CORE QUESTIONS and REPORT TEMPLATE
for
FY 2011 NSF COMMITTEE OF VISITOR (COV) REVIEWS

Guidance to NSF Staff: This document includes the FY 2010 set of Core Questions and the COV Report Template for use by NSF staff when preparing and conducting COVs during FY 2010. Specific guidance for NSF staff describing the COV review process is described in Subchapter 300-Committee of Visitors Reviews (NSF Manual 1, Section VIII) that can be obtained at <www.inside.nsf.gov/od/oia/cov>.

NSF relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. Committee of Visitor (COV) reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and (2) comments on how the results generated by awardees have contributed to the attainment of NSF's mission and strategic outcome goals.

Many of the Core Questions are derived from NSF performance goals and apply to the portfolio of activities represented in the program(s) under review. The program(s) under review may include several subactivities as well as NSF-wide activities. The directorate or division may instruct the COV to provide answers addressing a cluster or group of programs – a portfolio of activities integrated as a whole – or to provide answers specific to the subactivities of the program, with the latter requiring more time but providing more detailed information.

The Division or Directorate may choose to add questions relevant to the activities under review. NSF staff should work with the COV members in advance of the meeting to provide them with the report template, organized background materials, and to identify questions/goals that apply to the program(s) under review.

Suggested sources of information for COVs to consider are provided for each item. As indicated, a resource for NSF staff preparing data for COVs is the Enterprise Information System (EIS) –Web COV module, which can be accessed by NSF staff only at http://budg-eis-01/eisportal/default.aspx. In addition, NSF staff preparing for the COV should consider other sources of information, as appropriate for the programs under review.

ARRA Addendum: If awards funded by the American Recovery and Reinvestment Act (ARRA) were made during the period of time under review by the COV, you will need to add guidance to the COV on review of these activities and some specific questions to the template that cover the ARRA award processes and the resulting portfolio of awards. While the COV need not review all ARRA awards, there should be ARRA awards included as part of the sample of awards, and there should be materials that explicitly describe the ARRA portfolio and its characteristics. The NSF Recovery Act Policies and Procedures can be found at:
http://infoshare.nsf.gov/showFile/3370/2009RecoveryPoliciesProcedures1009.pdf. The NSF Funding Priorities are found in Section III.

Guidance to the COV: The COV report should provide a balanced assessment of NSF's performance in two primary areas: (A) the integrity and efficiency of the ***processes*** related to proposal review; and (B) the quality of the ***results*** of NSF's investments that appear over time. The COV also explores the relationships between award decisions and program/NSF-wide goals in order

to determine the likelihood that the portfolio will lead to the desired results in the future. Discussions leading to answers for Part A of the Core Questions will require study of confidential material such as declined proposals and reviewer comments. *COV reports should not contain confidential material or specific information about declined proposals.* Discussions leading to answers for Part B of the Core Questions will involve study of non-confidential material such as results of NSF-funded projects. The reports generated by COVs are used in assessing agency progress in order to meet government-wide performance reporting requirements, and are made available to the public. Since material from COV reports is used in NSF performance reports, the COV report may be subject to an audit.

ARRA Addendum: Awards funded by the American Recovery and Reinvestment Act (ARRA) were made during the period of time under review by the COV. We have included questions on the template that deal explicitly with this subset of the overall portfolio and the extent to which it met the objectives of the Act and the priorities articulated by the NSF Director. Key information regarding ARRA and NSF priorities as well as optional program-specific priorities will be provided to you.

We encourage COV members to provide comments to NSF on how to improve in all areas, as well as suggestions for the COV process, format, and questions. For past COV reports, please see http://www.nsf.gov/od/oia/activities/cov/covs.jsp.

