Berkeley Engineering

*Educating Leaders. Creating Knowledge. Serving Society.*

# Berkeley Engineering: Meeting the Challenges of University Research

**Prof. Tsu-Jae King Liu**

*Electrical Engineering & Computer Sciences Dept.*

*College of Engineering*

*University of California at Berkeley*

*UGIM 2012 Keynote Presentation*

# UC-Berkeley Overview

- **Founded in 1868**
- **35,838 students (25,540 undergraduates)**
- **2082 faculty, 130 departments (48 of 52 ranked in top 10), 80 interdisciplinary research units**
- **University faculty, alumni, and researchers have won 66 Nobel Prizes, 9 Wolf Prizes, 7 Fields Medals, 15 Turing Awards, 45 MacArthur Fellowships, 20 Academy Awards, 11 Pulitzer Prizes**
- **Lawrence Berkeley National Laboratory was founded on the UC Berkeley campus in 1931 as an interdisciplinary research center**

# College of Engineering Overview

**2011 US News & World Report**

**#1 Graduate Programs:**

- **Civil Engineering**
- **Computer Science**
- **Environmental Engineering**
- **Computer Engineering**

## *Academics*

- **7 departments**
- **208 full-time faculty**
- **9 programs in Top 5 *US News & World Report rankings* at both undergraduate and graduate levels**

## *Research*

- **Leading-edge research in information technology, high-performance computing, advanced materials, nanotechnology, mechatronics, green manufacturing, environmental science, energy systems, healthcare systems, smart transportation, synthetic biology and regenerative medicine, nuclear energy and applications**
- **80 faculty in National Academy of Engineering**

# College of Engineering by the Numbers

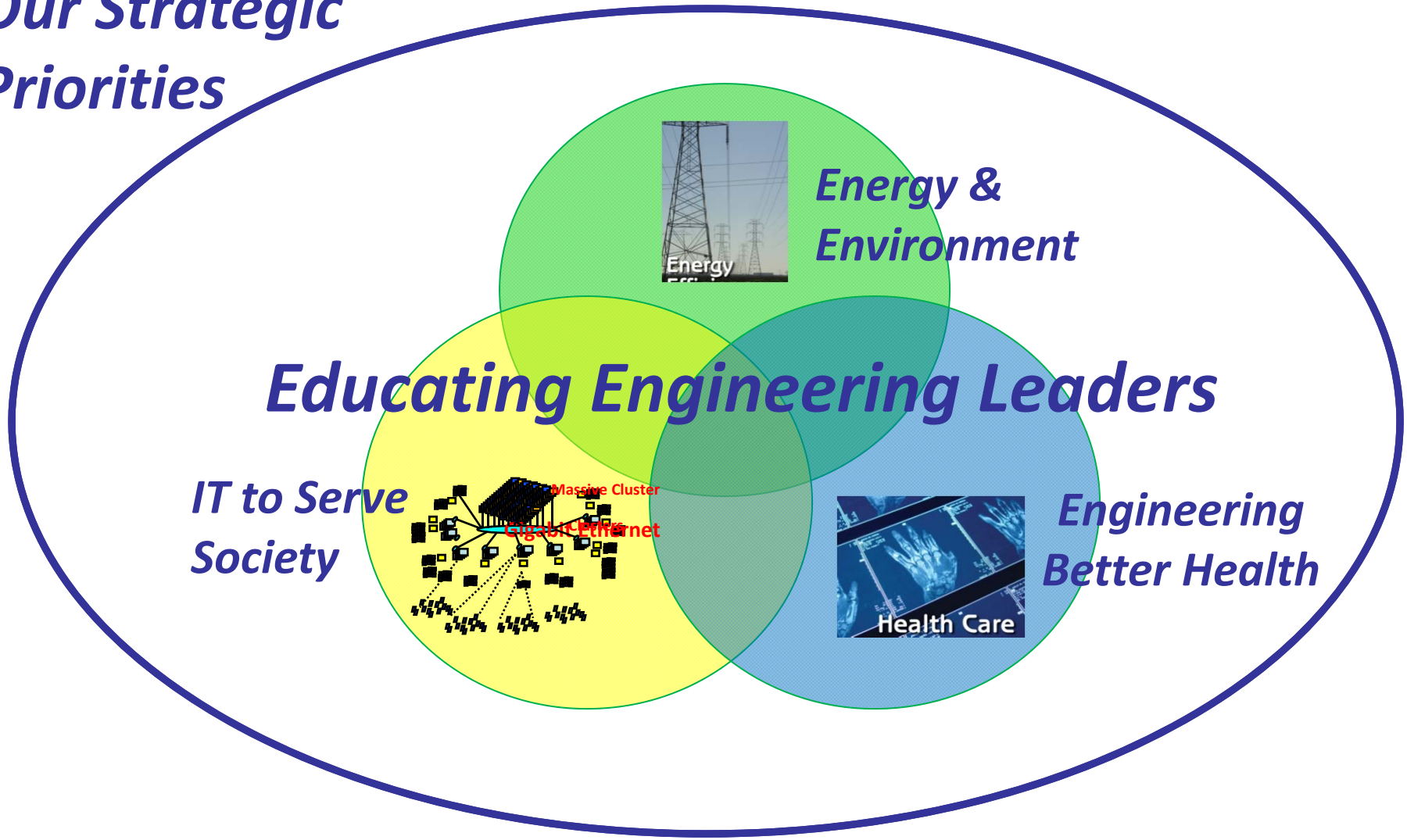
**208 full-time faculty**

**2,870 undergraduate + 1,564 graduate students**

| DEPARTMENT | Undergraduate | Graduate |
|---|---|---|
| Electrical Engineering & Computer Sciences | 1013 | 507 |
| Mechanical Engineering | 548 | 291 |
| Bioengineering | 396 | 165 |
| Civil & Environmental Engineering | 352 | 344 |
| Industrial Eng. & Operations Research | 119 | 64 |
| Materials Science & Engineering | 105 | 99 |
| Nuclear Engineering | 54 | 56 |
| Other* | 283 | 38 |

*Computational Engineering, Engineering Mathematics and Statistics, Engineering Physics and Environmental Engineering Science

# Our Strategic Priorities




**Mission: Prepare engineers and scientists with the multidisciplinary skills to lead enterprises of all scales, in industry, government and the nonprofit sector.**

**Undergraduates:** ***Cultivating leaders***

**Ctr for Entrepreneurship & Technology, Blum Ctr for Developing Economies**

**Master's of Engineering Degree Program:** ***Professional engineering education***

**Breadth of coursework in leadership**

Depth of coursework in area of technical specialization

**Integrative capstone project**

**Executive Education:** ***Meeting the needs of companies and organizations***

**Tailored executive education and other educational programs in technology innovation and management**

# MEng Curriculum

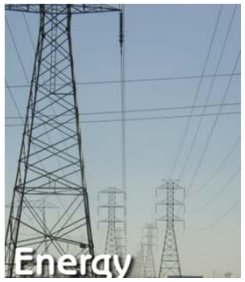
**24 units in 2 Semesters**

| | Fall Semester | Units | Spring Semester | Units |
|---|---|---|---|---|
| **Leadership coursework** | **Engineering Leadership 1** | 3 | **Engineering Leadership 2** | 3 |
| | **Innovation Lecture Series** | 1 | | |
| **Capstone Project** | **Capstone Project** | 2 | **Capstone Project** | 3 |
| **Technical Coursework** | **Technical Elective 1** | 3 | **Technical Elective 3** | 3 |
| | **Technical Elective 2** | 3 | **Technical Elective 4** | 3 |
| | Total units: | **12** | Total units: | **12** |

Capstone project teams of 3-4 students spend approximately 8 to 15 hours per week working on the project.

