EFRI Fall 2008 Update

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Director, Office of Emerging Frontiers in Research and Innovation

NSF ENG Fall 2008 Advisory Committee Meeting
October 15-16, 2008

EFRI - "One Slide Description"

- Established on October 1, 2006, EFRI supports higher risk, higher payoff opportunities leading to:
  - new research areas for NSF, ENG, and other agencies
  - new industries/capabilities resulting in a leadership position
  - significant progress on advancing a "grand challenge"
- Successful topics would likely require:
  - small- to medium-sized interdisciplinary teams
  - the necessary time to demonstrate substantial progress and evidence for follow-on funding through other established mechanisms
- The current investment for EFRI totals $25 million for 4-year awards at $500k per year.

Key EFRI Criteria

- **TRANSFORMATIVE**- Significant leap or paradigm shift in fundamental engineering knowledge
- **NATIONAL NEED/GRAND CHALLENGE**- Strong potential for significant progress on a national need or grand challenge
- **INTER-DISCIPLINARY**- Three or more disciplines
- **ENG LEADERSHIP**- What partnerships are proposed and what is role of ENG

NSF Definition of Transformative Research

- Transformative research involves ideas, discoveries, or tools that radically change our understanding of an important existing scientific or engineering concept or educational practice or leads to the creation of a new paradigm or field of science, engineering, or education.
- Transformative research results often do not fit within established models or theories and may initially be unexpected or difficult to interpret; their transformative nature and utility might not be recognized until years later.
- Characteristics of transformative research are that it:
  - Challenges conventional wisdom
  - Leads to unexpected insights that enable new techniques or methodologies, and/or
  - Redefines the boundaries of science, engineering, or education.

EFRI Office Topics

Steady State: **~10 Active Topics**

~50 Active Awards

FY 07: Auto-Reconfigurable Engineered Systems (ARES)	FY 07: Cellular and Biomolecular Engineering (CBE)	FY 08: Cognitive Optimization & Prediction (COPN)	FY 08: Resilient and Sustainable Infrastructures (RESIN)
5 Projects	7 Projects	4 Projects	8 Projects

FY 09: Hydrocarbons from Biomass (HYBI)	FY 09: BioSensing & BioActuation (BSBA)	FY 10:	FY 10:
Current Competition		**Modified Approach**	

FY 11:	FY 11:

EFRI Teams

FY 2007

Auto-Reconfigurable Engineered Systems (ARES)
Scott Midkiff, ECCS
Kishan Baheti, ECCS
Maria Burka, CBET
Abhi Deshmukh*,CMMI
Bruce Hamilton, CBET
Glen Larsen, IIP
Stephen Nash*, CMMI
Mario Rotea*, CMMI

Cellular and Biomolecular Engineering (CBE)
Fred Heineken, CBET
Lenore Clesceri*, CBET
Jimmy Hsia*, CMMI
Lynn Preston, EEC
Robert Wellek, CBET

FY 2008

Cognitive Optimization (COPN)
Paul Werbos, ECCS
Semahat Demir, CBET
Fred Heineken, CBET
Eduardo Misawa, CMMI
Scott Midkiff, ECCS
Stephen Nash*, CMMI
Lynn Preston, EEC
Kenneth Whang, CISE

Resilient and Sustainable Infrastructures (RESIN)
Joy Pauschke, CMMI
Bruce Hamilton, CBET
William Schultz, CBET
Richard Fragaszy, CMMI
Barbara Kenny, EEC
Dagmar Niebur, ECCS
Matthew Realff*, CMMI
Dennis Wenger, CMMI

FY 2009

Biosensing & Bioactuation (BSBA)
S. Chi Liu , CMMI
Y. Gianchandani, ECCS
R. Baheti, ECCS
J. Daniels, EEC
L. Esterowitz, CBET
S. Jayasuriya, CMMI
R. Khosla, ECCS
B. Kramer, EEC
S. Midkiff, ECCS
E. Misawa, CMMI
L. Preston, EEC