FY 2011 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: January 20-21, 2011
Program/Cluster/Section:
Division: Office of Emerging Frontiers in Research and Innovation
Directorate: Engineering
Number of actions reviewed: **Awards: 10** **Declinations: 23** **Other: 28**
Total number of actions within Program/Cluster/Division during period under review: **Awards: 71** **Declinations: 271** **Other: 794**
Manner in which reviewed actions were selected: The sampling plan entails randomly selecting a specified percentage of each type of proposal from each solicitation and proportionately from each Frontier Topic or a minimum of 2 from each category for each solicitation. Ten percent of the awards and declinations will be selected for review. The review of the EFRI awarded and declined proposals will include a review of the associated preliminary and full proposals. Three percent of all non-actions will be reviewed. This will include all preliminary proposals not invited to submit full proposals and submissions that were returned without review.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The COV feels that the review methods for the EFRI program are very appropriate and rigorous, and well suited for the size and scope of a program that supports mid-size multidisciplinary teams (at approximately $0.5M per year for 4 years). Pre-proposals in targeted areas are first solicited and screened, and a limited number of full proposals are then invited and reviewed thoroughly. Given the larger scope and multidisciplinary nature of the grants in this program, the panel review approach is well suited (actually ideal) in order to select the very best ideas that will have the greatest impact. At least 3 reviews and a panel summary are obtained for all proposals. This is a significant number of reviews given the 157 proposals in response to the 2010 EFRI solicitation.	YES

2. Are both merit review criteria addressed?	YES
a) In individual reviews? The COV looked at a subset of proposals from the EFRI program. In many of the individual reviews, both merit review criteria were addressed well. Most reviewers commented in-depth on the intellectual merit criteria. However, some reviews did not adequately address broader impacts. As a result, the COV recommends that the EFRI solicitation re-emphasize to the community and to the reviewers the need for a strong discussion of broader impacts in order to secure an EFRI grant.	
b) In panel summaries? Most panel summaries, particularly for those proposals that were funded, addressed both merit review criteria well, effectively reflecting input from the panelists.	YES
c) In Program Officer review analyses? The review analyses were very good in the jackets looked at by the COV. They were consistent with the reviews and panel summary. The best review analyses corresponded to funded proposals - as might be expected, since those proposals were likely discussed in depth. In a few cases, the review analyses corresponding to preproposals that were not selected for full proposal submission were very brief.	YES

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: The COV found that many of the individual reviewers commented in detail and in an expert manner on each proposal, describing their opinion about the overall vision, specific implementation, PI qualifications, education activities, the appropriateness of the team, whether the proposal addressed a grand challenge and would have broad impact, and whether the idea might be transformative. For these in-depth reviews, the COV found that the rating was in line with the review comments. However, in some cases, reviews were too brief to provide useful feedback to the P.I.	YES

4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: By and large the panel summaries synthesized the individual panel reviews.	YES
5. Does the documentation in the jacket provide the rationale for the invite/do not invite or award/decline decision? Comments: The COV traced the path of individual proposals by reading the proposals, the individual reviews, the panel summaries, the program officer review analysis and context statements. The documentation in the e-jackets was sufficient to justify the decisions made. There were 1330 distinct PI jackets and the COV reviewed 61 of them.	YES

6. Does the documentation to PI provide the rationale for the invite/ do not invite or award/decline decision? Comments: From the combination of the individual reviews and the panel summary, in the vast majority of cases, the PI would be able to recognize the strengths and weaknesses of the proposal that led to a decision to invite/do not invite or award/decline. The individual reviews pointed out many issues that the PI could learn from and improve in subsequent proposals. Thus, the feedback could be useful for the PI.	YES

7. Is the time to decision appropriate? Comments: The ERFI team deserves much credit for the short dwell times, especially given the rigorous nature of the review process. The average dwell time for the EFRI program is truly excellent - well below the NSF target and the NSF ENG and NSF-wide averages, with dwell times of 4.1 months for awards and 4.6 months for declines. The NSF ENG average was 5 months, and the NSF wide average was 5.6 months.	YES

8. Additional Comments

a) Additional comments on the quality and effectiveness of the program's use of merit review process.

When there is big span in ratings for a proposal (e.g. F and E), the COV recommends that the program officers seek to understand why the proposal garnered such differing ratings, so that the goal of the EFRI program in supporting transformative, novel, multidisciplinary research is achieved. When there is a large difference in ratings, there is a possibility that some panelists did not have sufficient expertise to judge the proposal, or that the idea is so new that reviewers are challenged to understand it. Thus, such proposals should be discussed carefully to probe the reasons behind the differing ratings.

b) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding?

