Berkeley Center for Green Chemistry

Marty Mulvihill, Executive Director

February 21st, 2013
ANSI Chemicals Teleconference

http://bcgc.berkeley.edu

Sustainability and Green Chemistry both motivate and inform the discovery and adoption of safer materials.

Sustainability

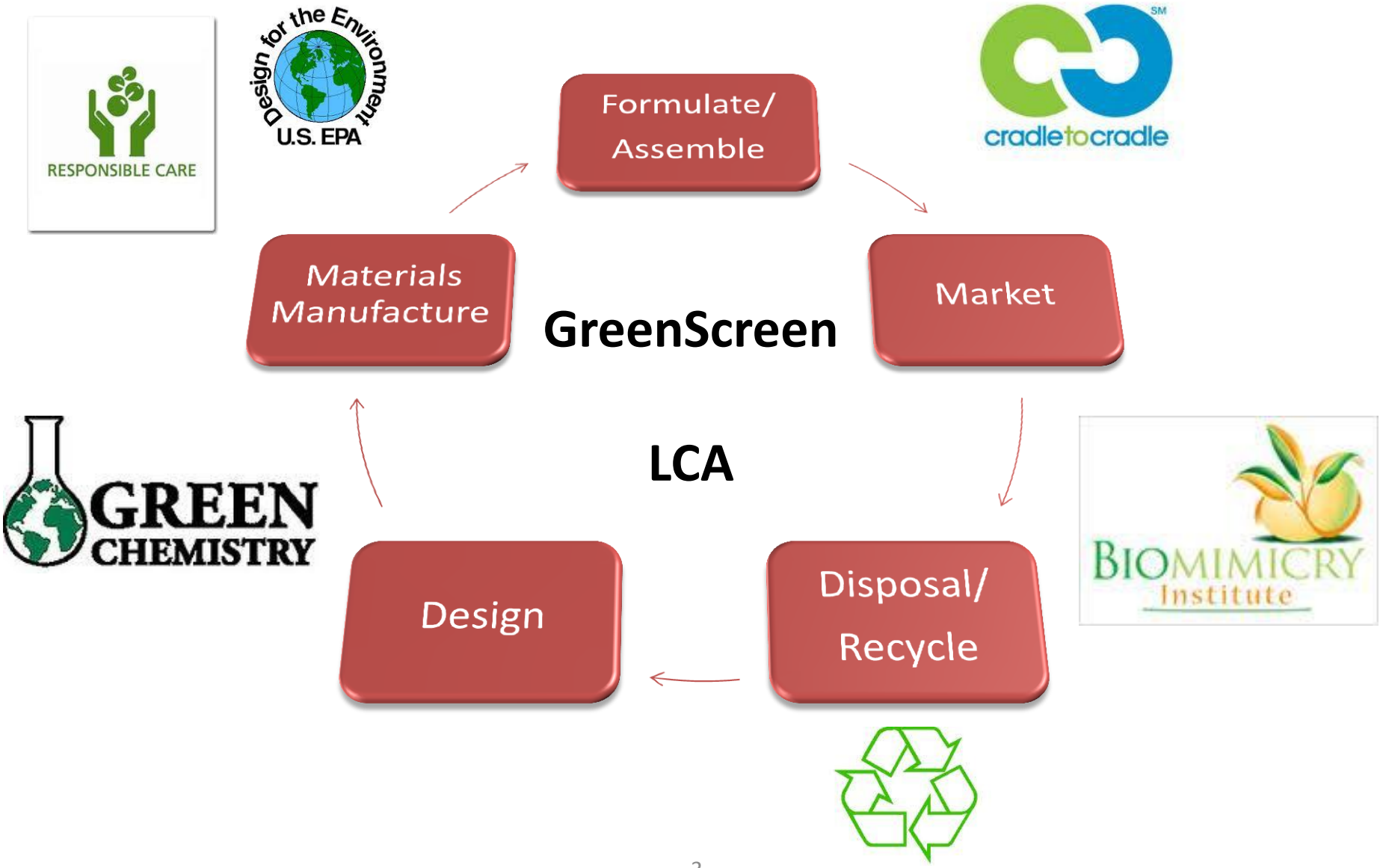
"Meeting the needs of the present without compromising the ability of future generations to meet their needs"

– *Our Common Future, Report of the Brundtland Commission, Oxford University Press 1987*

Green Chemistry

- Sustainability at the molecular level
- The science behind the discovery and implementation of safer, cleaner, and more efficient chemical processes and products
- Entails design of chemical products and processes that aim to eliminate the use and generation of hazardous substances based on **12 principles** that:
  - Seek to minimize:
    - Waste
    - Energy use
    - Resource use (maximize efficiency)
  - Use renewable resources

There are Many Related Approaches That Speak to Different Stakeholders



BERKELEY CENTER FOR GREEN CHEMISTRY

We have adopted a systems approach to advancing green chemistry.