Hydrocarbon from Biomass (HyBi)
J. Regalbuto, CBET
D. Niebur, ECCS
M. Burka, CBET
C. Cooper, CMMI
B. Hamilton, CBET
W. Schultz, CBET
P. Werbos, ECCS

Team Coordinators

*** Former PD / IPA**

FY 2007
Autonomously Reconfigurable Engineered Systems (ARES)

Systems that Modify Themselves

(5 Active Awards)

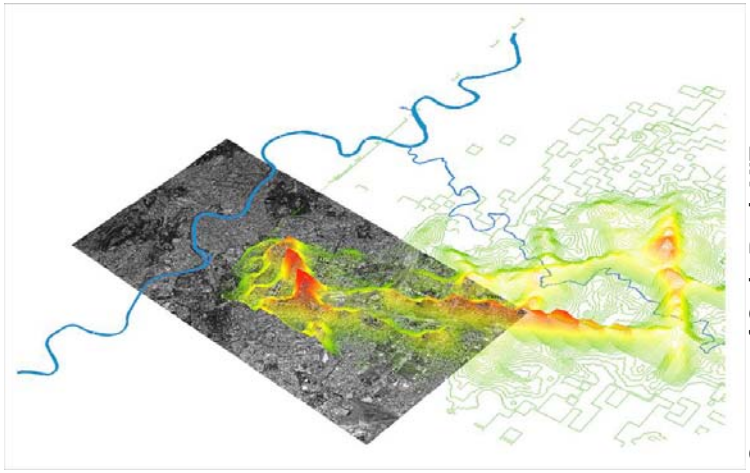
Key idea: *Autonomously reconfigurable engineered systems robust to unexpected/unplanned events*

1. **An Efficient Air Transportation System**
2. **Testing Autonomous Reconfigurability in a Wireless City**
3. **Foundations for Cyber-Physical Systems**
4. **Innovative Management of Ground Transportation**
5. **Robots that Think and Build**

http://www.nsf.gov/eng/efri/fy07awards.jsp

Foundations for Cyber-Physical Systems

Cyber-physical systems combine computational systems with physical and engineered systems and can include bionics, automated manufacturing, or systems for monitoring critical infrastructure. This project aims to address the key challenge of realizing a foundational, mathematical understanding of the interaction between the cyber and the physical in order to both configure a system to respond to unexpected events, and also to quantify the system's limits in responding.



Courtesy of Carlo Ratti, MIT

Rome in real-time: Combining maps (gray square) and density of cell-phone usage (shown as red and yellow 3-D peaks) follows activity of the city of Rome, and is a basis for understanding how a complex system could best respond to unplanned events.

Led by Munther A. Dahleh, Daron Acemoglu, Carlo F. Ratti (MIT), and John Doyle (CalTech) and titled, "Foundations for Reconfigurable and Autonomous Cyber-Physical Systems: Cyber-Cities and Cyber-Universities" (grant #0735956).

FY 2007

Cellular and Biomolecular Engineering (CBE)

How Cells Work: Uniting Engineering and Biology

(7 Active Awards)

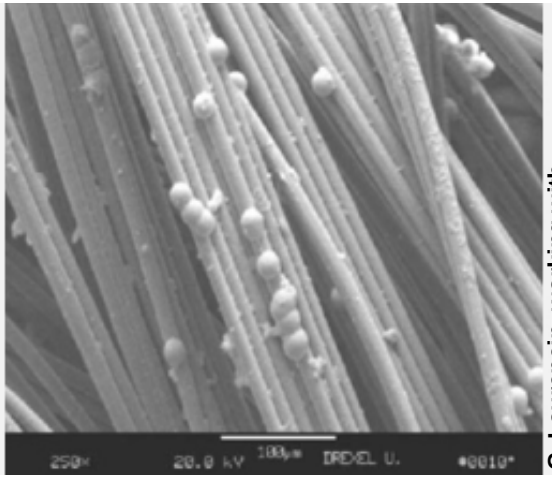
Key idea: **Comprehensive modeling, measurement, and control of coupled biological, chemical, electrical, mechanical, and thermal processes at the cellular and biomolecular level under multiple stimuli.**