The ERFI program used the ARRA funding to fund several Hydrocarbons from Biomass proposals. This area was very appropriate for ARRA funding because of potential relevance to a national need.

c) Additional comments on the quality and effectiveness of the program's use of EFRI specific criteria and topic specific required elements listed in the solicitation in the review process.

The COV believes that some reviews (and proposals) did not adequately address broader impacts at the level appropriate for a mid-scale NSF grant, since attention to broader impacts is very relevant to the continued success of the engineering and science research enterprise in the US. The COV recommends that the EFRI solicitation specifically request a description of how workforce and diversity at all levels will be enhanced by the proposed work (including at the leadership and student level). This is in addition to the potential technological, scientific and economic impacts of the proposed work. The EFRI program reviewers also need to comment in detail in the reviews about all the broader impacts of the work.

Additional Comments Regarding Time to Decision

The new innovative exploratory grant program (BECS) had slightly longer (one month) than NSF average dwell times, and the program director should be commended for taking the risk to develop a spin-off program model. It is recognized that taking this BES program out of the statistics, further reduces the average dwell time to an exceptional 3.2 months.

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: The program did use panelists with appropriate expertise and diverse backgrounds. However, most reviewers are from academia and government agencies/labs. The COV recommends the participation of more industrial reviewers.	YES
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 50% of reviewers reporting this information. Comments: The geographical distribution of the reviewers is now well balanced and has shown steady improvement over the years from 2007 to 2010. The types of institutions represented in the panels are diverse and balanced. However, the participation of underrepresented minority groups and women should definitely be improved.	YES

3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: The COV could not discern any issues regarding conflict of interest based on the e-jacket material.	YES

4. Additional comments on reviewer selection: The COV recommends that the program explore the inclusion of non-traditional/commercial reviewers such as lawyers, venture capitalists, and business people from companies. Better data should be collected from reviewers to more adequately reflect their demographics. The COV and the STPI Review recognize the fact that the EFRI program has unique objectives, and may require special consideration in reviewer selection. Therefore the selection process for reviewers should be well described for future EFRI COVs.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: The COV believes that many of the funded projects are exciting. The transformative nature of the projects is strong. The projects are very diverse. Generally, it is too early to assess research outcomes. However, it is not too early to develop a framework to assess or evaluate the portfolio of projects over time. The COV recommends EFRI management develop such a framework.	Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: Some of the funded projects did address education through course development. Most of the educational contribution to-date is likely centered on enabling the next generation of students to effectively work in an interdisciplinary setting. Students (particularly from underrepresented groups) benefit from exposure to role models unique to the interdisciplinary environment of EFRI. Education should be more emphasized in the annual conference. NSF should also compile and track information on courses and students.	Appropriate
3. Are EFRI awards appropriate in size and duration for the scope of the topics? Comments: The COV recommends that the size of awards going forward does not change.	Appropriate

4. Does the overall program portfolio (including ARRA funded awards) support potentially transformative research? Please comment specifically on ARRA awards, separately, as well. Comments: The overall portfolio is potentially transformative.	Appropriate
5. Does the program portfolio demonstrate synergy of the experts from different disciplines? Comments: The program has done an excellent job fostering synergy across disciplines.	Appropriate
6. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of awards to new investigators? Please comment separately for ARRA funded portfolio. Comments: EFRI should be commended for engaging a large number of investigators new to NSF funding. Moving forward, the COV recommends the program collects data that differentiates between early career investigators and established investigators who have been previously supported by other funding agencies.	Appropriate

8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: Generally yes. The COV would like to see the geographic distribution of preliminary, invited and final proposals in addition to the geographic distribution of the final awards.	Appropriate
9. Does the program portfolio have an appropriate balance of Institutional types. Comments: The diversity of institutions is very good. The COV notes that over time, the diversity of institutions has increased.	Appropriate
10. Does the program portfolio have an appropriate balance of disciplinary or interdisciplinary expertise to advance each of the Topics that have been supported? Comments: The EFRI solicitation requires interdisciplinary research teams. The COV encourages EFRI to continue inclusion of out of the box ideas and approaches. The reviewers should comment on the effectiveness of the team to execute the research as part of the proposal review. The COV was delighted to see fresh investigators join the NSF family of awardees as a result of the EFRI initiative.	Appropriate

