

**Report of the Committee of Visitors for the
Energy Frontier Research Centers
and
Joint Center for Artificial Photosynthesis
Energy Innovation Hub
Basic Energy Sciences
U.S. Department of Energy
to the**

Basic Energy Sciences Advisory Committee

**Review since Initiation of EFRCs (2009) and
JCAP (2010) through Fiscal Year 2012**

**Germantown, Maryland
May 29-31, 2013**

Executive Summary

A Committee of Visitors (COV), under the guidance of the Basic Energy Sciences Advisory Committee (BESAC), reviewed the programs of the Energy Frontier Research Centers (EFRCs) and the Joint Center for Artificial Photosynthesis (JCAP), an Energy Innovation Hub. The EFRCs and JCAP are supported by the Basic Energy Sciences (BES) program within the DOE Office of Science. The EFRC funding opportunity announcement, issued on April 4, 2008, resulted in awards to 46 EFRCs for five years starting on August 1, 2009, at \$2-\$5 million per year per award for a total award commitment of \$777 million over five years. The Fuels from Sunlight Hub funding opportunity announcement, issued on December 22, 2009, culminated in a \$122 million over five-year award to JCAP on September 29, 2010. This report covers the initiation and management of the EFRC (2009) and JCAP (2010) programs through fiscal year 2012.

Nineteen members of the COV met at the Germantown headquarters of BES on May 29–31, 2013. The charge to the COV, from Prof. John Hemminger, the chair of BESAC, was to: (i) Assess the efficacy and quality of the processes used to solicit, review, recommend, and document proposal actions and monitor active projects. (ii) Within the boundaries defined by the DOE missions and available funding, comment on how the award process has affected the breadth and depth of portfolio elements, and the national and international standing of the portfolio elements. The COV was chaired by Dr. Persis Drell. This was the first COV for both the EFRCs and JCAP.

The unanimous judgment of this COV is that the outcome of the EFRC and JCAP procurement processes resulted in the funding of research with high potential for scientific impact in areas relevant to the DOE BES mission and led by highly recognized and accomplished scientists. The high scientific quality of the review and selection process reflects very favorably on the good judgment and competence of the BES staff and program managers.

The review of the ERFC proposals was a formidable task that was generally well managed by the BES staff. The challenges were the consequence of the need to review and act on a large number of proposals on a short time scale. The reviewers were of high quality overall. Given the constraints of time and potential for conflict of interest, the BES staff did a good job of recruiting from international scientists, industry and some non-DOE government labs. However, there was a striking lack of diversity (gender and ethnic) in the reviewer pool.

The BES management processes for the EFRCs are very well implemented and effective. A number of well thought out mechanisms are in place and have been actively used to identify issues and resolve them. A number of the communication mechanisms between the EFRCs and the science community and the public are excellent, and, overall, the EFRCs have told an inspiring story to the general scientific community concerning the value of fundamental research that supports energy sustainability.

The solicitation and review process for the Hub was a very substantial task that was well managed by the BES staff. The panels selected for the reviews were judged to be excellent. The merit review process was thorough and well documented, and the award to the Joint Center for Artificial Photosynthesis (JCAP) was consistent with its ranking by reviewers as being the clear

leader in both the first and second review panels.

While both EFRCs and the Hub present new management challenges, the size and unique focus of the Hub makes it absolutely critical for success that an effective Hub management structure is established. Continued BES oversight for the JCAP Hub will be required to achieve the stated goals.

The COV makes the following specific major recommendations:

1. Although EFRC award documents provided a clear rationale for why a given project was funded, the documentation for the proposals declined was limited to the reviewers' comments and the total average score. We recommend that BES document the reasons for declining proposals that were reviewed well enough to be fundable.
2. For the promise of the Hub to realize its full potential with significant impact, the COV recommends that BES take steps to ensure full integration and synergy of activities within the Hub to achieve the appropriate focus on the singular goal to be achieved for the funded project period (5 years).

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1. Introduction

This report documents the findings from a Committee of Visitors (COV) that was assembled under the auspices of the Basic Energy Sciences Advisory Committee (BESAC) to evaluate the processes and programs of the Energy Frontier Research Centers (EFRCs) and the Joint Center for Artificial Photosynthesis (JCAP) Energy Innovation Hub in the Office of Basic Energy Sciences (BES).

The EFRC funding opportunity announcement, issued on April 4, 2008, resulted in the launch of 46 EFRCs on August 1, 2009. These Centers involve universities, national laboratories, nonprofit organizations, and for-profit firms, singly or in partnerships, selected by scientific peer review. They are funded at \$2 to \$5 million per year for a total planned DOE commitment of \$777 million over the initial five-year award period, pending Congressional appropriations. These integrated, multi-investigator Centers are conducting fundamental research focusing on one or more of several “grand challenges” and use-inspired “basic research needs” identified in major strategic planning efforts by the scientific community (<http://science.energy.gov/bes/news-and-resources/reports/basic-research-needs/>). The purpose of the EFRCs is to integrate the talents and expertise of leading scientists in a setting designed to accelerate research that transforms the future of energy and the environment.