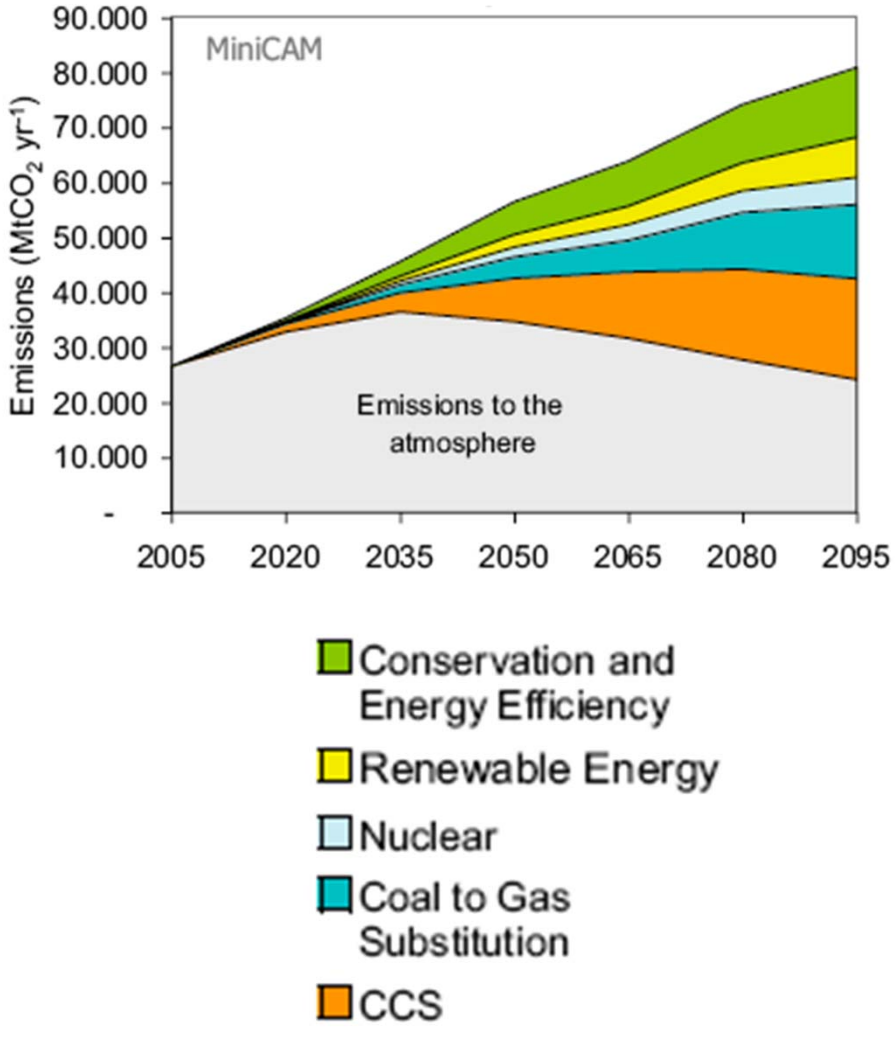
# Strategic Priority #1:

## Sustainable Energy & Environment



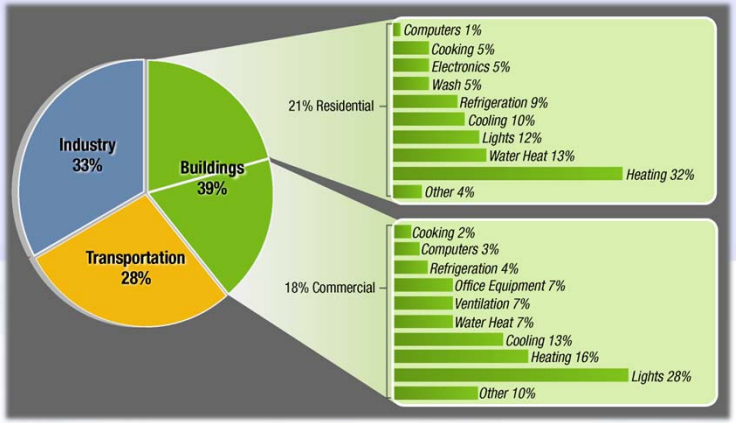

**Our integrated solution:**

1. Conservation & Energy Efficiency
   - Power-Aware Buildings
   - Fuel Efficiency
   - Sustainable Transportation
2. Renewable Energy
   - Alternative Fuels
   - Alternative Power
3. Nuclear Energy
4. Coal to Gas Substitution
5. Carbon Capture & Storage



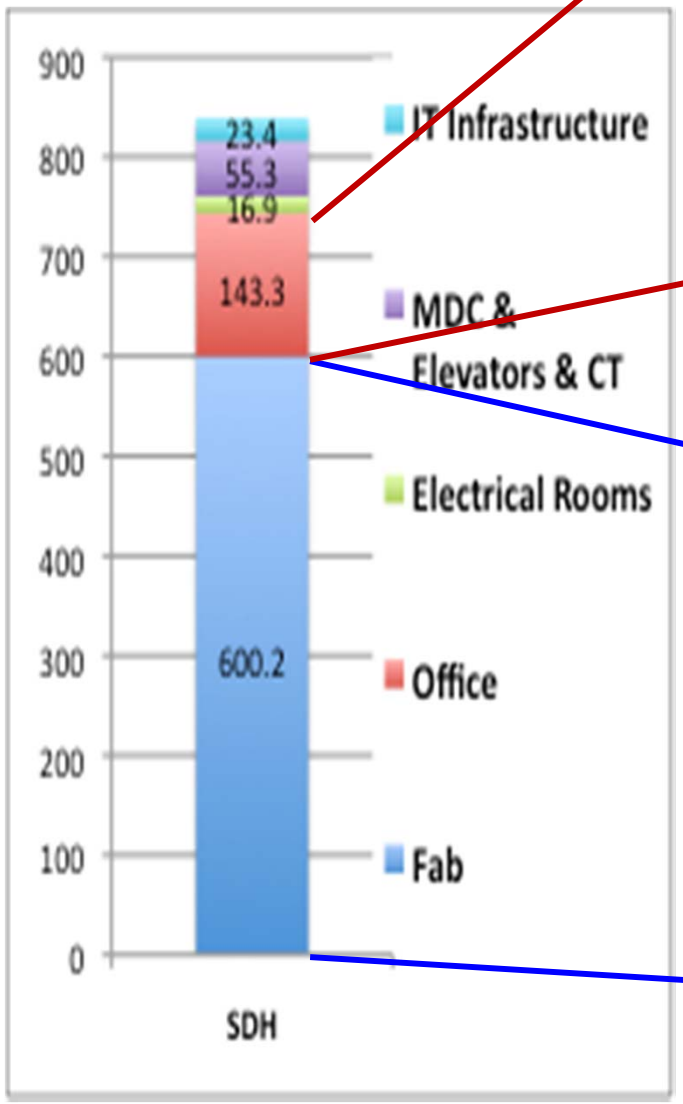
# U.S. buildings consume 39% of total energy and 71% of total electricity