11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: EFRI is uniquely positioned to take a leadership role in transforming the level of participation of those traditionally underrepresented in science and engineering. The COV strongly urges that a plan of action be formulated very soon and definitely before the next solicitation for proposals this summer 2011, so that the new diversity requirements are incorporated in this year's solicitation. The participation of underrepresented minority PIs and co-PIs is unacceptably low. EFRI should initiate a series of innovative efforts geared at addressing this issue. As an example EFRI could emulate the ERC in engaging minority serving institutions in their research and education plans. The EFRI program overall has a fairly good representation of female PIs and co-PIs, ranging from 30% female PIs in 2007 and 2010, to no awards to female PIs in 2008. The percentage of female investigators (PIs and co-PIs) ranges between 11% and 25% (these numbers are approximate because some co-PIs do not declare their data). Continued efforts to expand female participation are strongly encouraged. To ensure a diverse ethnic and gender distributions of the EFRI PIs and co-PIs, the COV recommends that the EFRI solicitation specifically request a description of how workforce and diversity at all levels will be enhanced by the proposed work (including at the leadership and co-PI level). In addition, the COV recommends that PIs be asked to offer presentation materials on diversity at the annual conference and/or Webex seminar.	Not Appropriate
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: The EFRI program is well-linked to national needs, such as the National Academy of Engineering's Grand Challenges. The COV was pleased to see recently developed partnerships with other funding agencies. The COV encourages EFRI to continue pursuing these partnerships.	Appropriate
13. Additional comments on the quality of the projects or the balance of the overall portfolio	

(including ARRA funded awards).

None.

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments:

The program is managed by a creative, improvisational, transformative Director, who has demonstrated real leadership qualities. He is assisted by a large number of interdisciplinary PDs. The COV applauds the enthusiasm and efforts of all PDs involved in the program. However, the COV also noted that some PDs appear to be micromanaging their projects. Some consistency in the management of the awards under the various EFRI topics should be attempted, possibly in discussions, during the annual PDs retreat, of each individual project's outcomes.

2. Responsiveness of the program to emerging research and education opportunities.

Comments:

Conceptually, EFRI is geared towards transformative research frontiers, and the topics of the solicitations are quite interesting with catchy acronyms. The elaborate process for the selection of topics (community input and NSF PDs and ELT retreats) also focuses on the program's responsiveness to emerging transformative research. To-date, the topics of the EFRI solicitations addressed emerging research opportunities rather than emerging education opportunities. However, commendably, some innovative aspects in education were proposed.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:

The process of topic selection, i.e. external process though ideas' solicitation and workshops, retreat with PDs and then retreat with the ELT, seems fairly involved. The COV felt that the process can be streamlined to become more efficient. In addition, EFRI could consider the web-posting of all topics proposed and discussed during the retreats, which could have a secondary benefit of attracting the interest of other funding agencies.

4. Additional comments on program management:

THE COV felt that the EFRI Director needs additional support for the development of a continuous assessment of the program and, also, in order to secure partnerships with additional funding agencies.

PART B. RESULTS OF NSF INVESTMENTS

The NSF mission is to promote the progress of science; advance national health, prosperity, and welfare; and secure the national defense (NSF Act of 1950).

In this Section, the COV is asked to comment on (1) noteworthy achievements based on NSF awards in the portfolio under discussion; (2) ways in which funded projects have collectively affected progress toward NSF's mission and the strategic outcome goals of Discovery, Learning, and Research Infrastructure: and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

In addition to identifying particularly noteworthy accomplishments or "highlights," the COV is encouraged to comment on the impact of NSF supported contributions to the field. For example, the COV report may include comments on NSF supported work in context of contributions to advance a field, impact of NSF investments to stimulate emerging new areas, and potential for transformative impact in research or education.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio. The COV is asked to use this information, members' own knowledge of the field, and other appropriate information to develop its comments for this section.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.*"
This category includes NSF's disciplinary and interdisciplinary research in science and engineering, education research, and centers.