The Fuels from Sunlight Energy Innovation Hub funding opportunity announcement, issued on December 22, 2009, culminated in a \$122 million over five-year award to JCAP on September 29, 2010. Led by the California Institute of Technology, in partnership with the Lawrence Berkeley National Laboratory, SLAC National Accelerator Laboratory, and the University of California campuses at Berkeley, Irvine, and San Diego, JCAP serves as an integrative Hub, bringing together a diverse community of scientists, to build critical foundational knowledge for the design of solar energy-to-fuel conversion systems that use Earth-abundant elements and demonstrate the efficiency, scalability, and sustainability to be economically viable. JCAP aims at accelerating solar fuels research and broadly engaging the scientific community to further develop new ways to produce carbon-neutral fuels.

Both the EFRCs and JCAP were selected by and are actively managed by a team of BES program managers. The current program managers are in the Materials Sciences and Engineering (EFRC) and Chemical Sciences, Geosciences and Biosciences (EFRC, JCAP) Divisions.

The COV met at the Department of Energy facilities in Germantown, MD for two and one-half days from May 29-31, 2012. This was the first COV review of the selection and management processes for the EFRCs and JCAP.

2. The Charge to the Committee of Visitors

The charge to the COV was established in a letter from the Chair of BESAC to Dr. Persis Drell, who had agreed to chair the COV. The letter is attached as Appendix I. The charge was to assess the procurement (award selection) and monitoring (management processes) for the Energy Frontier Research Centers (EFRCs) and the Joint Center for Artificial Photosynthesis (JCAP)

Energy Innovation Hub since their initiation in 2009 (EFRC) and 2010 (JCAP) through fiscal year 2012. The components of the programs that the COV was asked to review were: EFRC Award Selection, EFRC Management Processes, and JCAP Award Selection and Management Processes.

The COV was asked to focus on the following major elements for the EFRCs and JCAP: (i) Assess the efficacy and quality of the processes used to solicit, review, recommend, and document proposal actions and monitor active projects. (ii) Within the boundaries defined by the DOE missions and available funding, comment on how the award process has affected the breadth and depth of portfolio elements, and the national and international standing of the portfolio elements.

3. The Committee Membership

The COV membership was selected and approved by the COV chair, Dr. Persis Drell, in consultation with BES staff. The members were chosen to represent a cross-section of experts in their particular scientific field and/or for their expertise in managing large research programs. A balance was achieved between researchers who were involved in an EFRC or Hub application or are EFRC participants and those who were not (8 and 11, respectively), between academic (14) and national laboratory (5) staff, and between those who have previously served on a COV and those that have not (11 and 8, respectively).

Given the size of the EFRC and JCAP programs and the breadth of programmatic areas, a sizable committee was assembled. The COV consisted of a total of 19 members, including the chair. The 19 members were divided into an EFRC (12) and a JCAP (6) panel. The EFRC panel was further divided into two subpanels on award selection (6) and operations (6). Each panel/subpanel had a first and second “read,” that is, a first and second reading by different reviewers.

The following COV members kindly agreed to be the panel leads: Profs. Cynthia Friend and Marc Kastner (EFRCs), and Dr. Michelle Buchanan (JCAP).

A full listing of the COV members and their panel assignments for both the first and second reads is given in Appendix II and Appendix III, respectively.

4. The Review Process

The COV assembled in Germantown in the morning on Wednesday, May 29, and adjourned around noon on Friday, May 31. The agenda for the COV is attached as Appendix IV.

Prior to convening in Germantown, each COV member was supplied with the link to the EFRCs and JCAP COV website containing a comprehensive set of information pertaining to: the COV process, the report templates, the Funding Opportunity Announcements (FOAs), technical summaries, facts sheets, and web links to each of the programs. The availability of information relevant for the review well in advance of the review greatly assisted the COV in being well

prepared and organized to assess a large amount of material very efficiently. Additional information was also supplied to each member during the COV review in Germantown, including copies of the plenary presentations and an overview of the EFRC and JCAP programs. The majority of the COV review focused on electronic files, including proposals, award selection, management and science reviews, annual reports, meetings, and program statistics.

The COV began with a reiteration of the charge to the committee given on behalf of the BESAC chair, Prof. John Hemminger, by Dr. Harriet Kung, Director of BES. Dr. Kung also presented an overview of BES. Then, Dr. Persis Drell presented details of the overall review process. An overview of the EFRCs was given by Dr. Linda Horton, Division Director for Materials Sciences and Engineering and the interim EFRC Lead. An overview of JCAP was presented by Dr. John Miller, Acting Division Director for Chemical Sciences, Geosciences and Biosciences, and Dr. Mark Spitler, Program Manager for Solar Photochemistry. Discussion of EFRC and JCAP management continued through a working lunch with the COV members and BES staff. Following lunch, the panelists adjourned to their panel break-out rooms.

At the beginning of the panel break-outs, additional details for the EFRCs or JCAP were presented. For the JCAP panel, a more detailed presentation of the JCAP review and award process was provided by Dr. Eric Rohlfing, Acting Deputy Director for Technology of the Advanced Research Projects Agency–Energy (ARPA-E) on detail from BES. Dr. Rohlfing oversaw the Hub procurement and initial management processes as Division Director for BES Chemical Sciences, Geosciences and Biosciences through fiscal 2012. For the EFRCs, Dr. Horton and the EFRC management team were available for initial questions.

Each panel member was supplied with electronic copies of proposals to evaluate the JCAP and EFRC award/decline/monitor process and subsequent operations. Files included declined applications, awards, and management/review activities following the selection of awardees. The panels were free to request any additional information that they judged would help them in their evaluation process. After the initial discussion period, the program managers were not present during the review process but were on hand to answer questions or provide additional input as needed.