1. **Using Engineering to Understand How Bacteria Communicate**
2. **Cell Functions and Brain Disease**
3. **Simulating and Watching the Growth of Cancer Cells**
4. **Finding the Mechanism that Directs Blood Vessel Growth**
5. **Regenerating Complex Tissues from the Nanoscale**
6. **To Change or Replicate? Decoding How Cells Grow**
7. **How a Cell's Environment affects its Development**

http://www.nsf.gov/eng/efri/fy07awards.jsp

Regenerating Complex Tissues from the Nanoscale

- This team aims to mimic a biological system and reconstruct this tissue with precision from the nanoscale up.
- To maximize precision and control over the way the tissue takes shape, the researchers are combining advances in polymer chemistry for synthesizing nanoscale fibers, in using electric fields to group nanoscale fibers, and in using ion beams to control surface chemistry at the nanoscale.
- PI was named to "*SciAm* 50" for this research in 2007.



C. Laurencin, working with Edward A. Botchwey, Yusuf Khan, Lakshmi Nair, and Nathan S. Swami

This scanning electron microscope image shows the micro-scale architecture of a synthetic anterior cruciate ligament tissue, with additional cells growing on its surface. The team aims to realize similar precision at the nano-scale.

Led by Cato C. Laurencin (University of Virginia), along with Edward A. Botchwey, Yusef Khan, Lakshmi Nair, and Nathan S. Swami (University of Virginia), and titled, "Biological, Chemical, and Mechanical Surface Cues for Cell Migration, Proliferation, and Differentiation: An Integrated Approach to Regeneration of New Tissues" (grant #0736002).

FY 2008

Cognitive Optimization (COPN)

LEARNING FROM THE BRAIN

(4 Active Awards)

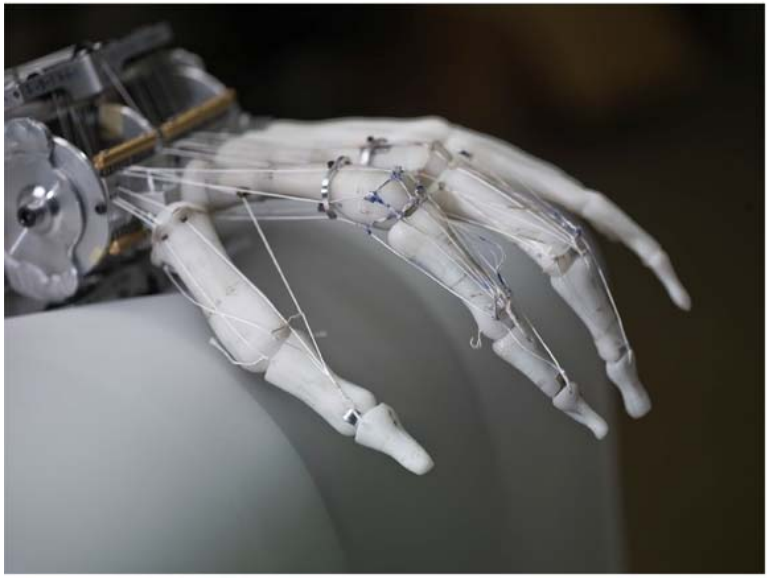
Key idea: **Understanding subsymbolic intelligence can lead to development of new designs and algorithms for optimal decision making and prediction in engineered systems.**

1. **Creating a learning algorithm of the brain**
2. **Studying neural networks with an innovative patch-clamp array**
3. **Determining how the brain controls the hand**
4. **Modeling control of the electric power grid on the brain**

http://www.nsf.gov/eng/efri/fy08awards.jsp

Determining how the brain controls the hand

- The project goal is to understand how to achieve dexterous, approximately optimal control of a hand, and those same algorithms will model human motor control.
- Dexterous robotic hands have a wide variety of possible applications in industry, space, and national security.
- Improved understanding of how humans learn to optimize hand performance will also have broader benefits, particularly for the disabled.