Applications — **Engineering**

Environmental Sustainability — **Natural Resources**

Collaboratively Advancing Sustainable Solutions

New Molecules — **Chemistry**

Economic Drivers — **Business**

Ensuring Human Health — **Public Health**

Students

- Undergraduate labs
- Four new interdisciplinary graduate courses
- Seminars and invited speakers

Stakeholders

- BCGC Consortium: Businesses, Governments, and NGOs
- Symposia in Green chemistry

BERKELEY CENTER FOR GREEN CHEMISTRY

Director, John Arnold
Chemistry

Marty Mulvihill
Executive Director

Richmond Sarpong
Chemistry

Megan Schwarzman
Public Health

Michael Wilson
Public Health

Chris Vulpe
Toxicology

Chris Rosen
Business

Alastair Iles
ESPM

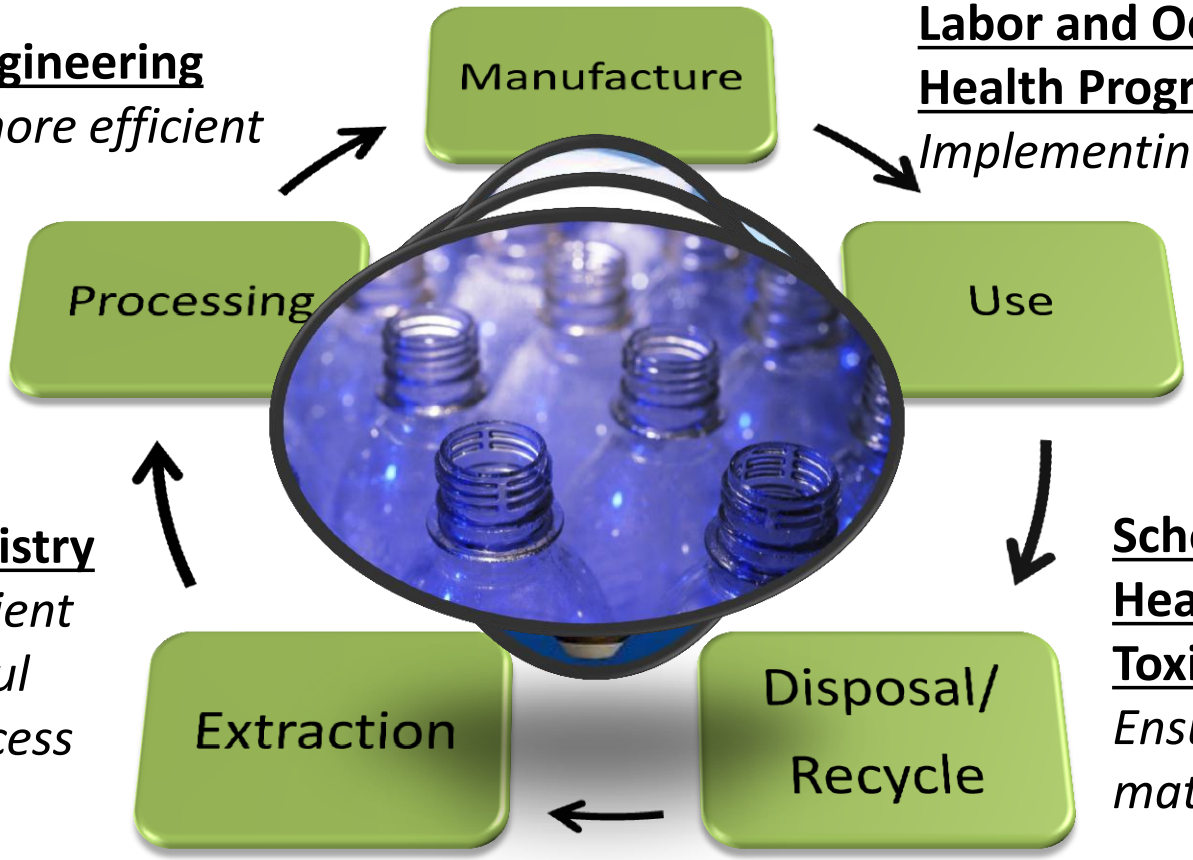
Our interdisciplinary leadership team reflects our integrated approach.