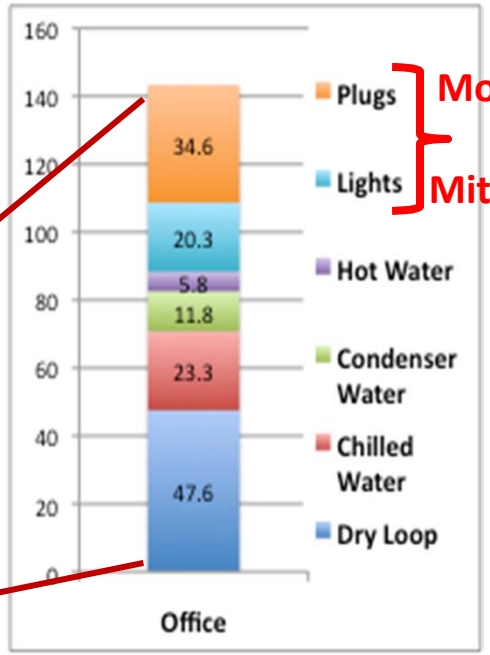
→ 48% of carbon emissions



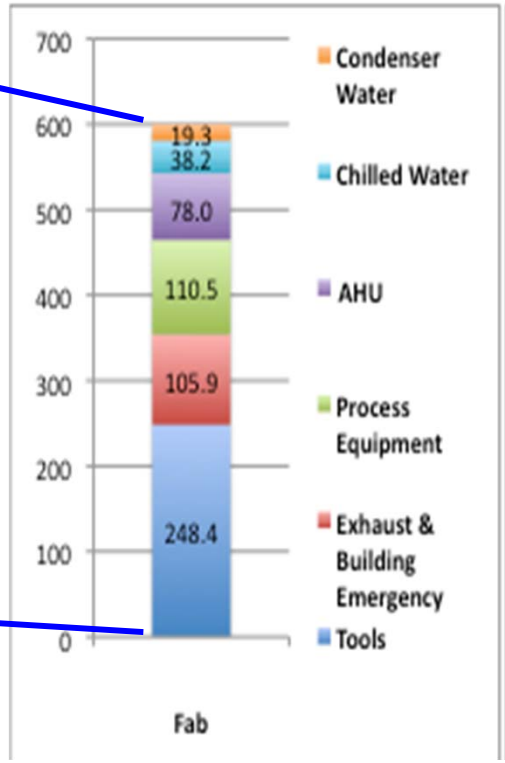

**Source: Buildings Energy Data Book, U.S. Dept. of Energy**

# Electricity Usage in Sutardja Dai Hall




Monitor & Mitigate!

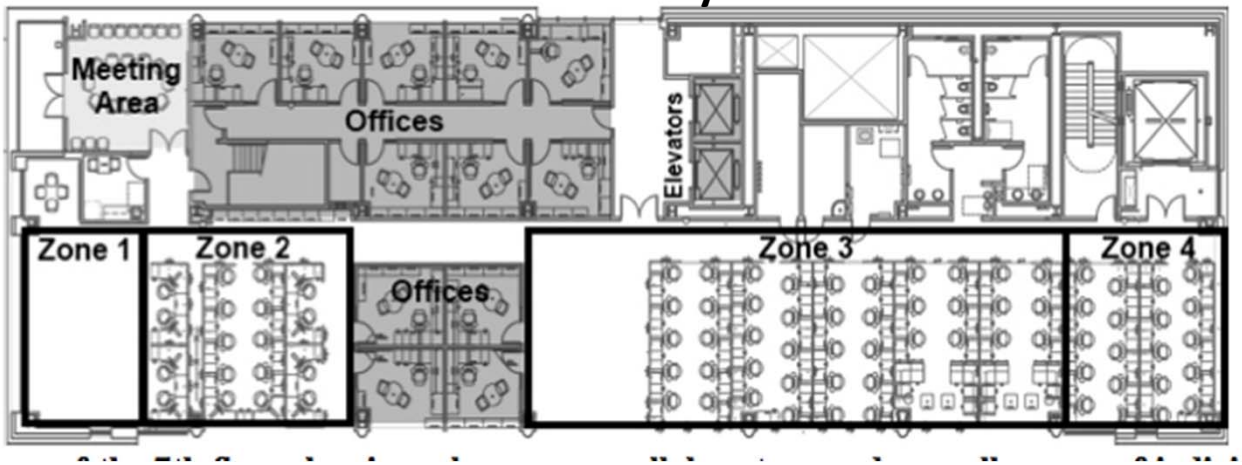



courtesy David Culler

# Automated Control for Energy Savings

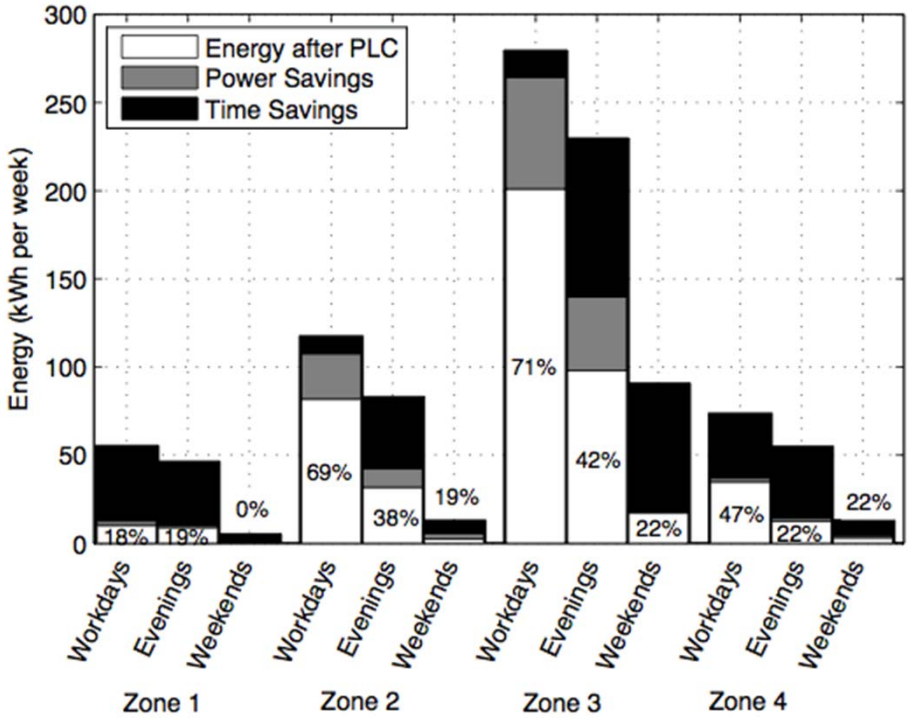
**Sutardja Dai Hall**

**4th Floor Layout**




- **Personalized automated Lighting Control (PLC)**
  - 3 controllable ballasts per fixture
  - 4 zones per floor