Led by Francisco Valero-Cuevas of the University of Southern California, in collaboration with Chang Liu of Northwestern University, Yoky Matsuoka of the University of Washington, and Emanuel Todorov of the University of California, San Diego (0836042).

FY 2008

Resilient and Sustainable Infrastructures (RESIN)

BUILDING RESILIENT AND SUSTAINABLE INTERDEPENDENT INFRASTRUCTURES

(8 Active Awards)

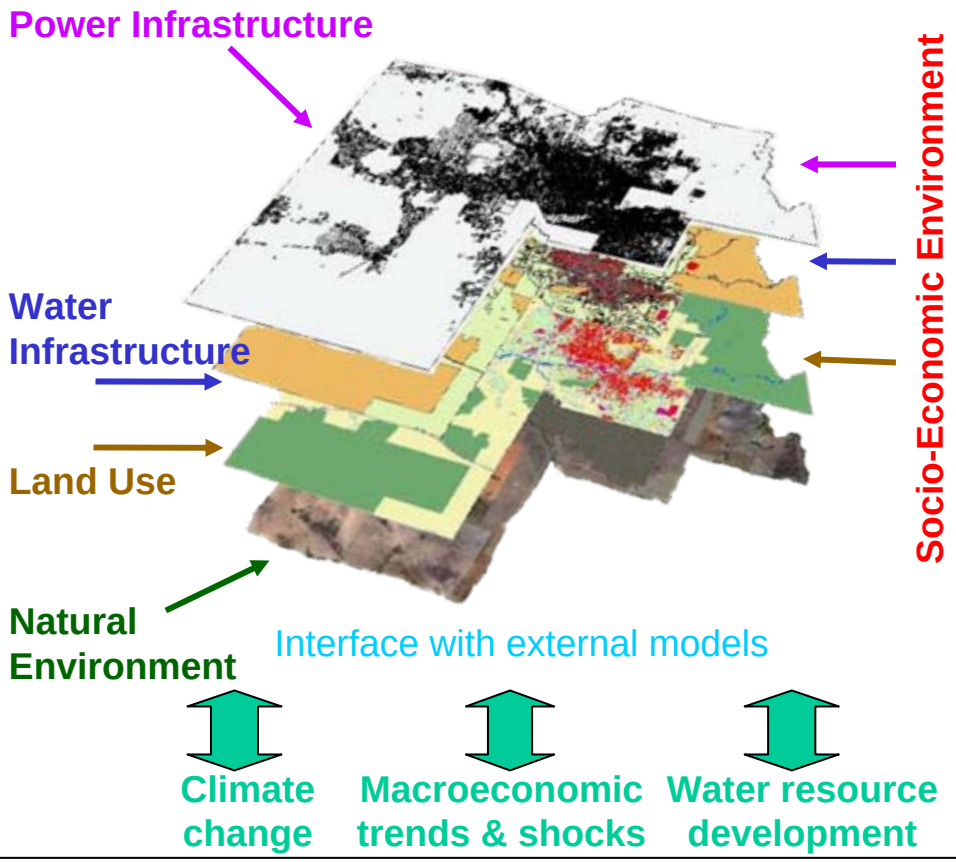
Key idea: **Build, renew, expand, monitor, and control critical interdependent infrastructures to be both resilient and sustainable.**

1. **Considering air quality and water availability in electricity production**
2. **Managing the risk of cascading failures**
3. **Designing infrastructure for biofuels**
4. **Bringing energy and water to urban areas**
5. **Supplying water where it is scarce**
6. **Optimizing energy and transportation infrastructures**
7. **Ensuring electricity and communications in a catastrophe**
8. **Integrating electric vehicles into the grid**

http://www.nsf.gov/eng/efri/fy08awards.jsp

Bringing energy and water to urban areas

- This project aims to
  - increase understanding of how urban water and energy infrastructures depend on one another
  - examine the life-cycle implications of different infrastructure options
- The overall goal is to maximize the resilience and sustainability of energy and water infrastructure systems.