We envision multidisciplinary integration that leverages disciplinary expertise.

Hass School of Business
Characterizing the Business drivers

College of Engineering
Developing more efficient processes

Labor and Occupational Health Program
Implementing understanding

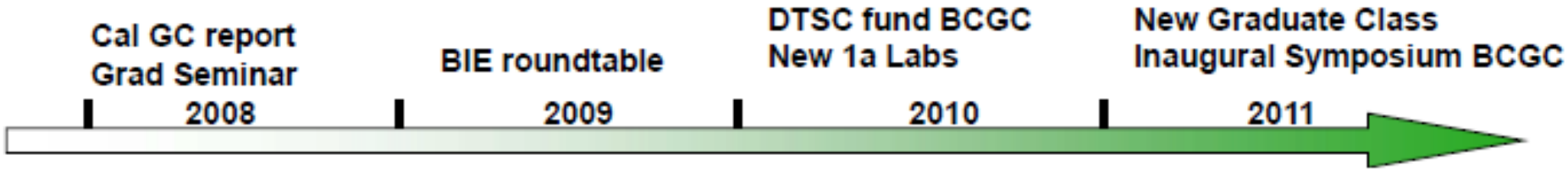


College of Chemistry
Using more efficient and less impactful chemicals & process

School of Public Health and Toxicology
Ensuring safer materials selection

College of Natural Resources
Understanding the impacts of chemical products on the environment

The BCGC began as a small group of people in Public Health and Chemistry

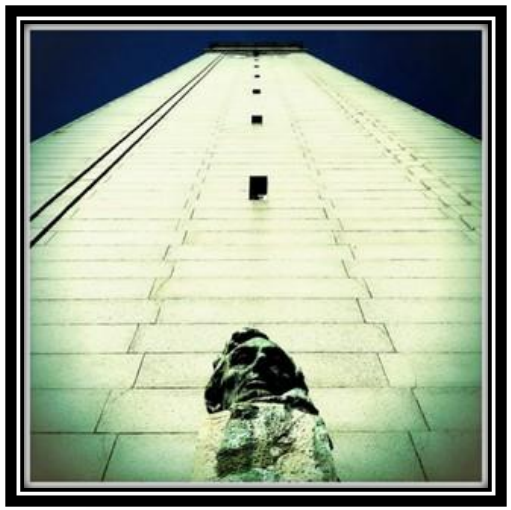


2012-2013 BCGC activities

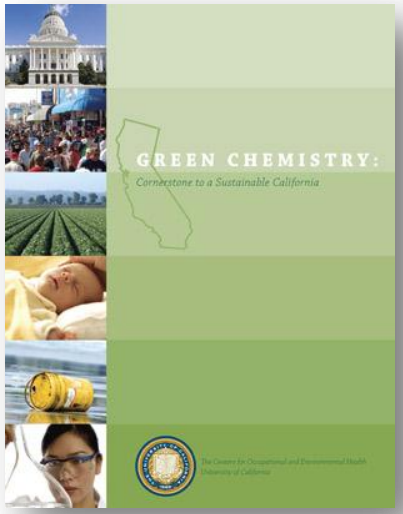
1. Helped generate long-term support for Undergraduate Green Chemistry Curriculum.
2. 3 new graduate seminar courses in the spring:
    1. Toxicology for Chemists 2. Ethics of Green Technology
    3. Metrics for Green Engineering
3. Pilot Greener Solutions class with Hewlett Packard and DTSC.
4. 5th year of the Green Chemistry and Sustainability Seminar
5. Launched new Systems Approach to Green Energy fellowship program with 3 million dollar grant from NSF.

And has grown quickly over the past 4 years.

Different approaches to meeting the Land Grant University mandate have been adopted across campus.



"…without excluding other scientific and classical studies and including military tactic, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life." **-Morrill Act 1862**



DOW®

DUPONT

3M

Our goal is to inform and support all of these approaches .

BERKELEY CENTER FOR GREEN CHEMISTRY

Mission: To bring about a generational transformation toward the design and use of inherently safer chemicals and materials.

Education

Integrate the chemical sciences, environmental health sciences, and the study of public and private governance into a cohesive **interdisciplinary educational program**.

