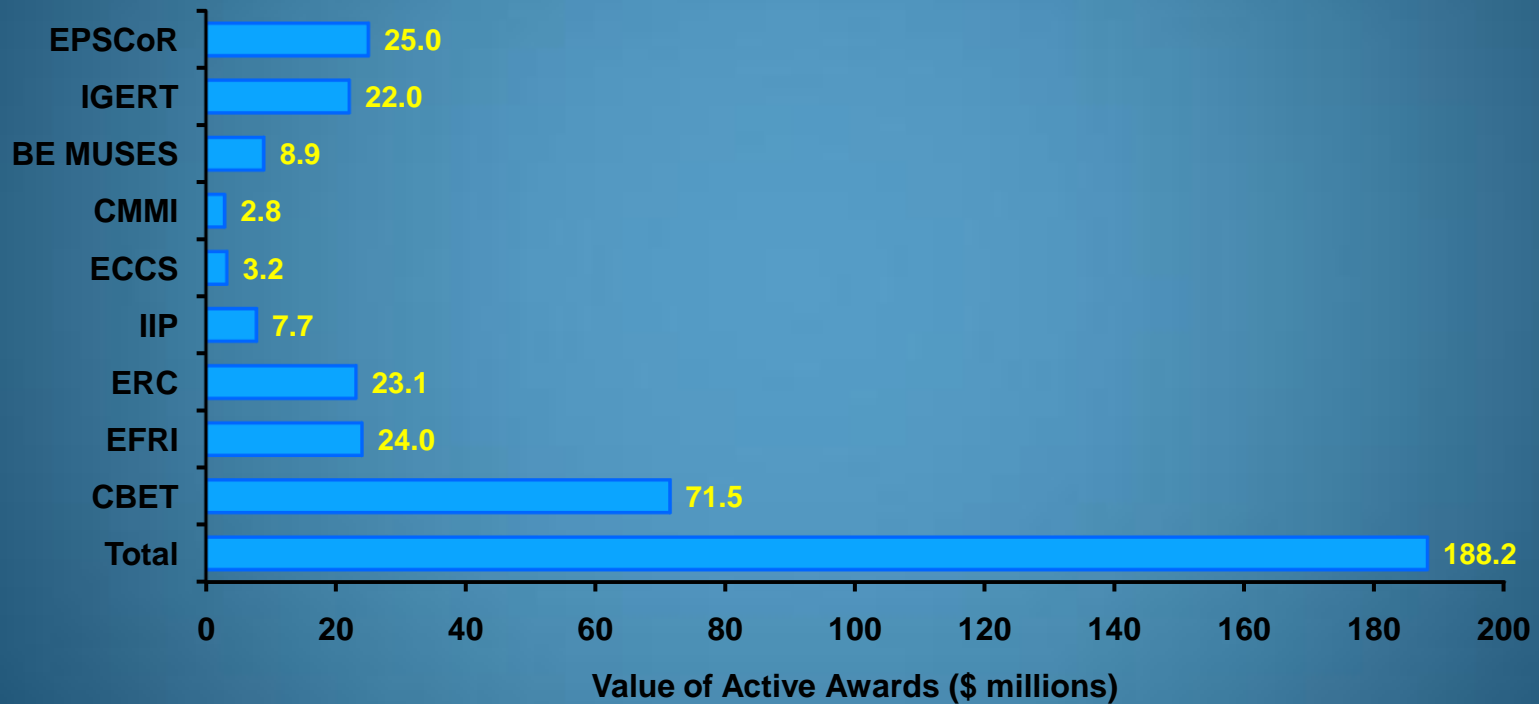
- ◆ Catalytic Distillation Studies
- ◆ Catalytic Reaction with Separation
- ◆ Catalysis in Supercritical Systems