Led by John C. Crittenden of Arizona State University (ASU), in collaboration with four ASU colleagues: Samuel Ariaratnam, George Karady, Ke Li, and Charles Perrings (0836046).

EFRI FY 2009 Topics (NSF 08-599)

1. **BioSensing & BioActuation: Interface of Living and Engineering Systems (BSBA)**
   - Key idea: ***Develop and employ bio-derived and bio-inspired technologies for sensing and detection, monitoring, actuation and control of stimuli and the environment.***

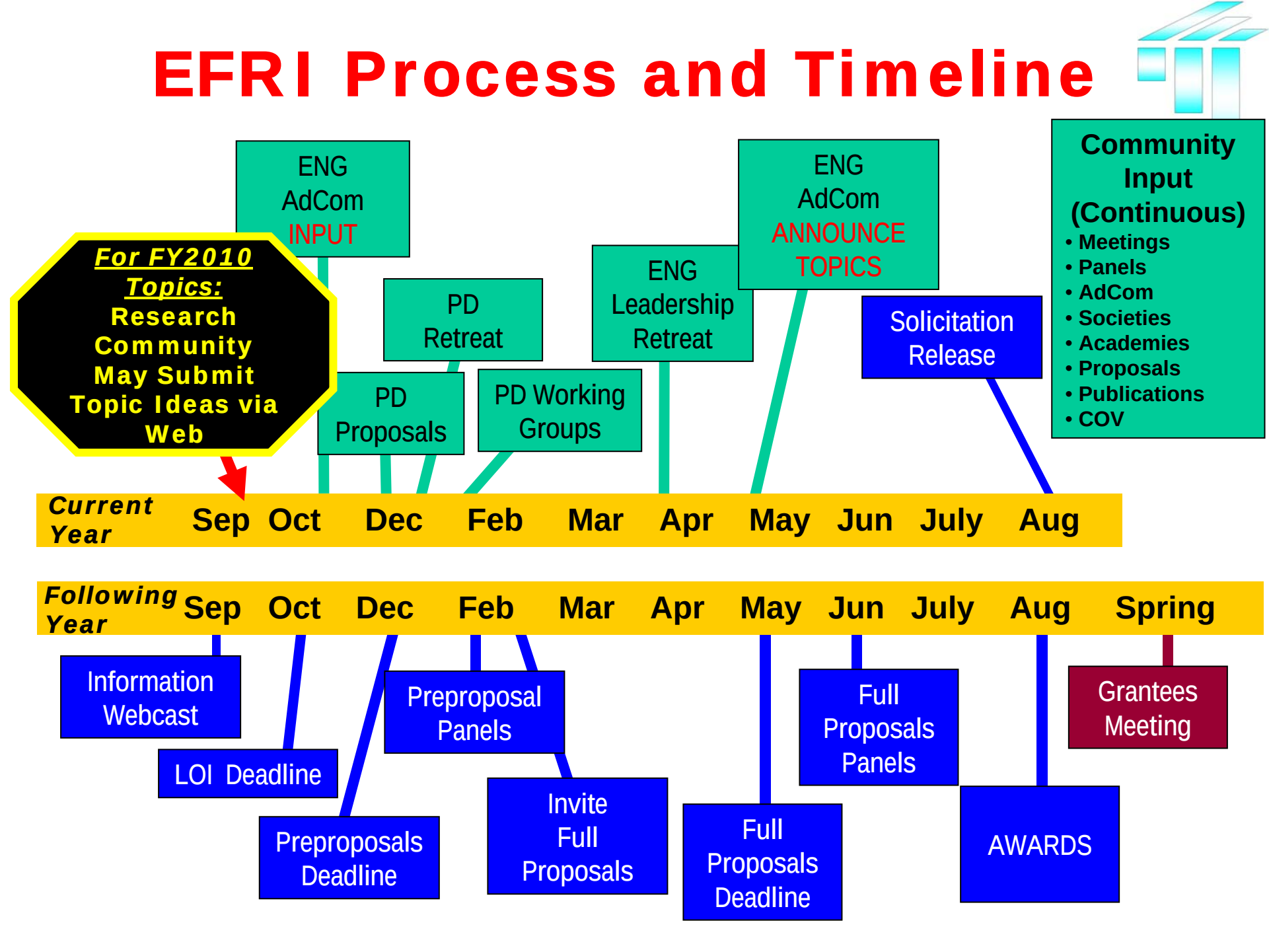
2. **Hydrocarbons from Biomass (HyBi)**
   - Key idea: ***Hydrocarbon biofuels such as green gasoline are an attractive alternative to ethanol; their production in a network of rural biorefineries can be accompanied by the distributed generation of electricity.***