The first reading of the files occupied the remainder of the first day with the panels preparing preliminary findings that were discussed with the COV chair, and shared with BES senior management. The checklist used by the panels during their review of the files is presented in Appendix V; it correlates with the report templates used by the panels as presented in Appendix VI. For the EFRC report, the EFRC award selection subpanel addressed question 1a on “Solicit, review, recommend, and document proposal actions;” the EFRC operations subpanel addressed question 1b on “BES Management processes for EFRCs.” Both subpanels contributed to questions 2a and 2b on the “Impact and Standing of the EFRCs.”

On the afternoon of the second day, the panel members were assigned to different panels for the second read. The panel leads, however, did not rotate and were available to add continuity and context for the second read members. The second read allowed the refinement and review of the preliminary findings from the first read.

At the end of the afternoon of the second day, the original members of each panel reconvened with the panel lead to merge and finalize the findings from the first and second reads, and to prepare materials for the final report. The entire COV then met in executive session to discuss and reach consensus on the major findings and recommendations.

On the morning of the third day the COV Chair and panel leads met and presented the major findings and recommendations to BES leadership, including the EFRC and JCAP program managers.

The written reports from the panels (Appendix VII) and the conclusions and recommendations drawn from the executive session provided the basis for this report.

5. Major Findings of the COV

The EFRCs and HUBs represent a large percentage (> 20% in FY 2013) of the BES investment in science outside of the Division of Scientific User Facilities. It is widely appreciated within BES that it is very important to ensure that the EFRCs and Hubs are successful and foster outstanding basic research. It was recognized from the onset that it would require new mechanisms to review and manage awards of the size of the EFRC (up to \$5M/yr) and Hub (about \$25M/yr).

1. The unanimous judgment of this COV is that the outcome of the EFRC and JCAP procurement processes resulted in the funding of research with high potential for scientific impact in areas relevant to the DOE BES mission and led by highly recognized and accomplished scientists. The high scientific quality of the review and selection process reflects very favorably on the good judgment and competence of the BES staff and program managers.
2. The review of the ERFC proposals was a formidable task that was generally well managed by the BES staff. The challenges were the consequence of the need to review and act on a large number of proposals on a short time scale. The reviewers were of high quality overall. Given the constraints of time and potential for conflict of interest, the BES staff did a good job of recruiting from international scientists, industry and some non-DOE government labs. However, there was a striking lack of diversity (gender and ethnic) in the reviewer pool.
3. The BES management processes for the EFRCs are very well implemented and effective. A number of well thought out mechanisms are in place and have been actively used to identify issues and resolve them. A number of the communication mechanisms between the EFRCs and the scientific community and the public are excellent and overall, the EFRCs have told an inspiring story to the general scientific community concerning the value of fundamental research that supports energy sustainability.
4. The solicitation and review process for the Hub was a very substantial task that was well managed by the BES staff. The panels selected for the reviews were judged to be excellent. The merit review process was thorough and well documented, and the award to the Joint Center for Artificial Photosynthesis (JCAP) was consistent with its ranking by reviewers as being the clear leader in both the first and second review panels.

5. While both EFRCs and the Hub present new management challenges, the size and unique focus of the Hub makes it absolutely critical for success that an effective Hub management structure is established. Continued BES oversight for the JCAP Hub will be required to achieve the stated goals.

6. Major Recommendations of the COV

1. Although EFRC award documents provided a clear rationale for why a given project was funded, the documentation for the proposals declined was limited to the reviewers' comments and the total average score. We recommend that BES document the reasons for declining proposals that were reviewed well enough to be fundable.
2. For the promise of the Hub to realize its full potential with significant impact, the COV recommends that BES take steps to ensure full integration and synergy of activities within the Hub to achieve the appropriate focus on the singular goal to be achieved for the funded project period (5 years)

Appendix I: Charge from the Chair of BESAC, Prof. John Hemminger to the Chair of the COV, Dr. Persis Drell.

UNIVERSITY OF CALIFORNIA, IRVINE

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SANTA BARBARA • SANTA CRUZ

JOHN C. HEMMINGER
VICE CHANCELLOR FOR RESEARCH
OFFICE OF RESEARCH
160 ALDRICH HALL

IRVINE, CALIFORNIA 92697
Phone 949-824-5796 Fax 949-824-2095
JCHEMMIN@UCI.EDU
[HTTP://SURFSCIPS.UCI.EDU](http://SURFSCIPS.UCI.EDU)

December 26, 2012

Professor Persis Drell
SLAC National Accelerator Laboratory
2575 Sand Hill Road
Menlo Park, CA 94025

Dear Persis:

The Basic Energy Sciences Advisory Committee (BESAC) has been charged by the Department of Energy's Office of Science to assemble a Committee of Visitors (COV) to review the procurement and management processes for the Energy Frontier Research Centers (EFRCs) and the Joint Center for Artificial Photosynthesis (JCAP)—an Energy Innovation Hub of the Basic Energy Sciences (BES) program.

Thank you for agreeing to chair this inaugural BESAC COV panel. Under your leadership, the panel should provide an assessment of the processes used to solicit, review, recommend, and document proposal actions and to monitor active projects. The panel should assess the procurement and operations of the programs since their initiation of 2009 (EFRC) and 2010 (JCAP) through 2012.