Bio-Economy Investment

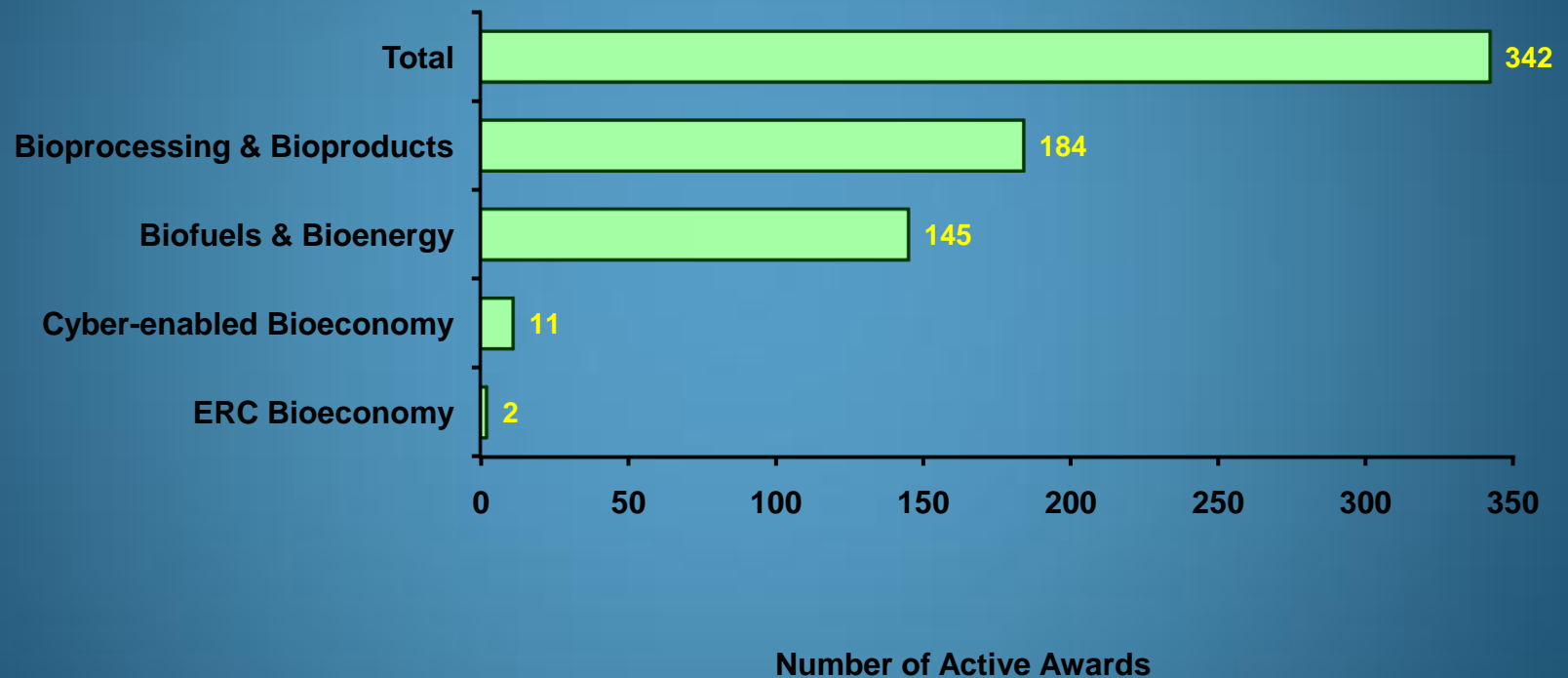
(b)