**→ >50% energy savings!**




**courtesy David Culler**

# National Science Foundation (NSF) Science and Technology Center (STC) for Energy Efficient Electronics Science

**Goal: Develop a new switch that can operate with $V_{DD}$ = 1 mV**

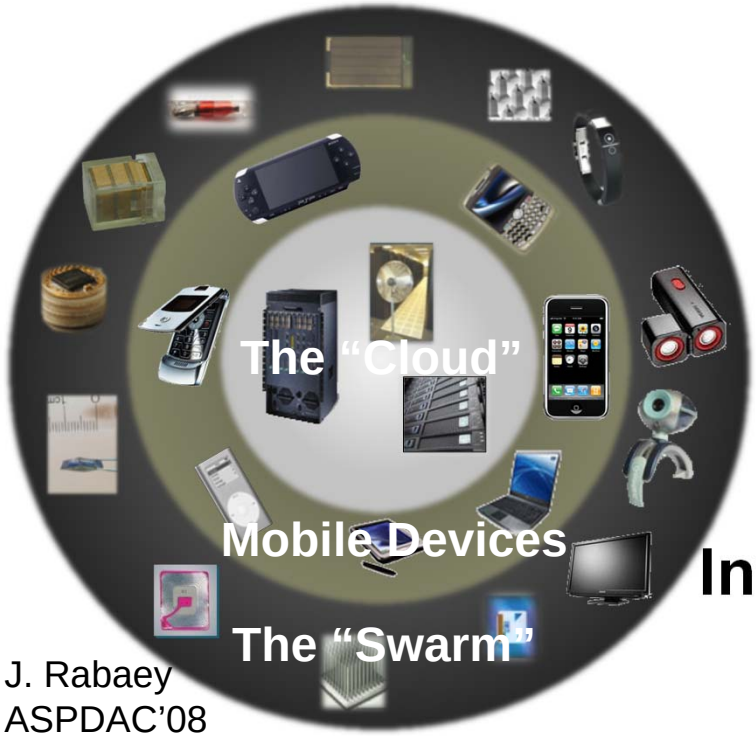
**PI: Eli Yablonovitch (UC Berkeley)**

**10-yr project, started 15 Sep 2010**

- **Theme I: Nanoelectronics** (Prof. Eli Yablonovitch)
- **Theme II: Nanomechanics** (Prof. Tsu-Jae King Liu)
- **Theme III: Nanomagnetics** (Prof. Jeffrey Bokor)
- **Theme IV: Nanophotonics** (Prof. Ming Wu)

Contra Costa-UC Berkeley-MIT-LATTC-Stanford-Tuskegee

# A Vision of the Future

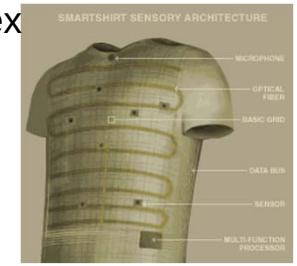



J. Rabaey
ASPDAC'08


## Information technology will be

- pervasive
- embedded
- human-centered
- solving societal scale problems

Sensatex

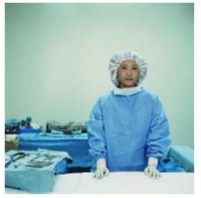



Philips

**Transportation**

**Energy**

**Health care**



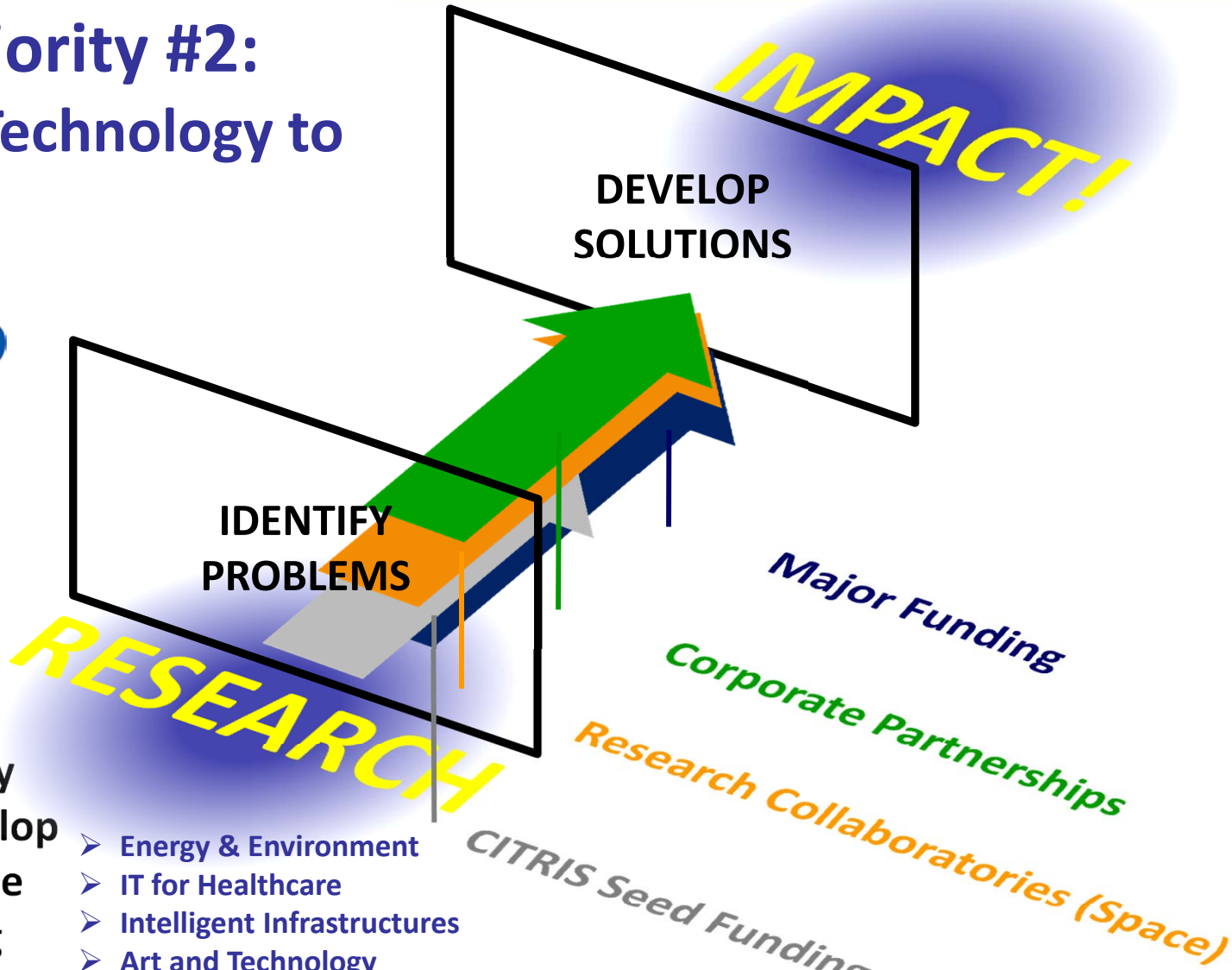
**Environment**

**Disaster response**

# Strategic Priority #2:
## Information Technology to Serve Society

CITRIS

- Established 2001
- 4 UC campuses
  - Berkeley
  - Davis
  - Merced
  - Santa Cruz
- Multi-disciplinary research to develop IT solutions to the most challenging societal problems




- Energy & Environment
- IT for Healthcare
- Intelligent Infrastructures
- Art and Technology
- IT for Emerging Economies

# Founding and Platinum Corporate Members
















# Associate Corporate Members




















# Industry Partnerships

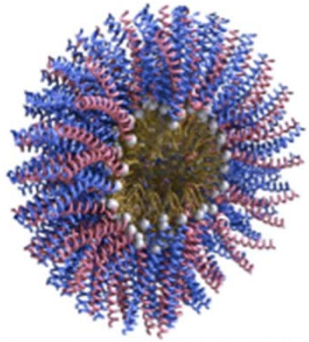
## Benefits to industry:

- Innovative ideas and research results
- Access to top students and faculty

## Benefits to university:

- Insight into problems faced by industry and society
- Application of research to solve real-world problems

# Strategic Priority #3: Engineering Better Health



- **Translational Biomedicine Institute**

  Amy Herr & Steve Conolly, UCB; Tejal Desai & Marc Shulman, UCSF

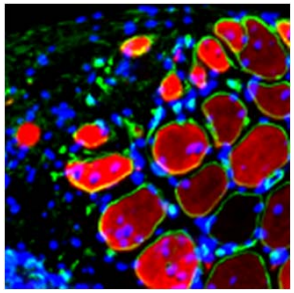
  - **BioMEMS & Microfluidics** (Luke Lee, Dan Fletcher, Amy Herr)
  - **Imaging** (Steve Conolly et al)
  - **Drug Discovery & Delivery**

(a) 1.5 T MRI (b) 0.5/0.13 T PMRI

- **Regenerative Therapies**

  David Shaffer, UCB; Arnold Kriegstein, UCSF

  - **Stem cells, tissue engineering, …**

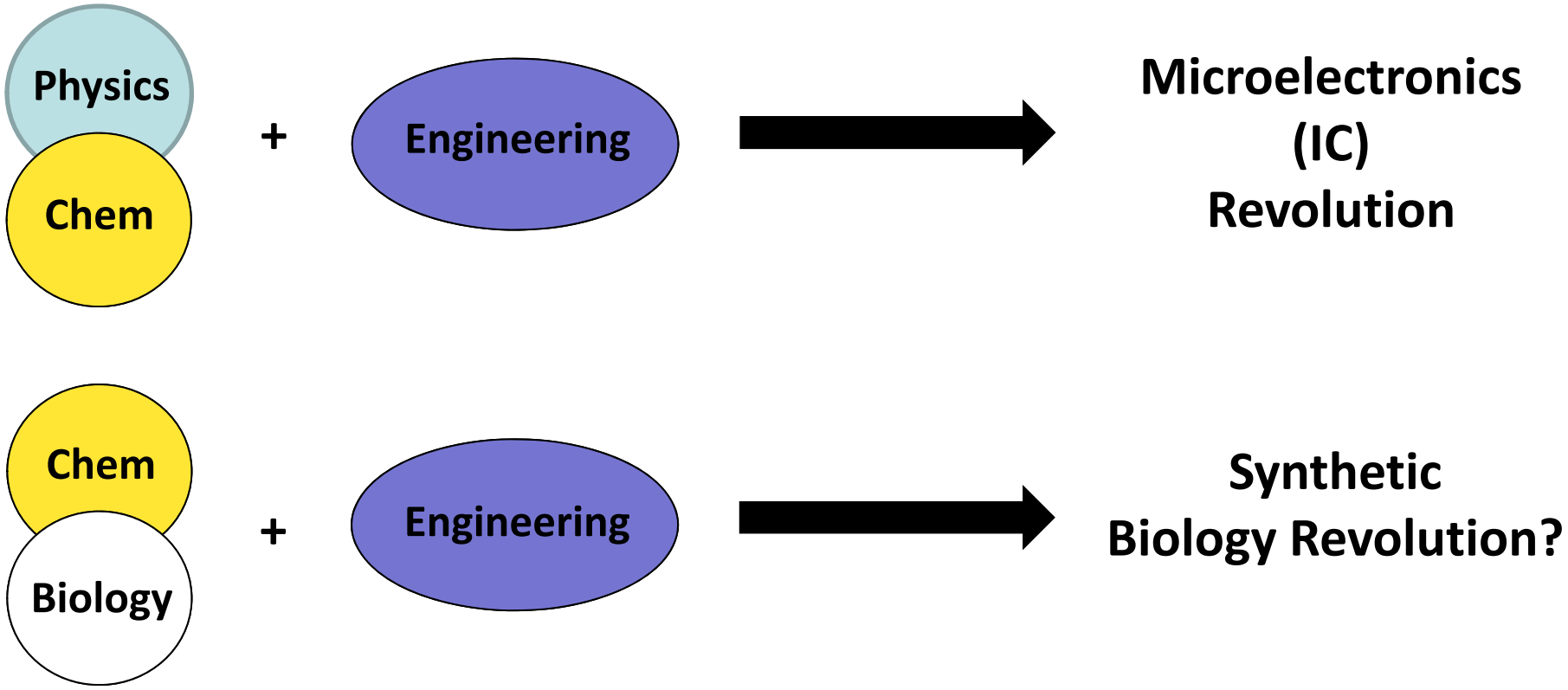


- **Synthetic Biology**

  Adam Arkin, UCB; Wendell Lim, UCSF

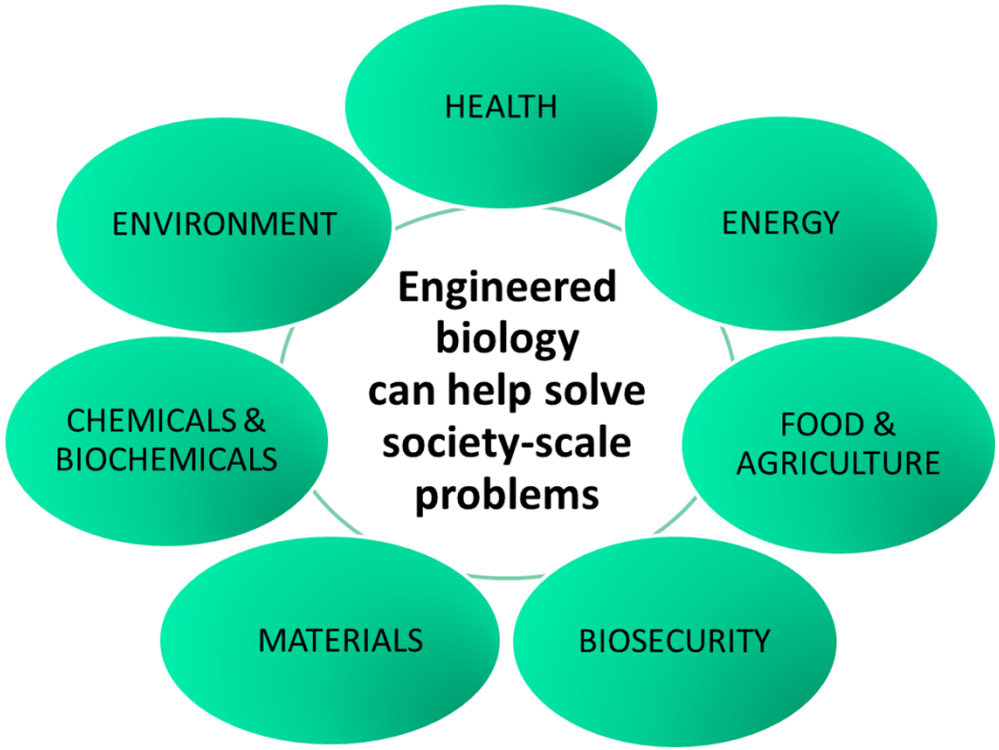
  - **Multivalent vaccines, cell-based therapies, biomaterials**

