The Energy Biosciences Institute
A New Chapter in University-Industry Relationships

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Humanities Top Ten Problems for the next 50 Years

1. Energy
2. Water
3. Food
4. Environment
5. Poverty
6. Terrorism & War
7. Disease
8. Education
9. Democracy
10. Population

2003: 6.3 billion people
2050: 8-10 billion people

Source: Richard Smalley, Energy and Nanotechnology Conference, Rice University, Houston, May 3, 2003

What Can a Research University Contribute?

- Education that is forward looking, that anticipates the trends and developments that will lead to solutions
- Research that creates new options and insights of relevance to emerging problems
- Syndication of problems across all branches of knowledge to facilitate holistic solutions
- Facilitated access to knowledge for the elements of society charged with implementing solutions

The Energy Biosciences Institute

- $350M committed by BP over 10 years
- Research mandate to explore the application of modern biological knowledge to the energy sector
  - Cellulosic fuels
  - Petroleum microbiology
  - Other (eg., bio -souring, -sequestration, -remediation, -lubricants, -corrosion, …)

EBI design factors

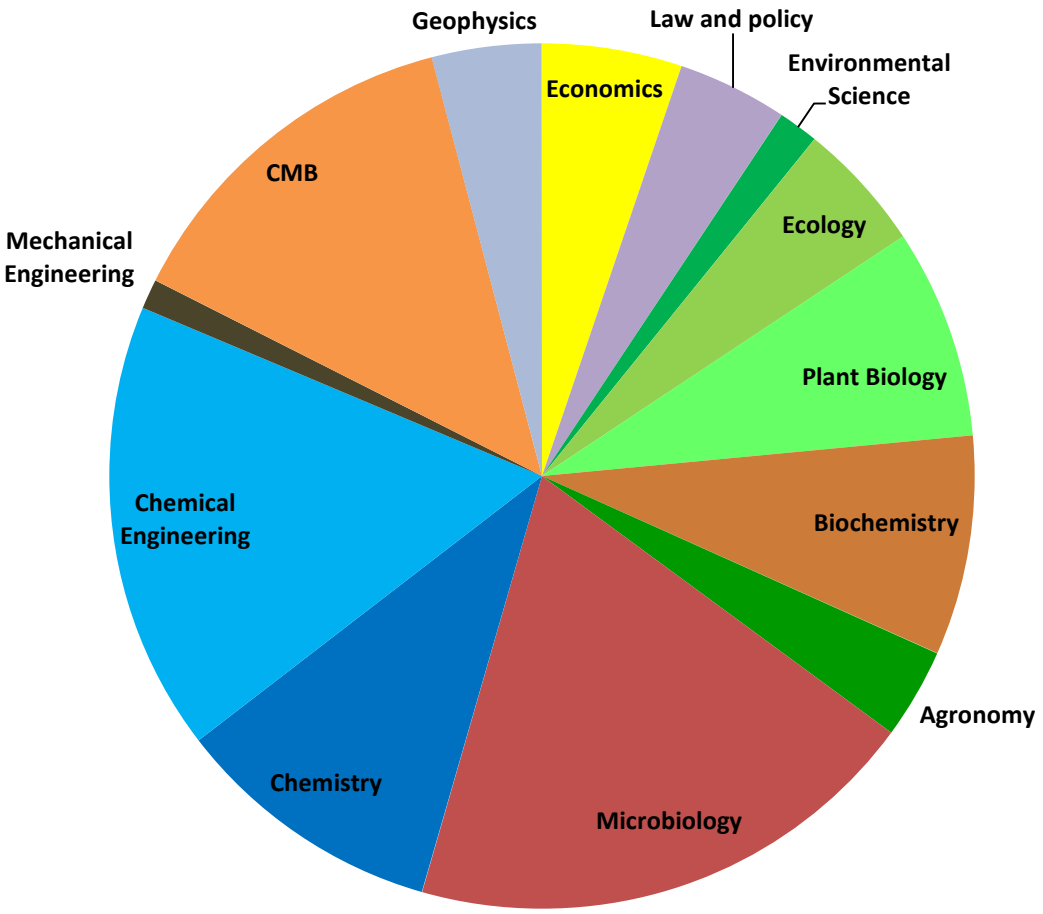
- Single organization doing open academic work
- Mission-oriented but long view
- Most or all research groups co-located
- Co-located BP researchers
    - Enhance industry connection to help motivate/guide open research
    - Potential to demonstrate at scale
- A substantial and long-term commitment to engage quality researchers ($350 M* over 10 years)
- Host Institutions that achieve academic excellence
- Arms length from the sponsors business units
- Shared governance (i.e., Board of Directors)

Summary of priorities

- Understand and improve the environmental and societal impacts of existing and proposed bioenergy industries
- Bring the price of bioenergy below the price of fossil energy
- Discover routes to biobased products that can displace large-volume fossil-based products
- Explore the role of biology in fossil fuel recovery and processing (e.g., souring and corrosion)

Composition of the EBI Research Team

(~270 researchers, 30 support)