The panel may examine any files from this period. We expect to structure the review into the following groups:

- (1) EFRC Procurement
- (2) EFRC Management
- (3) JCAP Procurement and Management

You will be provided with background material on these program elements prior to the meeting. The COV is scheduled to take place Wednesday, May 29, 2013 thru Friday, May 31, 2013 at the BES/DOE Germantown location at 19901 Germantown Road, Germantown, Maryland 20874. A presentation to BESAC is requested at the Summer BESAC 2013 meeting (as yet unscheduled). Following acceptance of the report by the full BESAC committee, the COV report with findings and recommendations will be presented to the Director of the Office of Science.

The Basic Energy Sciences Advisory Committee has given the panel the following charge:

- (1) For the EFRCs and JCAP, assess the efficacy and quality of the processes used to:
 - (a) solicit, review, recommend, and document proposal actions and
 - (b) monitor active projects.
- (2) Within the boundaries defined by DOE missions and available funding, comment on how the award process has affected:
 - (a) the breadth and depth of portfolio elements, and

(b) the national and international standing of the portfolio elements.

If you have any questions regarding BESAC or its legalities, please contact Katie Perine, Office of Basic Energy Sciences at (301) 903-6529 or via e-mail at katie.perine@science.doe.gov. Kerry Gorey, the Program Support Specialist for the EFRC, will provide logistical support for the COV meeting. She may be contacted by phone at (301) 903-7661 or via e-mail at kerry.gorey@science.doe.gov. For questions related to the overall COV, please contact Harriet Kung at (301) 903-0497, or via e-mail at harriet.kung@science.doe.gov. Also, if I can be of any help with the process, please feel free to contact me at (949) 824-5796 or via email at jchemmin@uci.edu.

Sincerely,



Digitally signed by John Hemminger
DN: cn=John Hemminger,
o=University of California, Irvine,
ou=Office of Research,
email=jchemmin@uci.edu, c=US
Date: 2012.12.26 09:50:02 -08'00'

John C. Hemminger
Vice Chancellor for Research, UC Irvine
Chair, Basic Energy Sciences Advisory Committee

Cc:
H. Kung, DOE/BES
L. Horton, DOE/BES
E. Rohlfig, DOE/BES
K. Perine, DOE/BES
K. Gorey, DOE/BES

Appendix II: COV Members and Contact Information

Last Name	First Name	Affiliation	Email
**Buchanan	Michelle	ORNL	buchananmv@ornl.gov
Burns	Carol	LANL	cjb@lanl.gov
Cava	Robert	Princeton	rcava@princeton.edu
Chabal	Yves	U Texas, Dallas	chabal@utdallas.edu
Chaka	Anne	PNNL	anne.chaka@pnnl.gov
Chamberlain	Jeff	ANL	jchamberlain@anl.gov
*Drell	Persis	SLAC	persis@slac.stanford.edu
**Friend	Cynthia	Harvard	cfriend@seas.harvard.edu
Galoppini	Elena	Rutgers	galoppin@rutgers.edu
Gates	Bruce	UC Davis	bcgates@ucdavis.edu
***Hemminger	John	UC Irvine	jchemmin@uci.edu
Hammes-Schiffer	Sharon	UI-UC	shs3@illinois.edu
Harris	Alex	BNL	alexh@bnl.gov
**Kastner	Marc	MIT	mkastner@mit.edu
McCusker	James	Michigan State	jkm@chemistry.msu.edu
Neal	Sharon	NSF/Delaware	shneal@nsf.gov
Ort	Donald	USDA/ UI-UC	d-ort@uiuc.edu
Osgood	Rick	Columbia	osgood@columbia.edu
Rogers	John	UI-UC	jrogers@uiuc.edu
Scott	Susannah	UCSB	sscott@engineering.ucsb.edu

*COV Chair

**Panel Leads

***BESAC Chair

Appendix III: COV Panel Assignments

COV Chair: Persis Drell (SLAC)

EFRC Panel	
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Co-Chairs (2)	Institution
Cynthia Friend	Harvard
Marc Kastner	MIT

First Read	
Panelist	Institution
<i>EFRC Award Selection</i>	
Yves Chabal	U Texas Dallas
Elena Galoppini	Rutgers
Donald Ort	USDA and U of I
John Rogers	U of I
Susannah Scott	UC-SB
<i>EFRC Management</i>	
Carol Burns	LANL
Robert Cava	Princeton
Jeff Chamberlain	ANL
Sharon Hammes-Schiffer	Penn State/ now at UIUC
Rick Osgood	Columbia

Second Read	
Panelist	Institution
<i>EFRC Award Selection</i>	
Robert Cava	Princeton
Anne Chaka	PNNL
Jeff Chamberlain	ANL
Bruce Gates	UC Davis
Rick Osgood	Columbia
<i>EFRC Management</i>	
Yves Chabal	U Texas Dallas
Alex Harris	BNL
Jim McCusker	Mich. St.
Sharon Neal	NSF/Delaware
Donald Ort	USDA and U of I

Award Selection Subpanel (Led by Friend)
 Management Subpanel (Led by Kastner)

Hub Panel	
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Chair	Institution
Michelle Buchanan	ORNL