**Understand Science + Engineer Systems = New Solutions**



# What is Synthetic Biology?

- **Engineering of biological components and systems to perform improved and novel functions that benefit society with transformational impact.**



# SynBERC
Synthetic Biology Engineering Research Center

**PI: Jay Keasling (UC Berkeley)**

**10-yr project, started in 2006**

**Goals:**

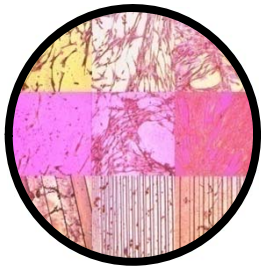
- **To develop the foundations for assembling standard biological parts into integrated biological systems useful for energy, health and the environment**
- **To explore how social forces shape and are shaped by SynBio**

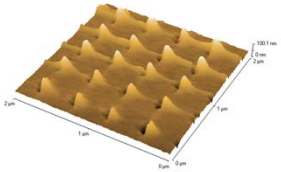
# Supporting Engineering Research

- Shared research laboratories
- Consolidated research support services

# The Marvell Nanofabrication Laboratory

## Bioelectronics

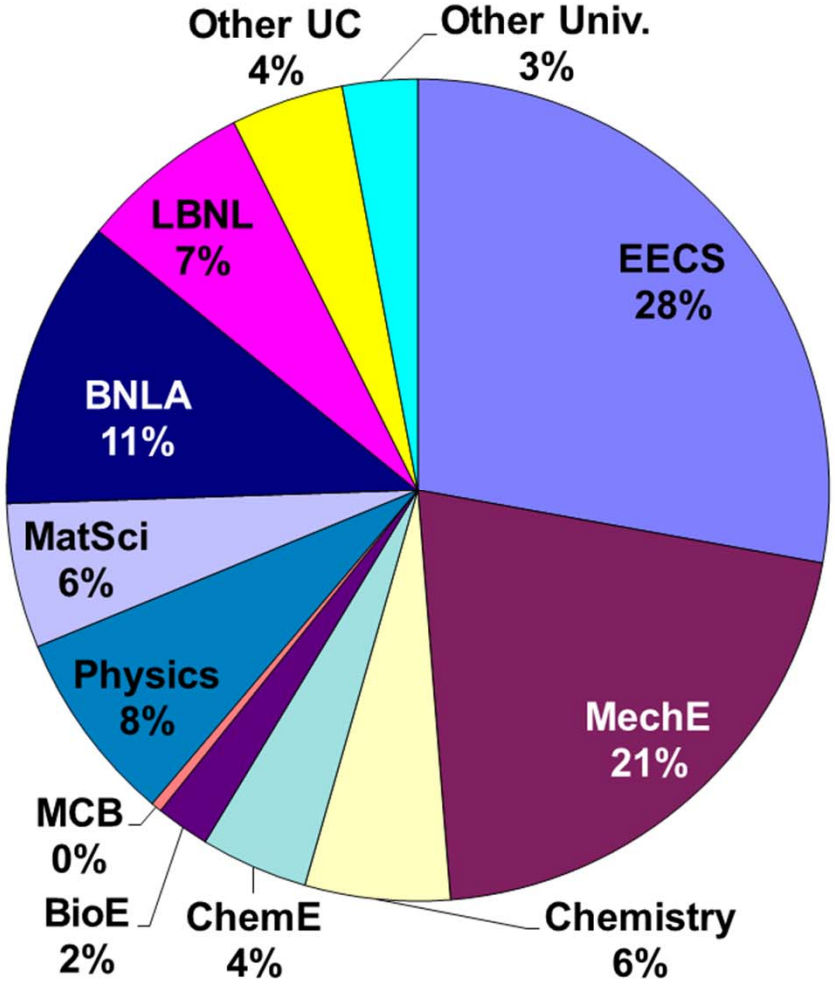




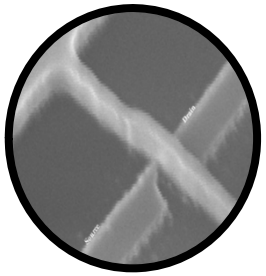
quantum dot growth


## Optoelectronics

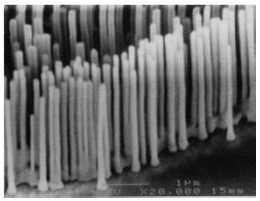
## Membership (474 total)

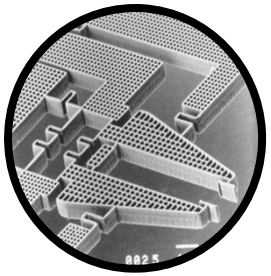



## CMOS



nanowire growth



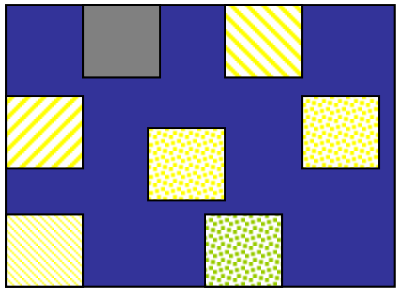


## MEMS

# Operational Models

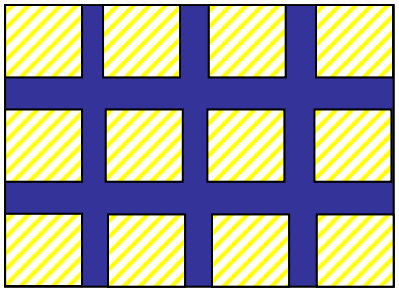
**Common Academic Model**

individual fiefdoms



**Successful Micro/Nanolab Model**

shared laboratory



**The shared model implies professional administration and support staff, funded by "per use" fees:**

- **efficient use of valuable laboratory space**
- **significant improvement in quality of support**
- **PI research flexibility**
- **research cross fertilization**