Research

Develop a **world-class research program** that designs novel chemical processes and materials and investigates new approaches to toxicity testing, exposure analysis, and alternatives assessment.

Engagement

Provide **technical support** to decision- makers, workers, community organizations and businesses working to **advance green chemistry**.

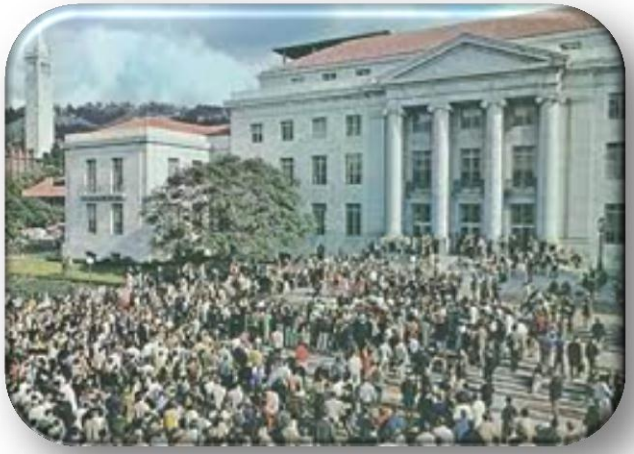
BERKELEY CENTER FOR GREEN CHEMISTRY

New Curriculum Development

Undergraduate Education

Introductory chemistry laboratory students (~2,500 students/year) now:

- Practice green chemistry
- Learn in context
- Use greener laboratory practices



Graduate Education

- Five new interdisciplinary graduate classes in green chemistry
- Project-based courses
- Green Chemistry and Sustainable Design Seminar (5th year)
- Systems Approach to Green Energy Graduate Fellowships (IGERT)

Funding provided under a grant from the California EPA, Department of Toxic Substances Control

New Curriculum Engages Undergraduates

Green Chemistry = New Chemistry

- Multi-week modules for research-like experience

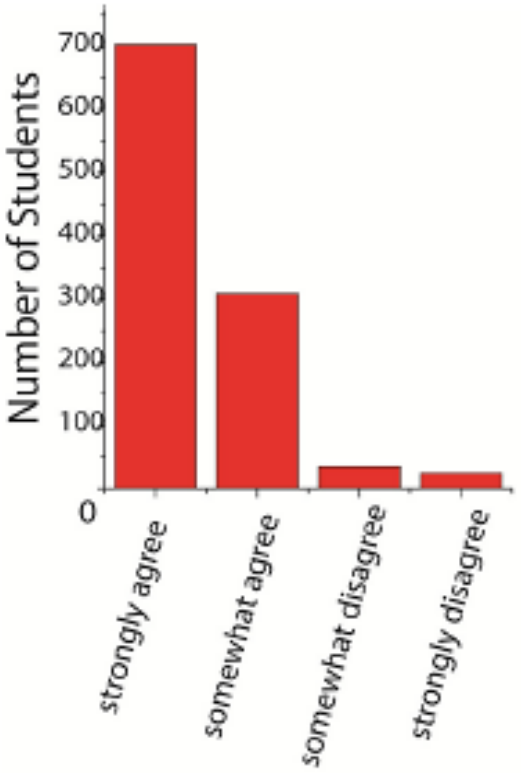
1. *BioFuels* 2. *CO_2 Acidification* 3. *Dyes*

- Give students a valuable learning context.
- Rigorous chemistry

- Bio-based starting materials
- Inherently safer reagents
- Discuss environmental concepts

Student Impact

"I believe Green Chemistry techniques and practices are important to modern society."