Deliverables

- Strategic insight
  - Create or find new opportunities and disruptions
  - Minimize technical and societal risk
- Technical Innovation
- Develop the field
  - Rational public dialog
  - Stimulate innovation, cooperation, best practices
- Training and recruitment
  - BP employees
  - students, postdocs, faculty educated about energy*

Some strategic decisions

- Invest in whole system analysis rather than key bottlenecks
  - Requires and rewards scale
  - Leverages the public research enterprise
- Much of the EBI portfolio does not lead to patents (eg., environmental and socioeconomic research)
  - Societal risk can be as important as technical risk
- Invest in potentially disruptive ideas without regard to the current business

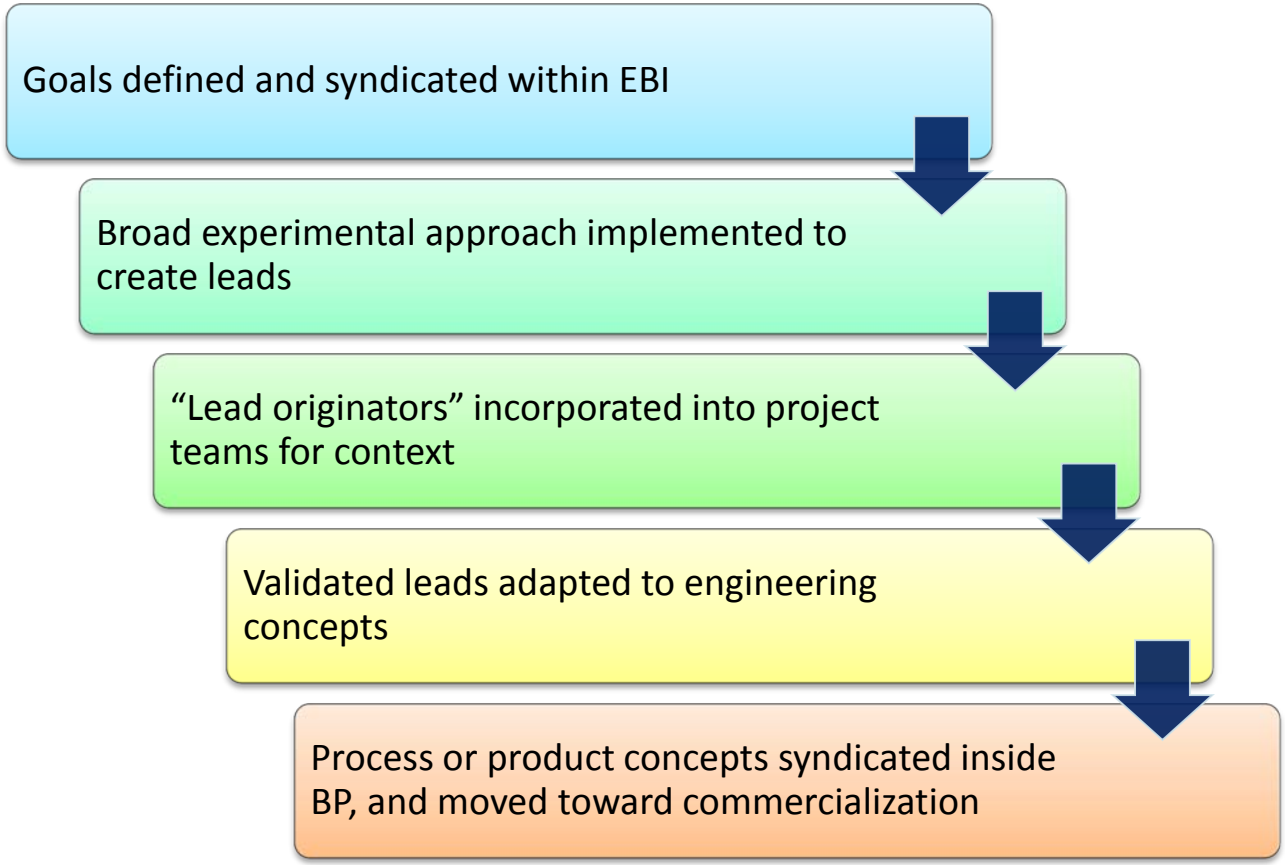
General Research Strategies

- Investing broadly to create capability and whole-system understanding
- Active research management – not a granting agency
- Where opportunities are not well defined we invest in workshops, reports, scenarios before research
  - Analysts* play major role in setting up and syndicating problems
  - BP managers provide perspective, expertise and analysis
- Colocated research groups facilitate horizontal integration
- Projects for small exploratory activities, programs for core activities
- Ten year horizon encourages work on environmental problems, difficult/risky problems, engages and attracts faculty

Constructing the research portfolio

- Recruitment phase used to engage investigators and develop topical knowledge
- Leadership sponsors workshops to brainstorm topics of potential interest and filters for promising ideas
  - Big ideas evaluated by engineering models
  - Promising big ideas broken down into smaller, research-ready ideas
- If internal capabilities exist, leadership solicits participation from existing investigators – otherwise, call for proposals
- “working groups” organized to syndicate knowledge and facilitate collaborations
- Engineering models refined and parameterized
- Handoff to sponsor begins…