***Engineering Research Support Organization***

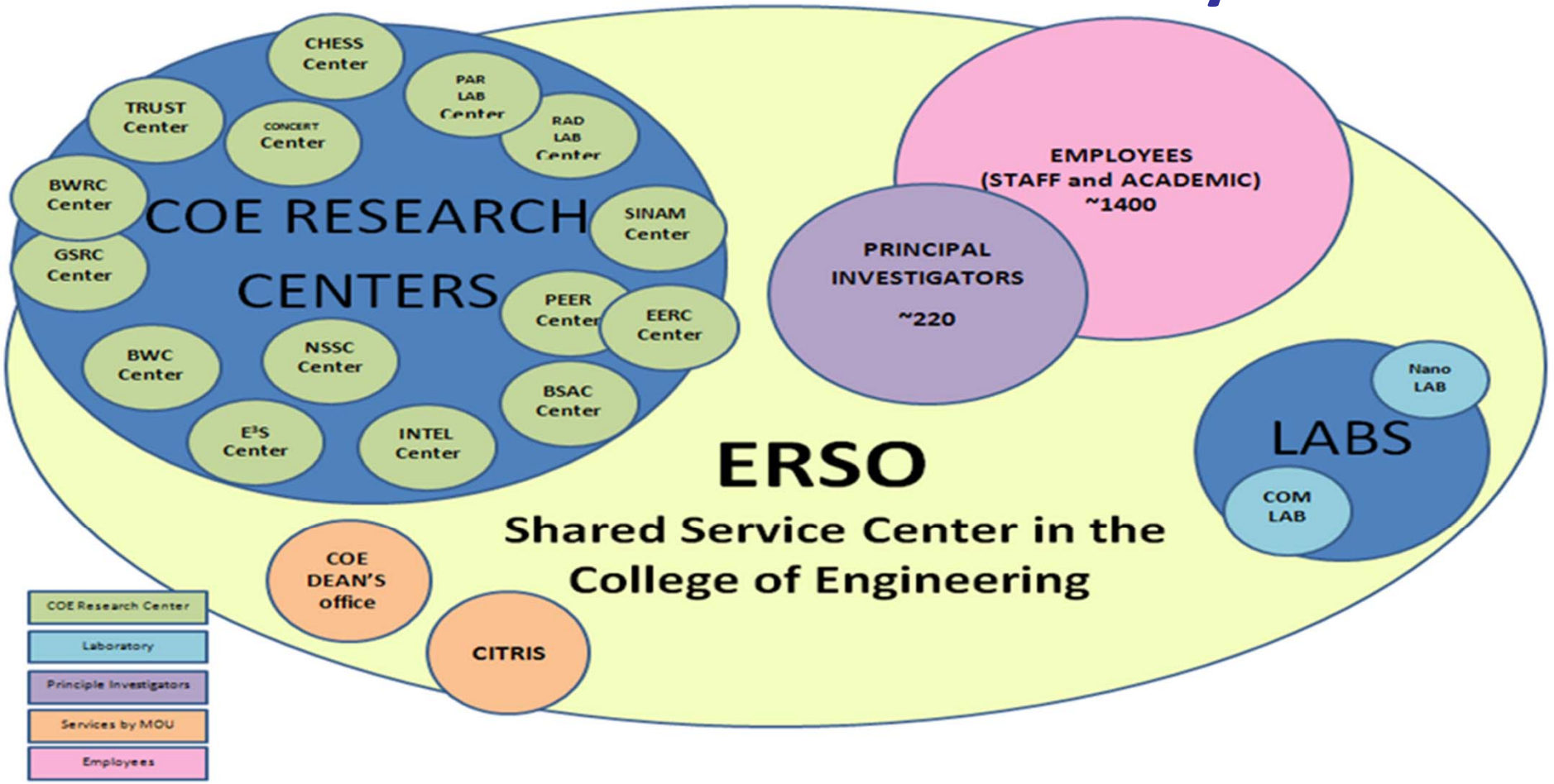
*University of California, Berkeley*

- **ERSO was formed in July 2005 to provide research support to CoE faculty via well-trained teams of staff**
  - Knowledgeable in sound business and research administration practices, financial management, and quality service delivery
  - Cross-trained to allow maximum use of resources
  - Structured with inherent flexibility to allow proper research support allocation to meet changing demands
- **Responsible for adherence with University Principles of Accountability**
  - Informed of current pertinent policies and procedures
  - Consistent in policy interpretation and application

# ERSO Research Support Services

- **Pre-award and post-award grants management**
- **Research gift administration**
- **Procurement of goods and services**
- **Shipping, receiving and delivery services**
- **Property management and equipment inventory**
- **Travel and entertainment payment requests**
- **Comprehensive human resources services**
  - staff and academic personnel
- **Comprehensive payroll services**

# ERSO Customer Community




**supported by ~70 ERSO Central Administrative staff**

# Management of Administrative Resources

**ERSO uses metrics to:**

- **Determine resource allocation**
- **Manage workload distribution**
- **Plan for future workforce needs and changes**
- **Determine restructuring or realignment of units**
- **Manage budget**
- **Manage performance**
- **Determine costing for services**
- **Determine priorities and areas of need**

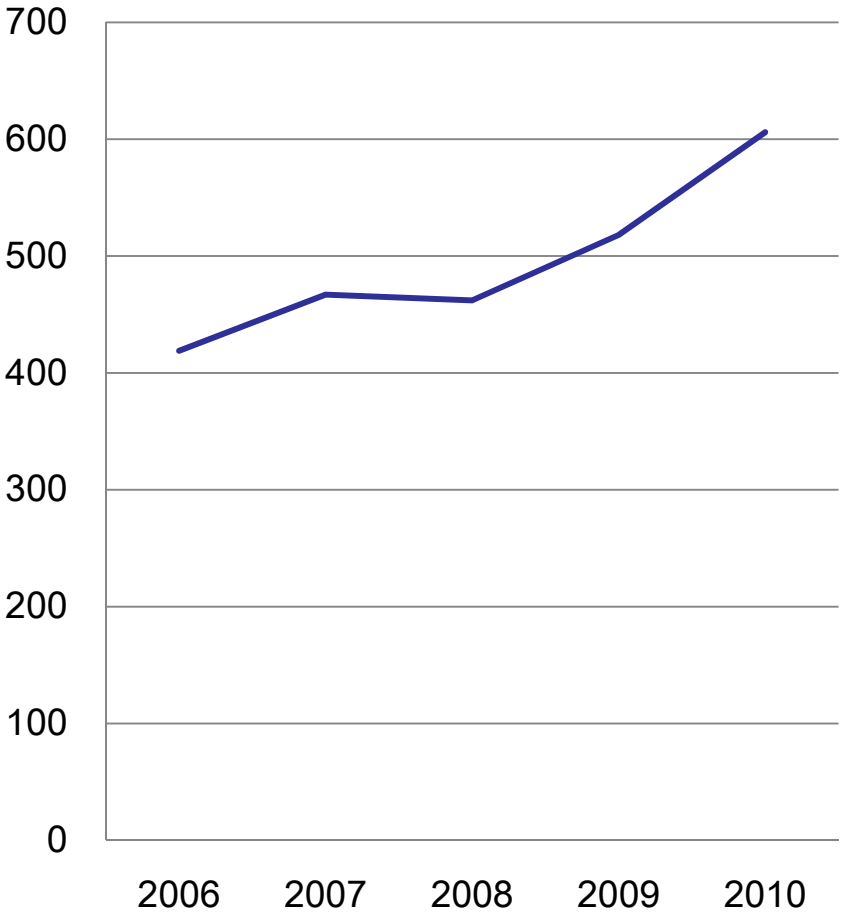
# Examples of ERSO Metrics

- **Customer satisfaction**
  - based on annual survey, feedback
- **Number of proposals submitted by PIs**
- **Number of awards and sub-awards**
- **Direct research expenditures**
- **# of transactions processed**