- ❖ 2500 student/year
- ❖ > 50% of Berkeley undergrads take chemistry

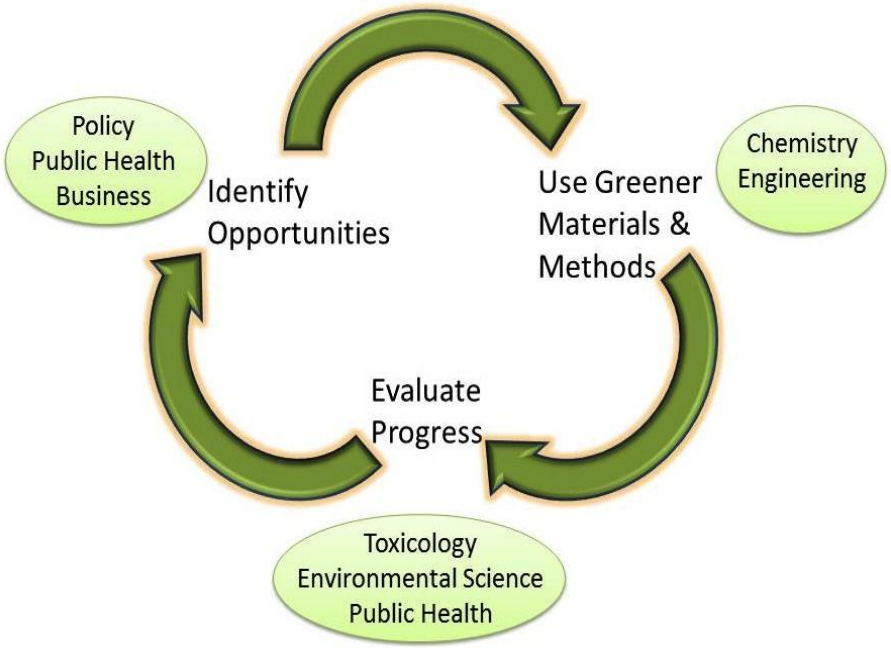
Graduate Curriculum and Fellowships Integrate Multidisciplinary Perspectives and Research Approaches

2012: Awarded a $3 million NSF grant to establish the SAGE (Systems Approach to Green Energy) graduate fellowship

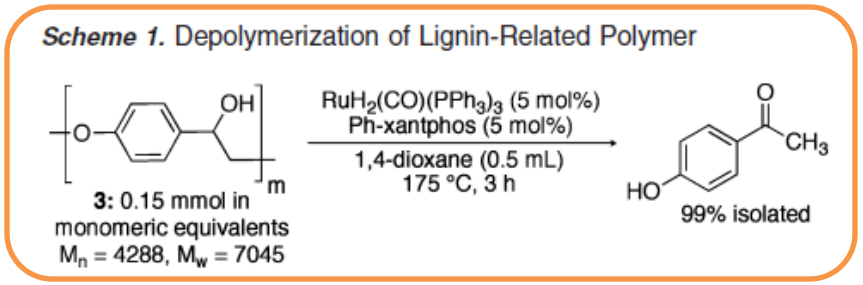
School of Public Health, College of Chemistry, College of Natural Resources, Haas School of Business, Goldman School of Public Policy, and College of Engineering

Student Fellowships

- Two year fellowships for graduate students to pursue interdisciplinary collaboration in green chemistry
- Innovation funding for student-driven research
- Project-based curriculum
- International opportunities
- Partnerships with government, non-profits, and businesses.

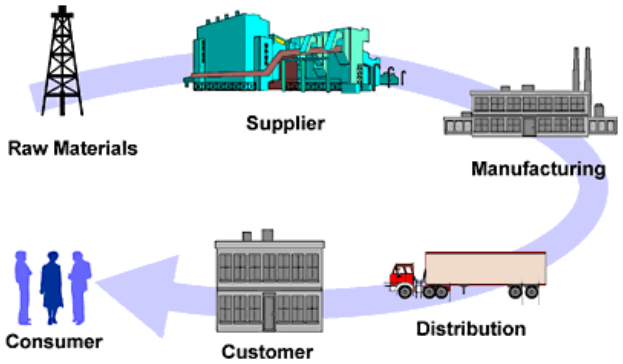


Our research interests range from the molecular to the society level analysis.



Bergman et al. JACS, 2010

Arnold et al. Catalyst Development



Dornfeld et.al. Laboratory for Sustainability and Manufacturing

Rosen and Beckman Sustainable Supply Chains

Meg Schwarzman and Michael Wilson, New Science for Chemicals Policy, Science, 2009.

Alastair Iles, Public Understanding of Science, 2011.

Our outreach actives support government decision makers, local schools, NGOs, and businesses

Researchers in the BCGC are called upon to provide testimony to the California Legislature, and to serve on advisory boards, including:

- Green Ribbon Science Panel (Cal/EPA)
- Biomonitoring Science Guidance Panel (Cal/EPA)
- Cumulative Impacts and Precautionary Approaches work group (Cal/EPA)
- Green Chemistry Commitment , an NGO, university & government collaboration to advance green chemistry education.