Comments:

The charge of the EFRI Program is to provide leadership and guidance to the Directorate for Engineering (ENG) to champion time-critical focus on important emerging innovation. Specifically EFRI makes annual recommendations on research priorities, funds and initiatives at the emerging frontiers of engineering research and education. The mission of the EFRI program is to fund interdisciplinary research in emerging areas that are transformative, address national needs and grand challenges and will position the NSF ENG Directorate as an unrivaled global leader in engineering research and education.

In its first three years of operation, the EFRI has devised and implemented an innovative, research community-inclusive and highly effective process to solicit, cultivate, refine and propose cutting edge interdisciplinary research topics that represent paradigm shifts in research approaches and have strong potential to create new research areas. The process expertly screens and defines topics that have the greatest opportunity to provide significant societal benefit and position the nation as a global leader in transformational engineering research and education.

Each year two pioneering solicitation topics were developed that span bioengineering and health to infrastructure, energy, sustainability and machines/robotics, ensuring the EFRI program provides a strong foundation for the mission of NSF: "To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense....". These topics were also expertly designed to align with and provide research support for National Academy of Engineering Grand Challenge areas. The breadth of funded projects in each research topic supports the research need for expedient discovery to overcome technology gaps as well as the investigator innovation in devising different approaches to provide technology solutions.

While transformative research is a common vision for many programs across a wide range of funding agencies, it is critical to acknowledge the differentiating advantages of the EFRI program over these other research programs. EFRI is unique in providing focused support for engineering innovation as opposed to basic science advancement, and in fostering unbridled creativity while minimizing constraints imposed by traditional research approaches that require extensive preliminary data. The EFRI approach is well positioned to overcome the limitations of these traditional research funding mechanisms which often result in incremental improvements instead of transformative solutions and creation of new fields of study.

The exemplary job of the EFRI leadership in developing and implementing the program is reflected in
1) the recruitment of broad support and participation across NSF directorates and divisions,
2) participation of other funding agencies including DOE and EPA,
3) recruitment of international collaborators including groups from Europe and China.

The success of the review process is reflected in the diversity of exceptional investigators and out-of-the box approaches which leverage novel methods including biomimicry.

The transformative nature of the funded projects places many in the basic research phase. Commendably the vision and transformative drive of the investigators is exemplified in translation of their discovery to practice through construction of working models that not only test theories but provide online feedback and integrated real-time process improvement.

Examples of excellence in EFRI research outcomes include:

ARES topic: NSF Award 0735953, Daniela Rus, MIT, Controlling the Autonomously Reconfigured Factory project in which the concept of autonomous robotic assembly was proven through construction of new robotic prototype systems that demonstrated the ability to adapt assembly and design to time-varying blueprint constraints, choices or circumstances, resulting in real-time smart design.

CBE topic:

1. NSF Award 0735997, Roger Kamm, MIT, A Multifaceted Approach to the Modeling of Angiogenesis in which a microfluidic device and growth factors were used to grow a functional microvascular network. The device and mathematical models can predict corrective actions/growth conditions to induce desired growth patterns or characteristics such as rate of vessel elongation.

2. NSF Award 0735987, William Bentley, University of MD, Biofunctionalized Devices: On Chip Signaling and “Rewiring” Bacterial Cell-Cell Communication in which biological nanofactories that trigger quorum sensing were engineered and used in quenching mode that interrupts bacterial communication. Novel methods for self-assembly of proteins in MEMS were also achieved.

COPN topic: NSF Award 0835878, Andrew Ng, Stanford, Deep Learning in the Mammalian Visual Cortex, in which they developed a learning algorithm of the brain that can read and understand video images and audio, and that uses a brain-like program for detection.

RESIN topic:

1. NSF Award 0835414, David Allen, University of Texas at Austin, The Interface of Infrastructure, Markets and natural Cycles: Innovative Modeling and Control Mechanisms for Managing Electricity, Water and Air Quality in Texas in which the team worked with the regional electricity provider to demonstrate a tool to make grids smarter and greener. Specifically innovations in cooling technologies can dramatically reduce the water needs of power plants and make the plants more resilient under drought conditions.