First Read	
Panelist	Institution
<i>JCAP Award Selection and Management</i>	
Anne Chaka	PNNL
Bruce Gates	UC Davis
Alex Harris	BNL
Jim McCusker	Mich. St.
Sharon Neal	NSF/Delaware

Second Read	
Panelist	Institution
<i>JCAP Award Selection and Management</i>	
Carol Burns	LANL
Elena Galoppini	Rutgers
Sharon Hammes-Schiffer	Penn State/ now at UIUC
John Rogers	U of I
Susannah Scott	UC-SB

Appendix IV: COV Agenda

Agenda -- Last Updated 05-24-2013

**Committee of Visitors Review: Energy Frontier Research Centers and Fuels from Sunlight Hub
May 29-31, 2013; DOE Germantown Complex**

Wednesday, May 29, 2013

Time	Activity	Participants/Lead	Location
7:50am	Pick-up via bus	COV Members/Kerry Gorey	Front of Hotel
8:00am - 8:50am	Check-in Germantown Facility	COV Members/BES Staff	North Lobby
8:55 am - 9:15am	Welcome and Charge to the Committee	Harriet Kung, BES Associate Director	A-410
9:15 am - 9:45am	Welcome and SC-BES Overview, including EFRCs and Hubs	Harriet Kung, BES Associate Director	A-410
9:45am - 10:15am	Instructions, procedures, and schedule	Persis Drell, COV Chair	A-410
10:15am - 10:30am	Refreshment Break		A-410
10:30am - 11:30am	Overview of EFRCs: Procurement and Management	Linda Horton, Materials Sciences Division Director and Interim Lead, EFRC Management Team	A-410
11:30am - 12:00pm	Overview of Fuels from Sunlight Hub: Procurement and Management	John Miller, Acting Division Director - Chemical Sciences, Geosciences and Biosciences	A-410
12:00pm - 1:15PM	Working Lunch: Discussion of initial questions from overviews and process Move to panel rooms	BES/COV members	A-410
Panel Breakouts 1:15pm - 4:30pm	EFRC Panel: Review EFRC folders	BES Rep: Linda Horton BES Staff: Dawn Adin, Robin Hayes, Craig Henderson, Jeff Krause, Gail McLean, Bob Stack, Thiyaga Thiyagarajan, and John Vetrano Admin Support: Kerry Gorey	A-410
	Hub Panel: Review Hub folders	BES Rep: John Miller BES Staff: Gail McLean, Eric Rohlfing, Mark Spittler, Dawn Adin Admin Support: Diane Marceau	E-401
4:30pm - 5:00pm	COV Executive Session - preliminary assessment	COV	A-410
5:00pm - 5:30pm	COV and BES Discussion - respond to questions and provide additional information	COV with BES Management	A-410
5:30pm - 6:00pm	Check-out Germantown Facility	COV Members/Kerry Gorey	North Lobby
6:30pm - 8:00pm	Dinner	BES/COV members	Carrabba's

Agenda -- Last Updated 05-24-2013

**Committee of Visitors Review: Energy Frontier Research Centers and Fuels from Sunlight Hub
May 29 - 31, 2013; DOE Germantown Complex**

Thursday, May 30, 2013

Time	Activity	Participants/Lead	Location
7:50am	Pick-up via bus	COV Members/Kerry Gorey	Front of Hotel
8:00am - 8:30am	Check-in Germantown Facility	COV Members/BES Staff	North Lobby
Panel Breakouts, cont'd 8:30am - 12:00pm	EFRC Panel: Continued review of folders	As above	A-410
	Hub Panel: Continued review of folders	As above	E-401
12:00pm - 1:00pm	Lunch in DOE Cafeteria		
Second Read Panels 1:00pm - 4:00pm	EFRC Panel: Second read by Hub Panel (Some members of EFRC panel continue reading EFRC folders)	As above	A-410
	Hub Panel: Second read by selected members of EFRC panel	As above	E-401
4:00pm - 4:30pm	Break and opportunity for discussion with BES representatives in both panel rooms	As above	
4:30pm - 5:30pm	COV Executive Session - preliminary assessment for panel assignments	COV	A-410
5:30pm - 6:00pm	COV and BES Discussion - respond to questions	COV with BES Management	A-410
6:00pm - 6:15pm	Check-out Germantown Facility	COV Members/Kerry Gorey	North Lobby
	Dinner on your own		

Friday, May 31, 2013

Time	Activity	Participants/Lead	Location
7:50am	Pick-up via bus	COV Members/Kerry Gorey	Front of Hotel
8:00am - 8:30am	Check-in Germantown Facility	COV/BES Staff	North Lobby
8:30am - 10:30am	Breakout Panels - Writing of Report	COV	A-410
10:30am - 11:15am	COV Executive Session	COV / BES Management	A-410
11:15am - 12:00pm	Closeout Session	COV / BES Staff	A-410
12:00pm	Adjourn - Thank You!		

Appendix V: Checklists for COV review

Checklist for COV Review -- EFRC Selection Process	
	Comments
I. Efficacy and Quality of Processes used for EFRC Selection	
(a) Solicit, review, recommend, and document proposal actions	
FOA: Adequate information for potential proposers?	
Review process: Consider, for example: Sufficient number of reviews? Qualified reviewers? Quality of reviews (consistent with criteria)?	
Documentation: Consider, for example: Quality of selection statements? Revised budgets? Content of generic memos ?	
II. Impact and Standing of the EFRCs	
(a) Breadth and depth of awards: Consider, for example:	
Overall quality of awarded EFRCs? Balance of innovation, risk, and interdisciplinary research? Technical diversity?	
Relationship to other BES portfolio? Relevant to mission?	
Length of awards? Award size?	