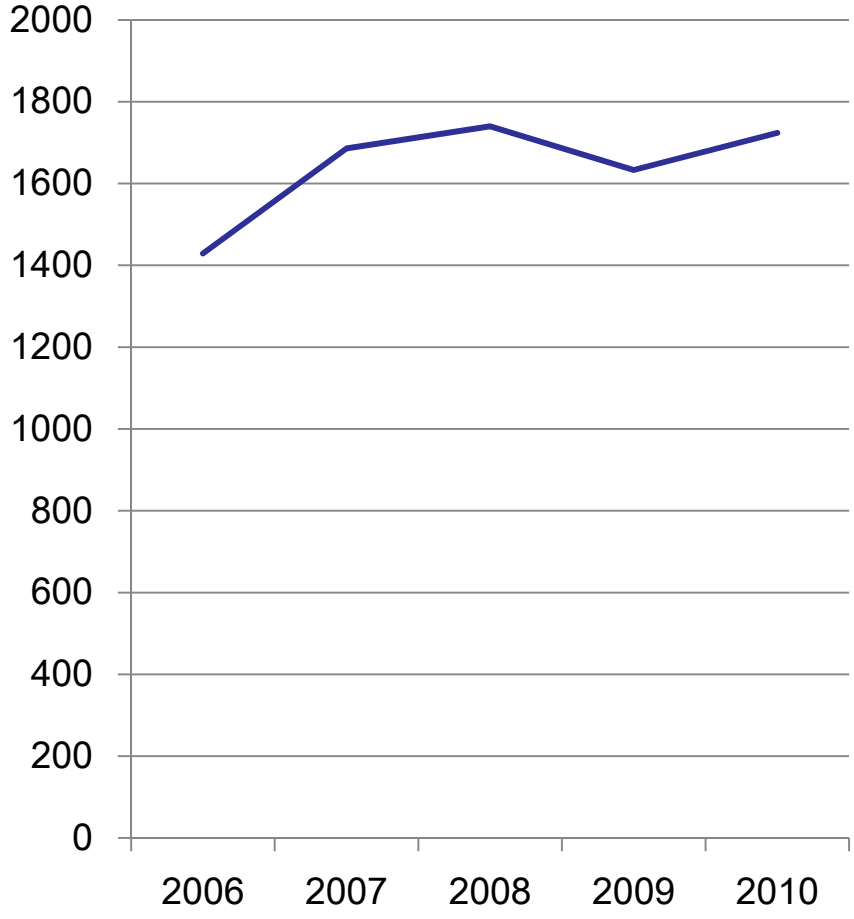
***Engineering Research Support Organization***

*University of California, Berkeley*

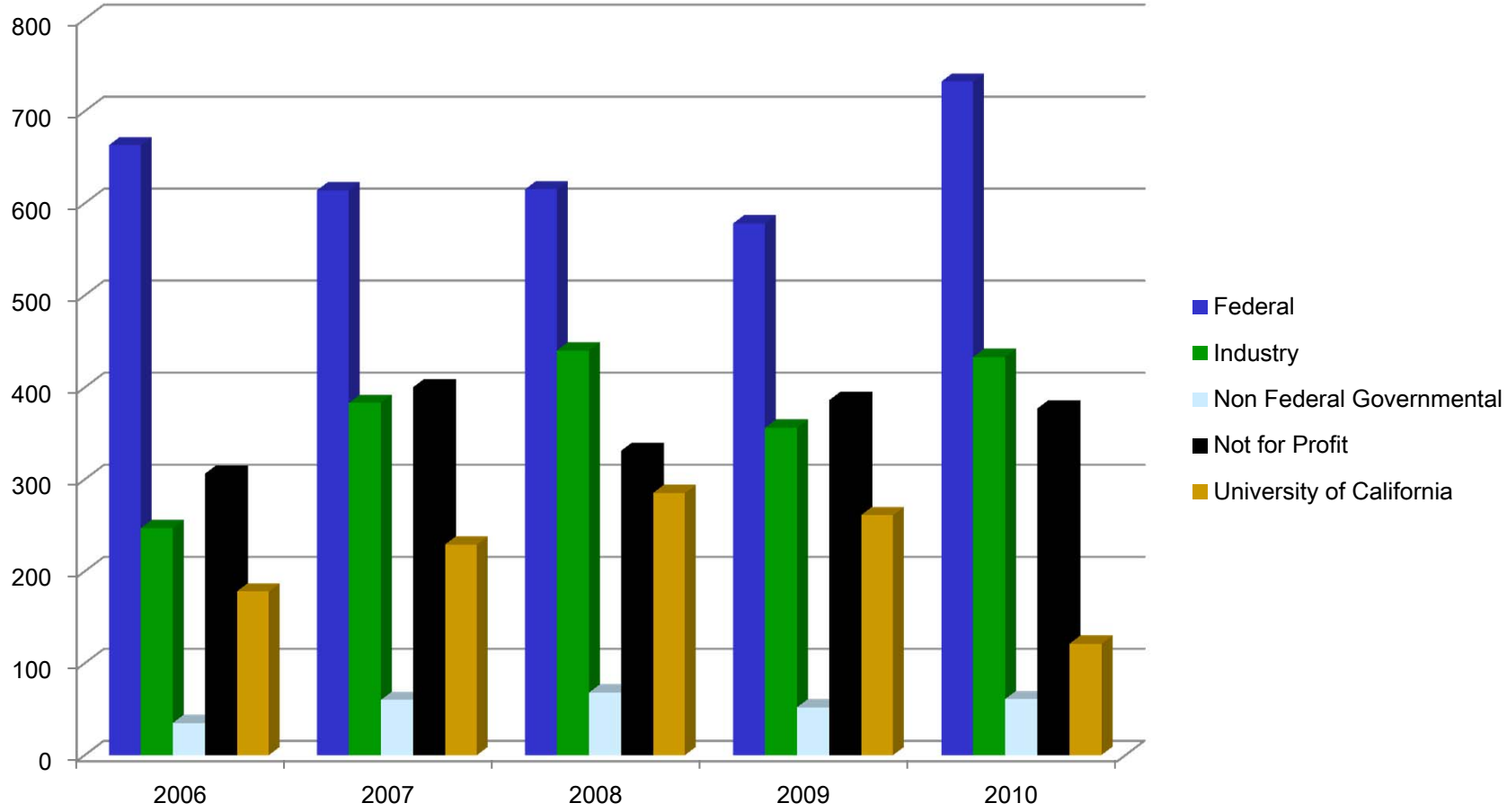
## Number of Proposals Submitted




## Number of Awards



# Number of Awards, by Sponsor Type

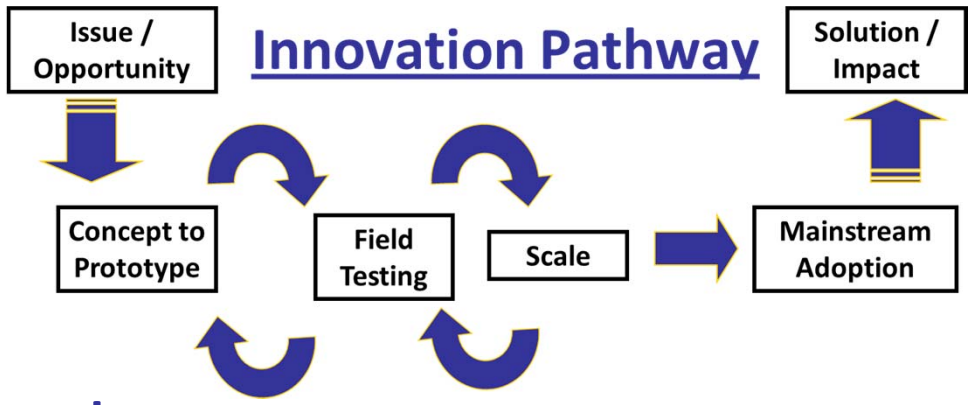


# Summary

- **Berkeley Engineering is dedicated to creating tomorrow's leaders and supporting today's pioneers, while expanding the base of engineering knowledge through original research and developing technology to serve the needs of society.**
- **Advances in technology continue to create opportunities for innovation in every field of engineering!**

**Keys to success include:**

- **Multidisciplinary teams**
- **Collaboration/partnerships with government & industry**
- **Shared research labs**
- **Comprehensive research support**



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# Welcome!