2. NSF Award 0835982, Ximing Cai, University of Illinois at Urbana-Champaign, Interdependence, Resilience and Sustainability of Infrastructures for Biofuel Development in which a microbial biofuel feedstock was developed that is more productive (cost and mass) than switchgrass in producing metric tons of alternative biofuels.

BSBA topic: NSF Award 0937987, Vadim Backman, Northwestern University, Photonic Technique For Sensing and Understanding Subcellular Structures at Nanoscale in which a method of lung cancer detection was developed using a noninvasive collection of a patients’ swabbed cheek cells and microscopic scanning. The technique is effective even in patients with other lung diseases such as COPD.

HyBi topic: NSF Award 0937721, William Roberts, NC State University, Algal Oils to “Drop’In” Replacements for Petroleum-Derived Transportation Fuels in which exceptional advances in biomass production and process scale factors yields a microalgae mass culturing process that can deliver large-volume lipid production for biorefining.

RESTOR topic: NSF Award 1038307, Sossina Haile, CalTech, Thermochemical Routes to Efficient and Rapid Production of Solar Fuels, in which the group is advancing technology for storage of solar energy.

SEED topic:

1. NSF Award 1038165, Minoru Taya, University of Washington, Toward Zero-Energy Buildings Based on Electrochromic Windows and Energy-harvesting, in which switchable dyes and polymers that react to light are used to reduce energy cooling and heating needs.

2. NSF Award 1038257, James Englehardt, University of Miami, Design for Autonomous Net-Zero Water Buildings, in which technologies for decentralization of water monitoring, quality control and operation and maintenance for low energy water reuse is developed. The system is designed to destroy contaminants in grey water and address architectural challenges and socio-cultural acceptability of reused potable water.

Transition of an EFRI first annual (FY2007) program solicitation investigator to follow-on funding exemplifies the transformative nature of the research innovation. Dr. Roger Kamm (MIT, NSF EFRI Award 0735997) PI in CBE (FY 2007 topic) was recently awarded one of five NSF STC (Science and Technology Centers) for research stemming from the PI’s EFRI award.

Examples of NSF programs well positioned for next-generation funding of current EFRI investigators include (listed by EFRI topic):

RESIN (FY 2008):

Resilient and Sustainable Infrastructure Cluster in NSF CMMI (Civil, Mechanical, and Manufacturing Innovation)

BSBA (FY 2009):

Biosensing topic under the NSF CBET division (Alex Siomian, NSF PD).

Given the size of the commitment to the EFRI program, NSF-wide efforts to develop pathways for EFRI funded investigators to seek follow-on funding should be pursued to ensure advancement of transformative research and innovation to products and technologies.

As EFRI accumulates experience with the program, a critical need will be to develop measurable metrics to ensure EFRI award decisions are aligned with NSF-wide goals. Well defined, quantifiable metrics will ensure success of the program, the national science agenda, and sustained leadership position of the Engineering Directorate. The importance of the development of a thorough and effective assessment program was highlighted in the Science and Technology Policy Institute EFRI program evaluation.

B.2 OUTCOME GOAL for Learning: "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"
This category includes K-12, undergraduate, graduate, and postdoctoral education and training; public understanding of science; and lifelong learning.

Comments:

The COV recognizes that as structured, the EFRI program is primarily focused on frontiers of research and innovation, and that educational activities are a secondary consequence. The major educational benefit is the development of a culture of interdisciplinary research and innovation.

EFRI projects are strong in the cross-pollination of ideas between various disciplines in emergent fields. Through the incorporation of EFRI research and discovery in the curricular and research training of undergraduate and graduate students and postdoctoral fellows, a cadre of scientists and engineers will enter the workforce prepared to address frontier challenges. Exchange of student researchers across laboratories in multi-institutional programs or with industrial partners is an excellent example of knowledge transfer that enhances outcomes.

Findings from EFRI projects are widely disseminated through publications, conference presentations, invited lectures, symposia and workshops. Representative K-12 outreach efforts include pre-college teacher workshops, summer programs for high school students, and science and engineering days.

EFRI is not unique in the challenges it faces in broadening participation of underrepresented minorities, women and researchers from other than research-intensive institutions. The COV encourages EFRI to seek and pursue opportunities to more fully engage members of underrepresented groups at all levels and across all research and educational activities.