Important Dates
EFRI FY 2009 (NSF 08-599)

- **Sep 10, 2008** — **Information Webcast**
  Over 200 registered viewers
- **Oct 14, 2008** — **Letters of Intent due (required)**
  358 LOIs received
- **Dec 2, 2008** — **Preliminary proposals deadline**
- **Early Feb 2008** — **Invitations to submit full proposals**
- **Apr 30, 2009** — **Full proposals deadline (by invitation only)**
- **May/June 2009** — **Review of full proposals**
- **By Sep 2009** — **Make awards**
- **Spring 2010** — **Grantees meeting**

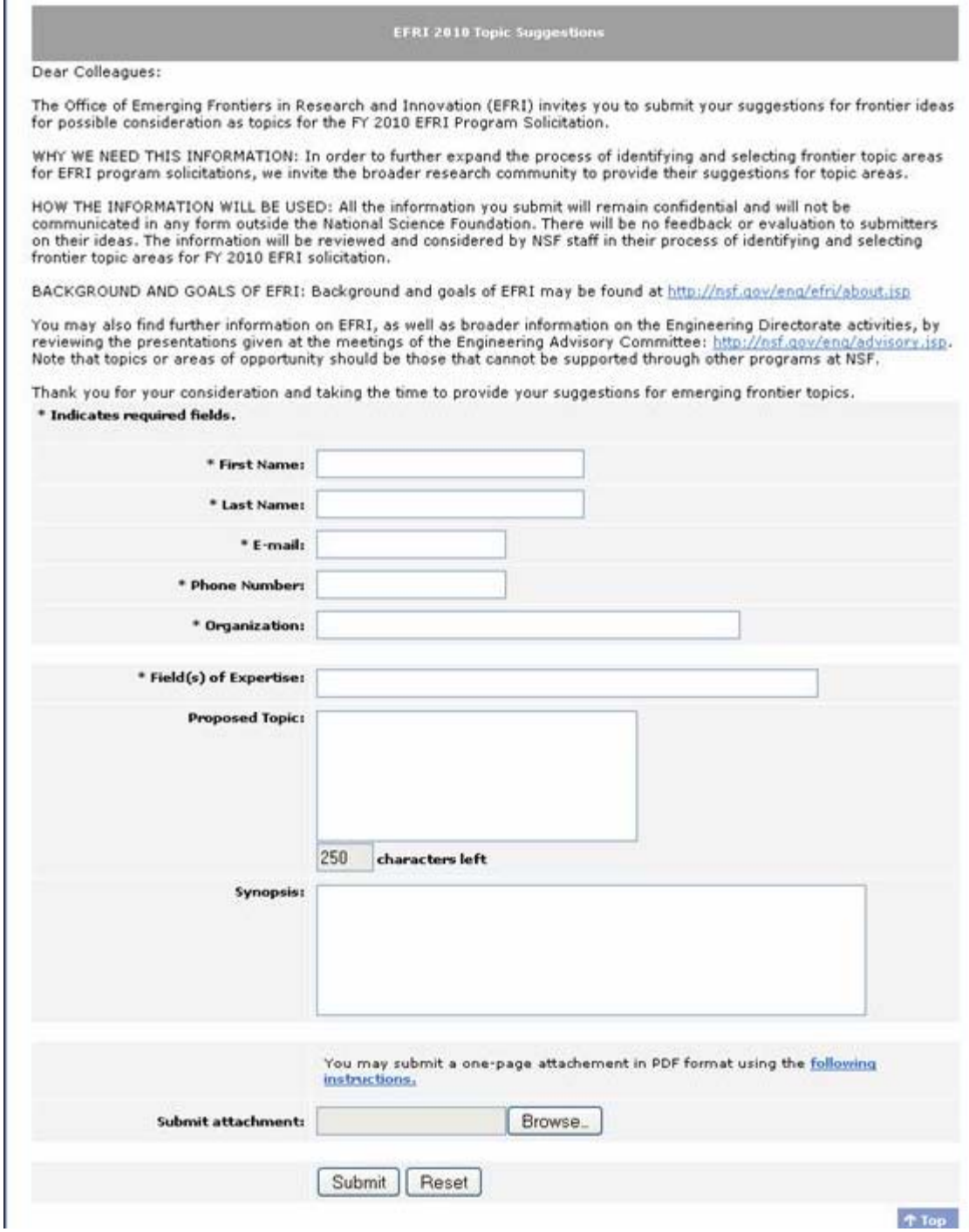
FY 2010
Modified Approach

EFRI Process and Timeline



How to Submit

- Dear Colleague Letter (08-071) guides you to: www.nsf.gov/eng/efri/efri2010
- Two Info Webcasts were held (Sep 10 and Sep 29)



EFRI 2010 Topic Suggestions

Dear Colleagues:

The Office of Emerging Frontiers in Research and Innovation (EFRI) invites you to submit your suggestions for frontier ideas for possible consideration as topics for the FY 2010 EFRI Program Solicitation.

WHY WE NEED THIS INFORMATION: In order to further expand the process of identifying and selecting frontier topic areas for EFRI program solicitations, we invite the broader research community to provide their suggestions for topic areas.