Checklist for COV Review -- General EFRC Management	
	Comments
I. Efficacy and Quality of Processes used for EFRC Management Oversight	
(b) BES management of EFRCs	
General Management approach: consider, for example:	
Communication to and among EFRCs: Mix of monthly phone calls, in person meetings Use of management reference documents? Web resources: Community website? Annual technical summaries? PI Meetings: Summit and Forum	
Annual Reports: Instructions? Quality of report?	
Peer reviews:	
Management review: Consider, for example: Reviewers qualified? BES feedback-EFRC response?	
Midterm science review: Consider, for example: Reviewers qualified? BES guidance-EFRC response?	
II. Impact and Standing of the EFRCs	
(b) National and international standing of EFRCs	
Are the EFRC PIs leaders in their fields? Are the EFRCs having impact?	

Checklist for COV Review -- JCAP Selection Process	
	Comments
I. Efficacy and Quality of Processes used for Hub Selection	
(a) Solicit, review, recommend and document proposal actions	
FOA: Adequate information for potential proposers?	
Review Process: Consider, for example:	
Approach for the first (virtual panel) and the second (reverse-site panel) merit review panels?	
Sufficient number of reviews? Qualified reviewers? Quality of reviews (consistent with criteria)?	
Documentation: Consider, for example:	
Completeness of selection statement? Revised budgets? Content of declination notifications?	
II. Impact and Standing of JCAP	
(a) Award breadth and quality: Consider, for example:	
Quality of the JCAP proposal? Balance of innovation, risk, and interdisciplinary research?	
Complement the BES research portfolio? Relevant to the DOE's mission?	
Size and duration of award?	

Checklist for COV Review -- JCAP Management	
	Comments
I. Efficacy and Quality of Processes used for JCAP Management Oversight	
(b) Management Processes	
Communication to and from JCAP:	
Mix of monthly phone calls and in person meetings?	
Annual and Quarterly Reports:	
Quality of reports?	
Peer reviews:	
Information provided to reviewers prior to reviews adequate?	
2011 Reverse-Site Management Review	
Qualified reviewers? BES guidance letter and JCAP response?	
2012 On-Site Science and Management Review	
Qualified reviewers? BES guidance letter and JCAP response?	
II. Impact and Standing of JCAP	
(b) National and International Standing. Consider, for example:	
JCAP PIs national/international leaders in their fields? Potential and/or actual impact of JCAP evident?	

Appendix VI: First Read/Second Read COV Report Template

EFRC PANEL REPORT TEMPLATE

BES COMMITTEE OF VISITORS (COV)

Reviewing the EFRCs and JCAP Hub

Based on the Charge to the COV:

- 1) For the EFRCs, assess the efficacy and quality of the processes used to:
 - (a) solicit, review, recommend, and document proposal actions and
 - (b) monitor technical and administrative progress.

- (2) Within the boundaries defined by DOE missions and available funding, comment on the impact and standing of the EFRC awards:
 - (a) the breadth and depth of EFRCs, and
 - (b) the national and international standing of EFRCs.

I. Efficacy and Quality of Processes used for EFRC Selection and BES Management Oversight

Based on the COV's study of the review and selection process that led to the EFRC awards and BES management of EFRCs, please provide brief findings, recommendations, and comments on the following:

(a) Solicit, review, recommend, and document proposal actions

Consider, for example:

- consistency with priorities and criteria stated in the program's solicitation, announcement, and guideline
- adequate number of reviewers for balanced review; use of reviewers having appropriate expertise/qualifications; use of a sufficiently broad pool of reviewers; avoidance of conflicts of interest
- efficiency/time to decision
- completeness of documentation making recommendations

Findings:

Comments:

Recommendations:

(b) BES Management processes for EFRCs

Consider, for example

- “color group” approach and management guidance documents
- written progress reports
- the management peer review in the first year of operation
- Summit and Forum principal investigator meeting
- mid-term science peer-reviews
- effective interactions between program managers and PIs

Findings:

Comments:

Recommendations:

II. Impact and Standing of the EFRCs

Taking into account the DOE, BES, and Division missions, the available funding, and information presented about EFRCs, comment on how the EFRC **award and oversight processes** have affected:

(a) The breadth and depth of EFRC Awards

Consider, for example:

- the overall quality of the science
- the balance with respect to innovation, risk, and interdisciplinary research
- the technical diversity of the awards
- the relationship of EFRCs to other parts of the BES (optional)
- the relevance of EFRCs with respect to the missions of BES and DOE
- the appropriateness of award scope, size, and duration

Findings:

Comments:

Recommendations:

(b) The national and international standing of EFRCs

Consider, for example:

- the evolution of individual EFRCs with respect to science directions
- the uniqueness, significance, and scientific progress and impact
- the stature of the principal investigators in their fields
- the leadership position in the nation and the world

Findings:

Comments:

Recommendations:

JCAP COV PANEL REPORT TEMPLATE

BES COMMITTEE OF VISITORS (COV)

Reviewing the EFRCs and JCAP Hub

Based on the Charge to the COV:

- 1) For JCAP, assess the efficacy and quality of the processes used to:
 - (a) solicit, review, recommend, and document proposal actions and
 - (b) monitor technical and administrative progress.