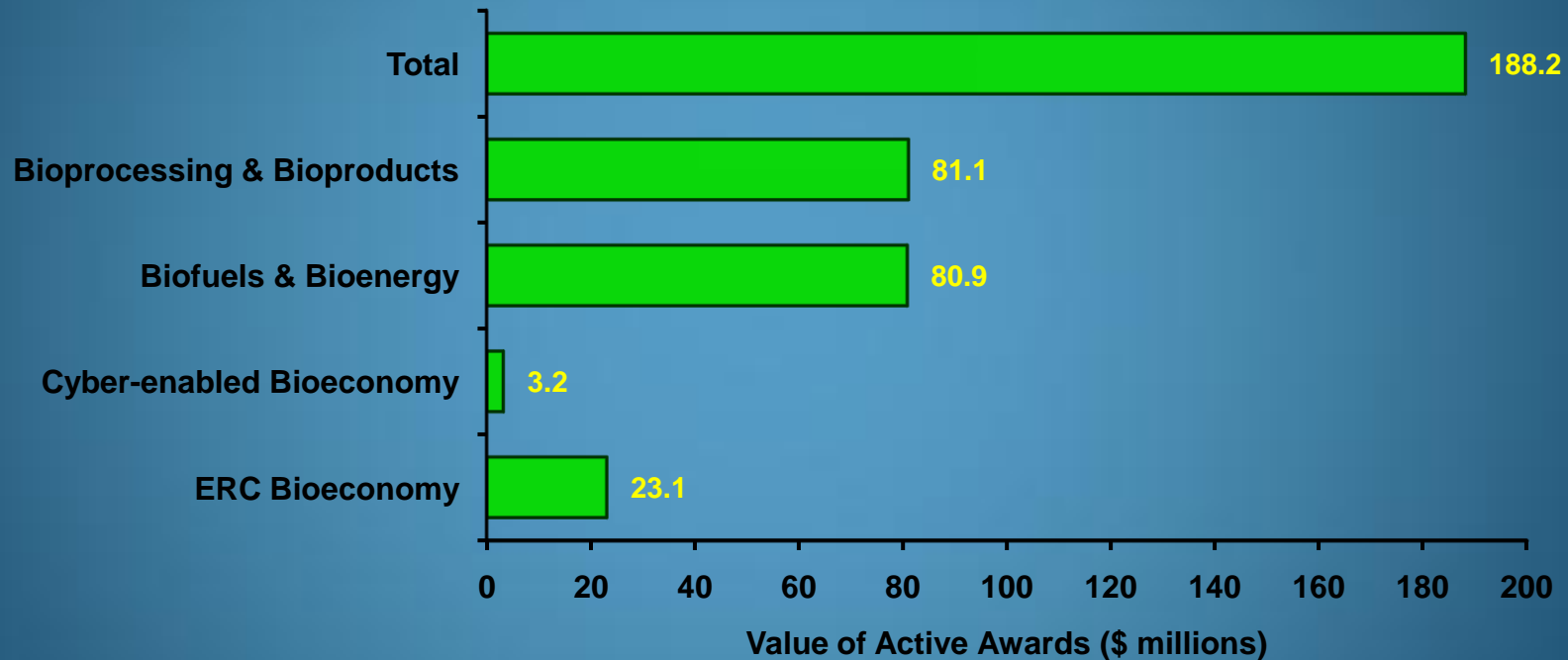
Bio-Economy Investment



Focus within Bio-Economy Support



