From Lab Bench to Fuel Pump:

Policy Implications in the Development of Lignocellulosic Biofuels

Maria Fernanda Campa

Dave Bjornstad, Amy Wolfe, and Barry Shumpert

Governance of Emerging Technologies: Law, Policy, and Ethics

May 20–21, Chandler, AZ





Thank you!

- This work is part of a larger Scientific Focus Area (SFA), Ethical, Legal, and Social Implications (ELSI) of Emerging Technologies.
- Our amazing group:



 This research is sponsored by the DOE's Office of Science, Office of Biological and Environmental Research, Genomic Science Program.



Lignocellu...what?

• Why lignocellulosic biofuels?



www.nature.com



http://www.disco-project.eu/images/field.jpg



http://bioenergycenter.org/besc/resources/images/gtlgallery.cfm



Today's talk—a glimpse of the choices, decisions, and tradeoffs of mission-inspired research

- Different look at governance.
 - Intermediate between policies and their societal objectives.
- Science for society perspective.
- We explore the implications of two main decision junctures:
 - Scientists' decisions about what to study.
 - Scientists' decisions about what to do with their research results.
- With the goal to help mission-inspired science achieve its societal objectives.



Why we are studying this topic

- Our research focuses on science for society.
- The development of lignocellulosic biofuels is an example of mission-inspired research.
- The tech innovation needed to achieve this societal objective requires fundamental science research.
- Conduct of science is embedded in social, behavioral, and institutional systems.
- It is important to understand choices, decisions, and tradeoffs that accompany mission-inspired research.
 - Current events. Congress is questioning the peer review process (proposals).



R&D is a necessary intermediate between this policy and its societal objective

Policy Driver

- Bush's 2007 State of the Union Address
- Energy Independence and Security Act (EISA) of 2007
- DOE

BioEnergy Science Center (BESC)

- 18 partners from public, private, and academic institutions
- Mission-inspired research



- Energy independence
- Clean energy
- 36 billion gallons of lignocellulosic biofuels by 2022
- "Twenty-in-ten"



BESC, the institution—basic research for an applied purpose

From BESC's website:

- "Main goals:
 - Developing multitalented microbes and converting plant biomass into biofuels in a single step (consolidated bioprocessing).
 - Designing plant cell walls for rapid deconstruction."



Source: http://bioenergycenter.org/besc/index.cfm



BESC, the scientists—conducting research within this institution

- Affiliated with 18 partner institutions across the country.
- Multidisciplinary backgrounds (biological, chemical, physical and computational sciences, mathematics and engineering).
- Many do both BESC and non-BESC research.

- How do diverse scientists navigate within this institutional context?
 - What kinds of decisions do they face?
 - What factors do they consider?
 - What choices do they make?
- What are the implications for science and for society?



We elicited insiders' perspectives

- Scientists, research managers, and commercialization specialists *at ORNL*.
- 11 open-ended, semistructured exploratory interviews.
- Focus on two choices within the institutional context:
 - What to study?
 - What to do with research results?





Responses were unexpectedly consistent

- Institutional structure matters in deciding what to study.
 - Strong research management, and tightly focused.
 - Drives and constricts research in certain ways.
 - Interdisciplinary nature of research management.
 - "BESC model works well, successful; strategically organized like bio-tech company."
 - BESC management is "unique."
 - 18 partners; industry, academia, public, and private sector.
 - "BESC is the most applied project BER has funded—basic research in an applied field."
 - Office of Science is NSF-like part of DOE.
 - Office of Science expects high-impact, peer reviewed publications from BESC
 - And-atypically-disclosures, patents, and licenses.



Responses were unexpectedly consistent

- Journal publications remain the "coin of the realm."
 - Even with explicit recognition that disclosures, patents, and licenses are key to BESC's "success."
 - Emphasis on disclosures, patents, and licenses create a dilemma.
 - Wide diversity of decisions.
 - "BESC does more pubs because of the time it takes to show commercial value needed for IP."
 - "Publications more important than IP, but IP part of BESC from beginning. Private sector affiliates more concerned with IP."
 - "If I want to make a mark in the field, would want to publish. But if leaning toward IP I would want to protect findings (not publish). May leave details out of presentation to preserve information for IP."



Issues considered in our analyses

- Variation in patterns of response based on the type of research conducted
- Implications for science, society, and ability to achieve societal objective
 - of the choices about what is—and isn't—studied
 - of the choices of what to do with scientific results



Metrics—mismatch between societal objective and research "success"?

- Research has a societal goal, but research success is not measured by the achievement of that goal. It is measured by publications.
- Outgoing Secretary of Energy Chu states that, "it's not about papers you publish, but the problems you solve."
- Publications vs. patenting—to what extent do either help achieve societal objective?
- What is the linkage between disclosures and accomplishing the societal goal?
- What is the linkage between publications and accomplishing the societal goal?
- A million publications can help measure scientific success, but that does not mean the EISA goal is accomplished.
- Should there be additional metrics? What should they be?
- Particularly in light of this new controversy about NSF-funded science



Conduct of Science

 Scientists' perspectives and conduct of science change depending on what decisions they make to accomplish *their* goals.





http://worldenergyblog.com/wp-content/uploads/2010/03/switchgrass_interview_591.jpg



http://www.scientificamerican.com/article.cfm?id=biofuel-from-bacteria



To what extent do answers vary according to type of research—plants, microbes, and computational

- There are no striking differences in the responses to what to study and what to do with the results of research.
 - Strong BESC management influence on topics studied based on Center's goals.
 - Results communicated primarily through publications and presentations, but IP also encouraged.
- But there are notable differences across research focus—researchers are cognizant about what lies ahead, but what lies ahead is different depending on the research focus.
 - Plants: "Would you do research on this if you knew a farmer would never use that because of labor intensity?"
 - Microbes: "Research tools not necessarily commercial tools. Transgenics, for example, may or may not happen outside the lab."
 - Computational: "I don't have to account for it; don't make anything on the computer. Microbiologist have to think about it since they actually make stuff."



Conclusions: insiders' perspectives reveal multiple drivers that influence choices

- Even at an R&D organization created to achieve a specific societal goal, other drivers affect scientists' choices.
- The effectiveness of BESC and the other BRCs as intermediates between the policy and the societal goal is not yet known.
 - But we have seen that there is a complex intra-institutional interaction that affects how choices are made.
- It is unclear who would or should deal with the full array of societal implications associated with the policy objective and its implementation.



Mapping the landscape for future mission-inspired research

- To what extent does this combination of patents, publications, and partnerships help R&D innovation reach the "fuel pump"?
 - Publications are necessary.
 - Patenting may be necessary.
 - What else? Are there other metrics or institutional arrangements that would better position the science to achieve its societal goal?
- What are unanticipated ripple effects of these choices?
 - For science.
 - For society.





- Comments, questions, and concerns??
- Contact email: <u>campaayalamf@ornl.gov</u>
 - Website: sti.ornl.gov