- (2) Within the boundaries defined by DOE missions and available funding, comment on the impact and standing of the JCAP award:
 - (a) the breadth and depth of JCAP, and
 - (b) the national and international standing of JCAP.

I. Efficacy and Quality of Processes used for JCAP Selection and BES Management Oversight

Based on the COV's study of the review and selection process that led to the JCAP award and BES management of JCAP, please provide brief findings, recommendations, and comments on the following:

(a) Solicit, review, recommend, and document proposal actions

Consider, for example:

- consistency with priorities and criteria stated in the program's solicitation, announcement, and guideline
- adequate number of reviewers for balanced review; use of reviewers having appropriate expertise/qualifications; use of a sufficiently broad pool of reviewers; avoidance of conflicts of interest
- efficiency/time to decision
- completeness of documentation making recommendations
- cooperative agreement

Findings:

Comments:

Recommendations:

(b) BES Management processes for JCAP

Consider, for example

- oversight plan
- written progress reports
- monthly teleconferences
- annual external peer reviews
- effective interactions between program managers and PIs

Findings:

Comments:

Recommendations:

II. Impact and Standing of the JCAP Award

Taking into account the DOE, BES, and Division missions, the available funding, and information presented about JCAP, comment on how the JCAP **award and oversight processes** have affected:

(a) The breadth and depth of JCAP

Consider, for example:

- the overall quality of the science
- the balance with respect to innovation, risk, and interdisciplinary research
- the evolution of the JCAP with respect to science directions
- the relationship of JCAP to other parts of the BES (optional)
- the relevance of JCAP with respect to the missions of BES and DOE
- the appropriateness of award scope, size, and duration

Findings:

Comments:

Recommendations:

(b) The national and international standing of JCAP

Consider, for example:

- the uniqueness, significance, and scientific progress and impact
- the stature of the principal investigators in their fields
- the leadership position in the nation and the world

Findings:

Comments:

Recommendations:

Appendix VII: Summary Reports from the Two Panels

EFRC COV PANEL REPORT
BES COMMITTEE OF VISITORS (COV)
Reviewing the EFRCs and JCAP Hub

I. Efficacy and Quality of Processes used for EFRC Selection and BES Management Oversight

BES Processes to solicit, review, recommend, and document proposal actions

Review Process: Findings

The outcome of the EFRC procurement process resulted in the funding of research with high potential for scientific impact in areas relevant to the DOE BES mission and led by internationally recognized and highly accomplished scientists. The quality of the selected proposals is borne out by the production of impactful science described in the recent (January 2013) Congressional report on the EFRCs and in science highlights and stories available on the EFRC website.

The COV panelists recognize that the review of the ERFC proposals was a formidable task that was generally well managed by the BES staff. The challenges were the consequence of the need to review and act on a large number of proposals on a short time scale. The major challenge in the initial procurement was identification of reviewers who did not have a conflict of interest because of the large number of proposals and participants. This challenge was particularly acute in specific topical areas.

Given the constraints of time and potential for conflict of interest, the BES staff did a good job of recruiting from international scientists, industry and some non-DOE government labs. The pool from which reviewers were selected, however, was heavily international (e.g., 1/10 US reviewers on one subpanel)—due to the conflict of interest issues cited above. These international reviewers were largely limited to Europe and North America; the available pool of excellent researchers in Asia was underutilized (only two Asian reviewers were identified in total). Within the U.S., there was a heavy reliance on senior researchers who were already funded by DOE. There was a striking lack of diversity (gender and ethnic) in the reviewer pool, exemplified by at least two panels with only 1/17 women.

Despite the challenges articulated above and some variability, the reviews were of high quality overall. Many provided deep and critical comments, but there were a significant number of reviews that lacked the depth of insight that would be desirable. For example, some reviewers essentially restated the proposal; other reviewers merely focused on the reputation of the Director and other PIs. The number of reviews also varied significantly across and within the subpanels. In some cases, there were as few as three reviews submitted. The reviews also mainly focused on the quality of the science, and several reviews did not address the management of the project or potential for synergy in the EFRC, although these were called out as important criteria in the FOA (p. 25). Overall, it appears that BES Staff used good judgment in making decisions in cases for which the reviews varied or did not focus on management.

Review Process: Comments

Mechanisms that could help decrease the number of proposals that must be reviewed in any one funding year could be considered. Examples of such mechanisms are to further limit the number of proposals from any given institution, to stagger the funding cycles of the existing centers, and/or to implement a two-stage review process. A secondary benefit would be more reviewers available in a given year without a conflict of interest.

If the reality of budget allocation and funding cycles would allow it, the process could benefit from increasing the time allotted for the proposal reviewing process in order to allow for an increase in the breadth and depth of reviews.

It would be desirable to broaden the pool of reviewers. Strategies to diversify the reviewer pool could include the use of more early-career researchers, a broader set of international reviewers (outside of Europe and especially from Asia), and trusted scientists with expertise outside of the topical area (1-2 per panel).

Documentation: Findings

Overall, the EFRC proposals selected for funding were of high scientific quality, reflecting the good judgment of BES staff and the generally high quality of the review process. The award documents for the proposals selected for funding are clear and compelling, including comments on all of the scientific, managerial, and budgetary aspects of the proposal. There was a well-defined outline of the team responsibilities and statements of how anticipated synergy was to be achieved.