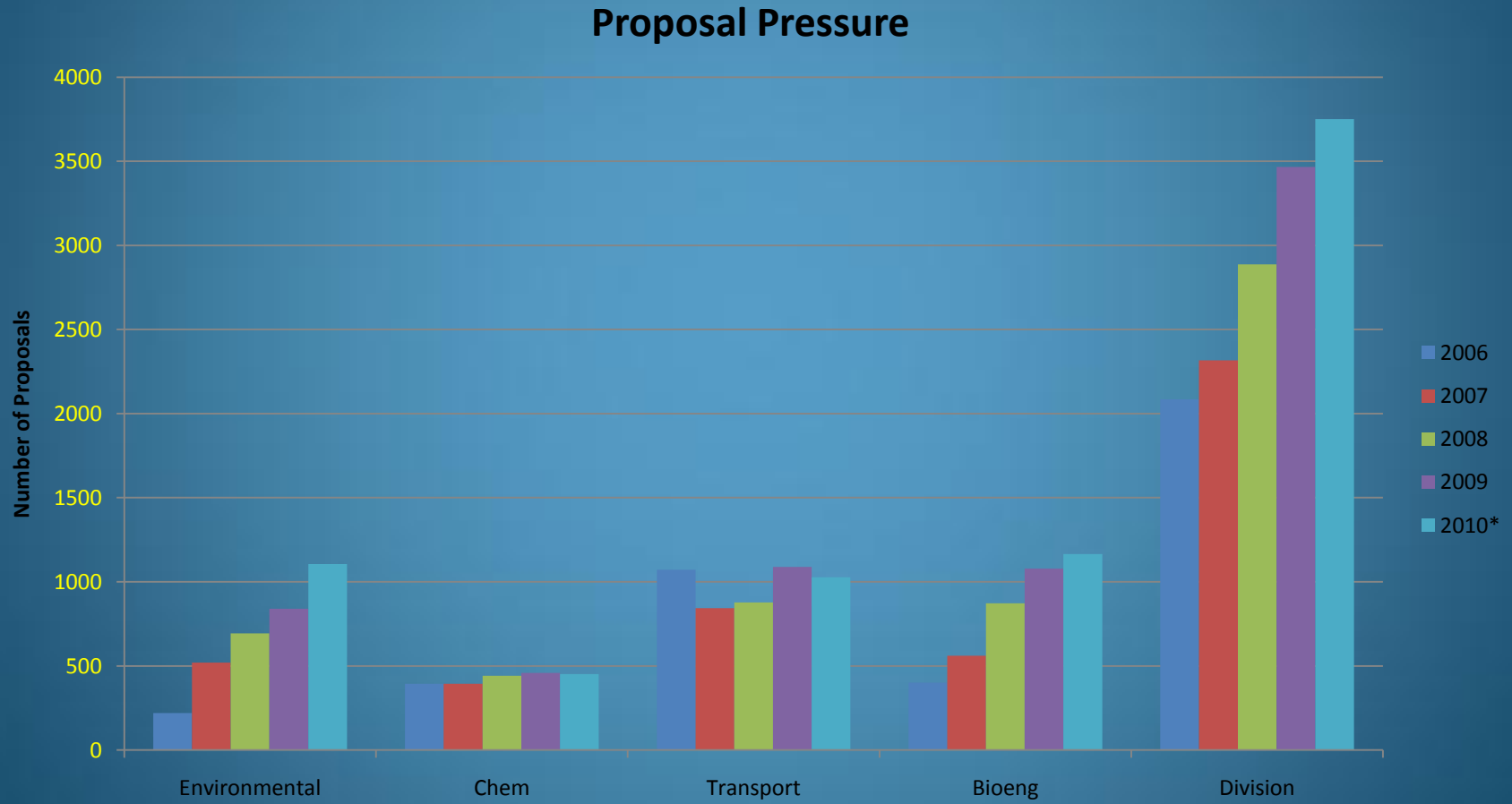
Focus within Bio-Economy Support



Steps towards Successful Proposals