HOW THE INFORMATION WILL BE USED: All the information you submit will remain confidential and will not be communicated in any form outside the National Science Foundation. There will be no feedback or evaluation to submitters on their ideas. The information will be reviewed and considered by NSF staff in their process of identifying and selecting frontier topic areas for FY 2010 EFRI solicitation.

BACKGROUND AND GOALS OF EFRI: Background and goals of EFRI may be found at http://nsf.gov/eng/efri/about.jsp

You may also find further information on EFRI, as well as broader information on the Engineering Directorate activities, by reviewing the presentations given at the meetings of the Engineering Advisory Committee: http://nsf.gov/eng/advisory.jsp. Note that topics or areas of opportunity should be those that cannot be supported through other programs at NSF.

Thank you for your consideration and taking the time to provide your suggestions for emerging frontier topics.

* Indicates required fields.

* First Name:

* Last Name:

* E-mail:

* Phone Number:

* Organization:

* Field(s) of Expertise:

Proposed Topic:

250 characters left

Synopsis:

You may submit a one-page attachement in PDF format using the following instructions.

Submit attachment: Browse...

Submit Reset

↑ Top

Questions For Advisory Committee

- **PROCESS**- What are your thoughts/input on the EFRI process?
- **OUTREACH**- How can you help reach out to the community?
- **EMERGING AREAS**- What are your thoughts/suggestions on emerging areas?

EFRI

TRANSFORMATIVE ~ NATIONAL NEED ~ INTERDISCIPLINARY

ENG LEADERSHIP

www.nsf.gov/eng/efri