COV recommendations in this area include: mentorship and development for research leadership, workshops for awardees on diversity and outreach, tapping into and leveraging existing NSF venues such as ADVANCE, and establishing dialogue between partner organizations/agencies to enhance diversity. EFRI may also consider having individual awardees select a particular area within education and outreach on which to focus their efforts and achieve excellence.

B.3 OUTCOME GOAL for Research Infrastructure: "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*"
This category includes facilities, research instrumentation, and cyberinfrastructure.

Comments:

The research projects funded by the EFRI program have contributed to enhancing the nation's research capability through developing cutting-edge research tools in critical and emerging areas. Numerous projects in the areas targeted by EFRI have enabled the investigators to develop new

technologies that would not have been possible with traditional awards that are limited in size and scope. EFRI has filled the gap that has long existed between the ERC and the traditional funding programs and has helped accelerate development of new technologies. The focus on multi-disciplinary and multi-investigator research has promoted the utilization of the infrastructure resources across departments and campuses. The program has enabled the investigators to significantly enhance the utilization of the existing research infrastructure and, through their discoveries, create the need for new cutting edge research infrastructure. While the thrust of the EFRI program is not the enhancement of infrastructure, it is obvious that it will have a significant impact on the future research infrastructure demands in the nation driven by cutting-edge research and discoveries.

COV identified the following projects/topics as examples of research efforts that help support NSF goals for advancing the research infrastructure.

Autonomously Reconfigurable Engineered Systems (ARES)
0735953 Daniela Rus of MIT, Controlling the Autonomously Reconfiguring Factory
The development of new robotic prototype systems capable of autonomously assembling and disassembling truss structures will lead to the need for research infrastructure capable of moving this technology into the market place. The availability of intelligent robots in construction and delivery will revolutionize the building industry and an industry geared towards the fabrication of these robots will have a significant economic impact on the nation.

Cellular and Biomolecular Engineering (CBE)
0735987 William Bentley of University of Maryland, Biofunctionalized Devices - On Chip Signaling and "Rewiring" Bacterial Cell-Cell Communication

This research project is targeted towards cell-cell communication system mediated by bacterial signaling autoinducers in a process known as “quorum sensing”. The investigators have developed a microfluidic system with integrated sidewall electrodes that allows quantitative characterization of the electrodeposited chitosan hydrogels and other polymer hydrogels that could assist with cell entrapment and localization. They have also developed a simple process for fabricating Surface Enhanced Raman Spectroscopy (SERS) substrates with excellent enhancement characteristics that allow the detection of low concentrations of small molecules. The project is now enabling them to integrate these SERS substrates with microfluidic systems for in situ analysis of cellular response to external stimuli. The concept of 'in-film' bioprocessing has also been developed. The investigators have created the first biological 'nanofactory' which enables the synthesis and delivery of bacterial autoinducers on the outer surfaces of targeted cells. This is an entirely new mode of delivery of small molecules to cells. Nanofactories were utilized to capture and study quorum sensing responses in microfluidic channels.

This project has the potential to create a need for new research infrastructure to permit the technology to reach the market place.

Resilient and Sustainable Infrastructures (RESIN)
O835982 Ximing Cai of the University of Illinois, Interdependence, resilience and sustainability of infrastructure for biofuel development

The project is focused on developing strategies to sustainably operate and expand the interdependent infrastructure systems of the emerging bio-economy. The outcome of this research project could lead to the development of new technologies pertaining to biofuels and will trigger the need for enhanced infrastructure for pursuit of research to the next level.

Hydrocarbons from Biomass (HyBi)
In this initiative there were a large number of funded projects that could lead to significant need for enhanced research infrastructure to permit the researchers to move their discoveries to the market place. This clearly demonstrates the success of the EFRI program in enabling highly interdisciplinary research communities to develop technologies that push the demand for new research infrastructure to address a critical national needs.

PART C. OTHER TOPICS

C.1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

The COV is very enthusiastic about the EFRI program overall. As a new program, it has been well designed, with the right combination of structure and flexibility to develop compelling interdisciplinary topics and draw in strong, creative proposals. EFRI has been effectively designed to enable PIs to freely explore topical areas of higher risk than conventional NSF programs. The topic selection process has successfully engaged PDs from across the Engineering Directorate and other parts of NSF. These are both clearly strengths of the program.