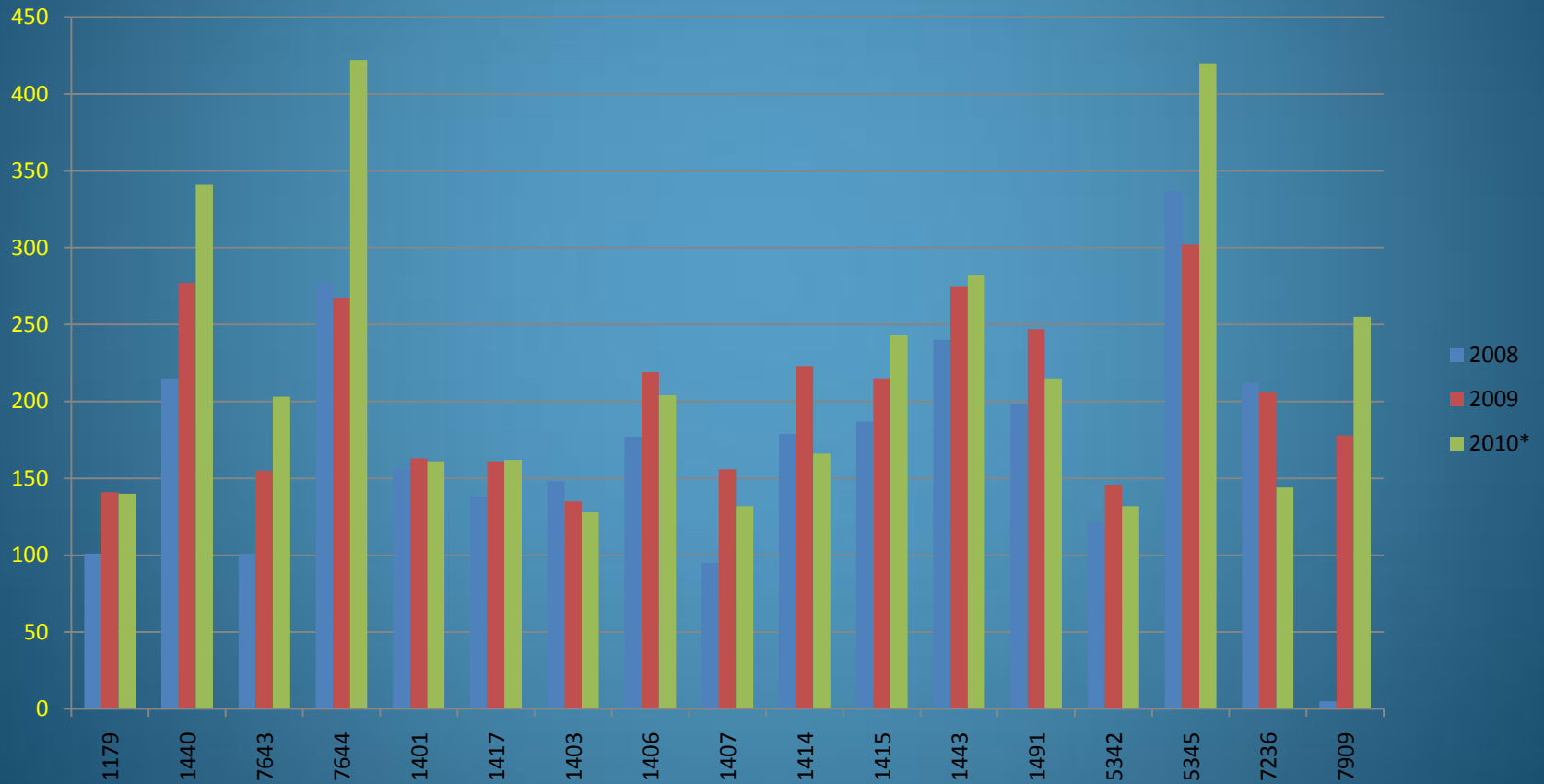
- Begin with
 - Dialog with program officer
 - White paper
 - Short biography