Pathway to innovation



Expected Outcomes

- A route from batch to continuous processing
  - Costs of production below petroleum, very low GHG
- A route from lignocellulose to gasoline, diesel, and jet fuel
  - A hybrid process in which bioproducts are converted to fuels by catalysis, very low GHG
- Novel bio-based lubricants with improved performance
  - Costs of production below petroleum

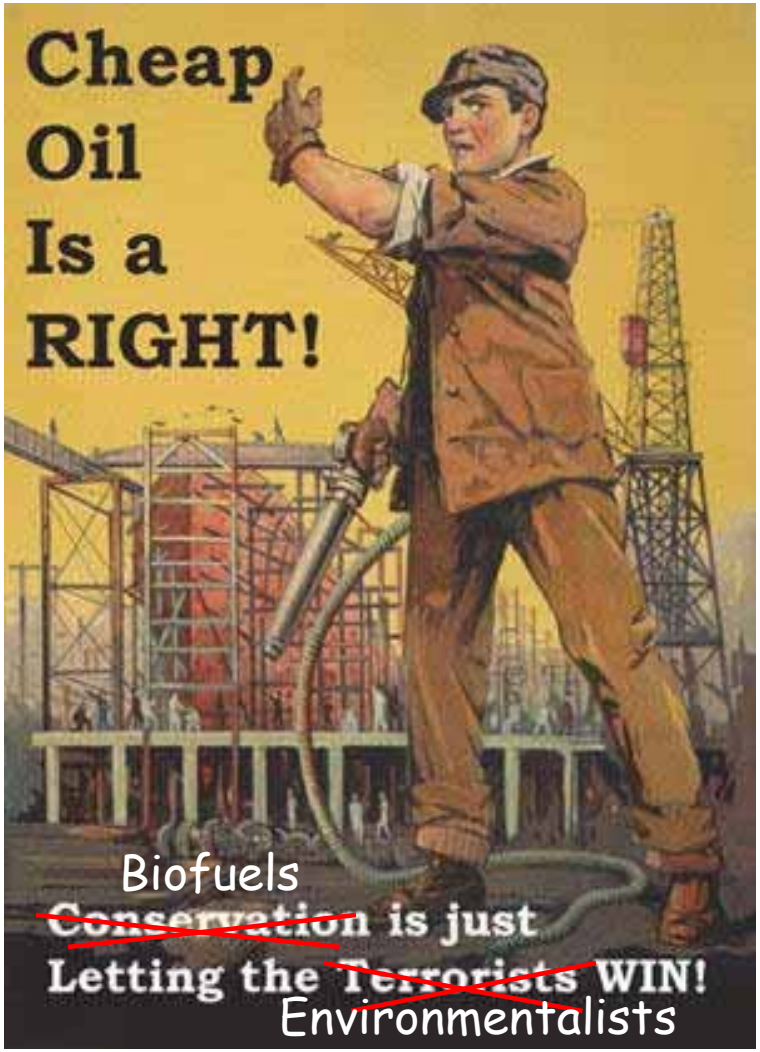
Some lessons learned

- Active management is essential but is probably only possible with large awards because of the time commitment required to coordinate multidisciplinary research
- Ownership of the funding by a small leadership team (rather than a consortium of faculty PIs) allows culling of unproductive activities and dynamic allocation of resources to emerging opportunities
- Academics want to contribute to societal challenges (eg., climate change)
- The 10-year timeline was very important in recruitment and goals
- Faculty need help to explore new directions. Most of the faculty involved had never worked in biofuels previously
  - Analysts helped educate
  - Facilities enabled work in new topics by providing access to materials, analytical capabilities, field sites …

Problems with the EBI model

- Even with three institutions (and ten new faculty positions), it is challenging to access all the relevant expertise.
  - There is a tradeoff between the advantages of co-location and the disadvantages of limited expertise.
  - A partial solution is “staff scientists”
- Corporate partners can find it challenging to incorporate new products and processes (but it is a “good type of challenging”).
- The timeline of academic research is long (even relatively applied academic research)

Change is hard



Problems with agencies

- Federal funding for academic (chemical) engineering is broken
  - Faculty are unable to obtain research funding for crucial subjects (eg., process engineering) so departments are hiring outside the discipline
- Funding for the National Labs is broken
  - The atomization of funding for the labs has resulted in a culture of opportunistic fund raising rather than mission-oriented work
  - The costs of collaboration are too high

Things that are going well

- DOE programs in renewable energy
  - BES
  - Bioenergy Research Centers (BRCs)
  - Energy Frontier Research Centers (EFRCs)
  - Advanced Research Projects Agency – Energy (ARPA-E)
  - (Some) Energy Innovation Hubs (Hubs)

www.energybiosciencesinstitute.org

http://www.bioenergyconnection.org/