National Chemistry Week Event Photo- Barnes

- Support undergraduate volunteering in classroom. (See Your Future)
- Participate in local ACS outreach events (National Chemistry Week)
- Science communication through (EHN)

BERKELEY CENTER FOR GREEN CHEMISTRY

The BCGC Consortium is one way to participate.

DEPARTMENT OF TOXIC SUBSTANCES CONTROL

KAISER PERMANENTE®

LOHP
LABOR OCCUPATIONAL HEALTH PROGRAM

CHANGE

DOW®

DUPONT®

ACS Green Chemistry Institute®

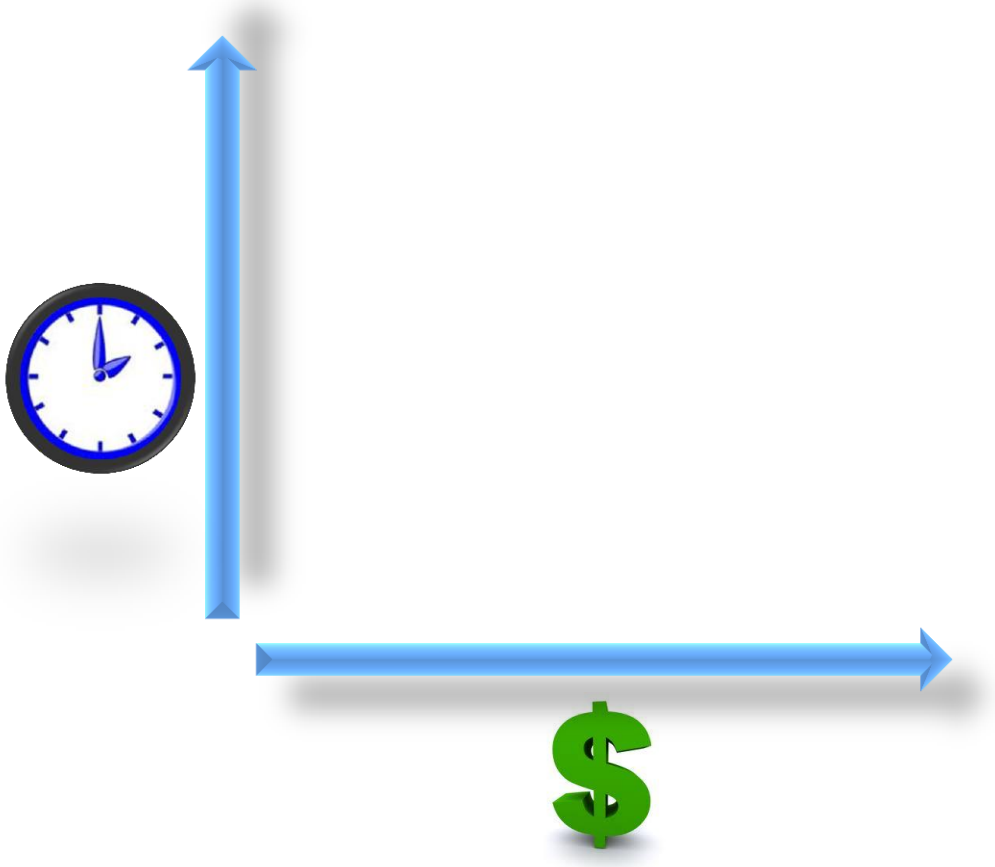
Sichuan HengKang Development Co.

- Starting in November 2011, we have been building a multi-stakeholder BCGC Consortium
- Soliciting membership, contact Marty Muvihill (marty_m@berkeley.edu)

There are many ways to collaborate with the Berkeley Center for Green Chemistry.

Education:
Invited Talks
Executive Education
Workshop Organization
Conference Participation
Consortium Membership

Research:
Consortium Membership
Sponsored Research
Joint Grants (NSF-SBIR)



BERKELEY CENTER FOR GREEN CHEMISTRY

http://bcgc.berkeley.edu

Successful Partnerships Requires Identifying Appropriate Scope and Methods for Engagement.

Initiation	Campus Partner	Method for Engagement
Broad Questions	Students, courses, Centers, Science Shop	Internships, gifts, consortium membership,
Specific Information or Data	Faculty Members Through the center for Interdisciplinary scope	Joint Grant, Contracts, or Sponsored Research (IP always open if through BCGC)
New Materials or Processes	Faculty Members	Joint External Grant NSF-SBIR (Standard campus IP), or Sponsored research (IP negotiated)