The COV identified some gaps in the program.

The COV felt that while "transformative" is an important descriptor of the program, the term could be more crisply defined within the context. It is offering recommendations to help the program mature so that the NSF can better understand and potentially increase the impact of the program.

The COV also felt that there was heavy program emphasis on topic selection and light emphasis on post-award support. The COV recommends that PDs should offer annual written feedback to the PIs on the project's consistency with based on their presentations at Webex conference and/or annual reports.

There seemed to be a gap between upfront program design and outcome/impact assessment of the program at the portfolio and project level. It would be worthwhile for the program management to develop a framework for assessing the outcomes and impacts of the EFRI program so that appropriate data can be collected for ongoing projects.

C.2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions. Specifically, please comment on the Selection Process for the solicitations' Frontier Topics. Has the approach been effective in identifying important emerging topics? Is the current process for soliciting and evaluating community input effective? Do you have suggestions for improvements on either aspect?

- Sustaining EFRI Topics (Champions for Topics, Post-EFRI support)

EFRI should continue addressing continuity of oversight when PD IPAs leave the NSF. The COV recommends that NSF offer guidance to individual grantees to develop a sustainability plan for their project in year 3 or 4. Also, the EFRI program should continue to develop relationships with funding programs in other federal agencies to develop pathways for potential sustained support for worthy ideas.

- Topic Selection Process (Criteria, Repeat Topic, No Topic)

The COV agrees that the selection process is generally fine. The COV recommends the program consider selecting topics every two years rather than every year to reduce Program Director workload and free up some management time to address program outcome and impact assessment.

There are several options for design of the two year cycle. Option one would be to pick two topics every two years, and then issue solicitations for the selected pair of topics on consecutive years. One benefit of this approach is that it gives the opportunity to build a research community around the topic, and also could provide an opportunity for the EFRI program to establish relationships with other funding agencies aligned with a given topic. Option two would be to pick 4 topics every two years and then solicit two the first year and two the second. The benefit of this approach would be maintaining a diversity of topics. Option three would be a hybrid of options one and two, where the program has the option to trade in one or two topics for the second year solicitation.

If the program decides to pursue the two year cycle, it is important to work to maintain the Program Director enthusiastic engagement. Also, the program should continue to creatively use other mechanisms, such as exploratory grants and workshops, to address the EFRI vision.

- PD Workload and Overlapping EFRI Activities

The workload for PDs, particularly in the topic selection process, is fairly high. The COV recommends EFRI consider modifying the selection cycle to select topics every two years as described above.

- Any Other Issues or Ideas?

C.3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

As a medium-sized interdisciplinary program addressing national challenges, EFRI fills an important niche in the overall array of programs within NSF. NSF should consider devoting additional staff resources to the program for program evaluation and impact assessment to manage EFRI and also so that other programs can learn from EFRI. These resources would include an assistant program director and appropriate administrative supporting personnel.

C.4. Please provide comments on any other issues the COV feels are relevant.

The COV believes that NSF should continue to experiment with ways to diversify the EFRI program scope and PI and student base, through exploratory topics, wild card slots, workshops and other creative ways to respond to the most novel and transformative ideas from the engineering and scientific community in the US. The EFRI program is already moving in this direction and the COV believes that such innovation is highly desirable in a relatively new program.

The annual grantee conferences and annual reports are a good opportunity to collect data to support the future assessment of the program. This can also send a message to the PIs on what activities and contributions EFRI values. For example, EFRI PIs could be asked to devote several slides to

courses and student engagement at the annual conference. Then the program could aggregate this data to document the number of students and new courses.

More generally, the COV recommends the EFRI consider starting to collect and track some outcome metrics. The program is at a maturity level where it makes sense to develop an evaluation / assessment program at both the project and program level.

C.5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

The COV felt that the STPI report could have been more helpful if it had directly focused on assessing the EFRI program utilizing metrics relevant to the questions presented to the COV.

SIGNATURE BLOCK:

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For the EFRI 2011 Committee of Visitors
Dr. Cato T. Laurencin
Chair