Fact: Increasing Submissions + Constant Budget



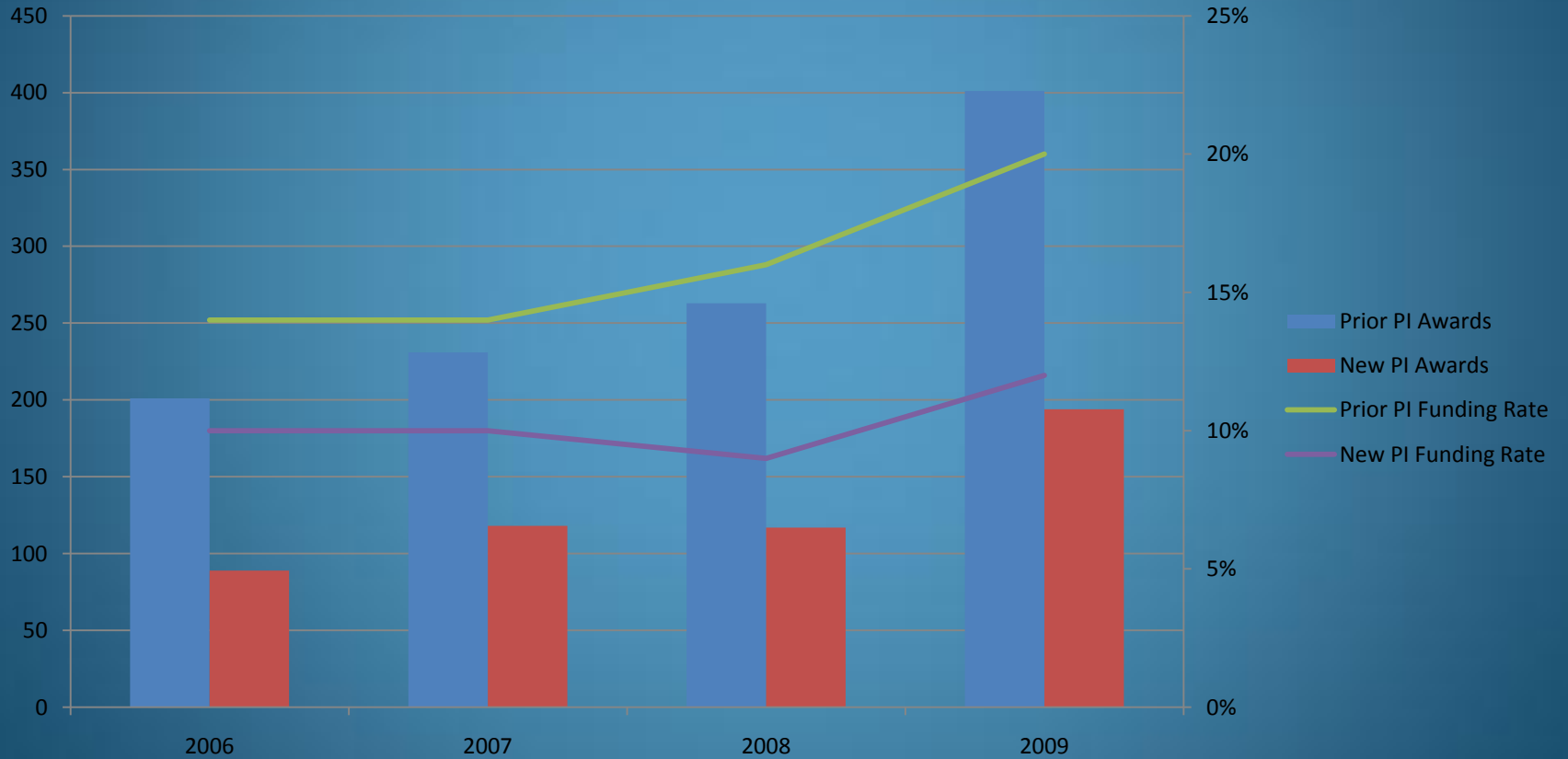
Proposal Submission in CBET

Proposal Pressure by Program



Experience Pays Off

CBET Funding Rates for Prior and New PIs



Steps towards Successful Proposals

- Begin with
 - Dialog with program officer
 - White paper
 - Short biography
- Get involved with NSF reviews

What Do Reviewers Look For?

- Proposals that address one or more NSF goals:
 - Discovery
 - Learning
 - Research infrastructure
 - Stewardship
- Intellectual merit
- Broader impact

Some Major Pitfalls

- Concentrating on your narrow focus, but ignoring other (major) aspects of the problem
- Hypotheses and Experimental Plan not in plain sight
- Disordered proposal write-up
- Too little (much) Preliminary Data

Early-Concept Grants for Exploratory Research (EAGER)

- Supports high-risk, exploratory, and potentially transformative research
- Began Jan. 1, 2009
- Up to \$300K over two years
- May be submitted any time; contact program officer prior to proposal submission

Some Major Pitfalls

- Concentrating on your narrow focus, but ignoring other (major) aspects of the problem
- Hypotheses and Experimental Plan not in plain sight
- Not everything that is Key is Spelled Out
- Disordered proposal write-up
- Too little (much) Preliminary Data
- Broader Technical Impact not discussed or too grandiose
- Broader Educational and Outreach not discussed or too grandiose

Final Comments

- There is a significant amount of funding focused on Energy and Bio-energy Issues
- Obtaining Funding is still a Competitive Venture
- Increase your Probability of Success by Developing Any Advantage and Following the Rules
- Comments and Questions from You