The evaluation methodology and criteria were clearly articulated by BES. Review panels organized by topical areas were used to identify “fundable” proposals. Other criteria were applied by BES to make final selections as articulated in the FOA (p. 37):

- Diversity of research activities that will address the scientific grand challenges and use-inspired basic research as articulated in the BESAC and BES workshop reports;
- Relation of the proposed EFRCs to the core research activities within the BES Materials Sciences and Engineering and Chemical Sciences, Geosciences and Biosciences Divisions;
- Potential for developing synergies between the proposed EFRC and other EFRCs or other ongoing BES research activities; and
- Total amount of DOE funds available.

Although award documents provided a clear rationale for why a given project was funded, the documentation for the proposals declined was limited to the reviewers’ comments and the total average score. There were a larger number of proposals worthy of funding, based on the reviews, than those actually funded, yet there was no record available for discussions that evaluated the merits of these proposals. Even though some declined proposals had scores that were better than or equivalent to those of the awarded proposals, there was no written documentation available to the COV panelists, rendering it difficult to evaluate this critical aspect of the procurement process. Some documentation of proposals that were considered “fundable” but were declined is desirable.

There was also a significant percentage of proposals that were clearly not worthy of funding based on the reviews or based on lack of compliance with the criteria described in the FOA. No additional documentation is deemed necessary for these clear-cut cases.

Documentation: Recommendation

Although EFRC award documents provided a clear rationale for why a given project was funded, the documentation for the proposals declined was limited to the reviewers' comments and the total average scores. We recommend that BES document the reasons for declining proposals that were reviewed positively enough to be fundable.

BES Management processes for EFRCs

Communication between BES and EFRCs: Findings

To manage the EFRCs effectively, the BES program managers need to understand clearly the activities and progress toward objectives within each EFRC. Furthermore, each EFRC director needs timely and effective feedback from the DOE sponsor regarding progress in his or her EFRC versus DOE's expectations. To achieve these goals, a wide array of communication tools has been developed and is being used very effectively for communication between BES and the EFRCs.

The effective tools include monthly conference calls with teams of EFRCs, visits by program management to the EFRC personnel, large annual meetings of all EFRC directors with DOE and a national summit, regular e-mail communication, including use of reference documents for best management practices, and the EFRC website and newsletters. Through these communication tools, DOE is able to deliver expectations for the quality of the work, expectations of synergy in the researchers' efforts, reviews of the work and the associated assessment of DOE, expectations for management efficacy, and science updates across the EFRCs.

Although the communication between BES and the EFRCs is robust and effective, the COV believes that management of the EFRCs would be aided by more in-person visits by BES program managers to the scientists managing and working in the EFRCs. The COV understands the budgetary constraints relevant to travel by DOE personnel, but believes that face-to-face visits with the scientists, both at their sites and at conferences, would give the BES program managers valuable insights to help them most efficiently manage the EFRCs, as well as to aid in developing career paths for young scientists.

Communication between BES and EFRCs: Recommendation

It is the recommendation of the COV that travel budgets be increased to allow for more frequent face-to-face visits by program managers to EFRC personnel. Such visits would complement the long-distance communications and enable the program managers to manage the EFRCs even more efficiently. Personnel visited should include EFRC management, PIs, post-docs, and

graduate students; visits could be a combination of site visits and attendance of scientific conferences.

Communication among EFRCs and between EFRCs and the public: Findings

Overall, the EFRC's have told an inspiring story to the general scientific community concerning the value of fundamental research that supports energy sustainability. The principal mechanism of that communication is through scientific publications, for which the record of the centers is very positive. The centers have tallied approximately 3400 publications from 46 EFRCs in 3.5 years, 110 of these in *Science* and *Nature*. Although the absolute success of teaming cannot be judged from co-authorship analyses, the trends in connections among members of many centers indicates growing collaboration between multiple PI's in centers, as intended.

DOE BES has established significant mechanisms to gather and distribute information on the activity and accomplishments of the EFRCs. The public website is engaging and other communication mechanisms have been used, including center-specific brochures and online stories; all EFRCs have websites. BES has collected information on outreach events, including public talks, local workshops or symposia, summer schools, and sessions at professional society meetings.

The 2011 EFRC Summit and Forum was a very positive mechanism for highlighting the EFRC concept and the resulting science, as well as for networking with others in the energy community, including the Applied Energy offices in DOE and other sponsors, for follow-on projects. We encourage this engagement, also seen in the 2010 Director's meeting. It is noted that fewer events were recorded in 2012 than in previous years. There is also uneven participation among the 46 centers.

BES has created a number of mechanisms to promote communication and scientific interchange among the EFRCs. These include web-based communication tools, phone calls, and meetings. The most notable mechanism is the grouping of centers into the color-coded groups, and the attendant regular communication through teleconferences. The teleconferences initially focused on best practices in setting up and managing centers. These color groupings now are collections of centers with common technical interests. Program managers indicate that they are an important mechanism for communication. However, we find that the BES-sponsored web-based password protected color group discussion groups are only lightly used.

In 2011, BES initiated an electronic newsletter. Although participation is not required, it provides an additional, valuable venue for interaction and information sharing. It is particularly noteworthy that a number of communication mechanisms are identified explicitly as efforts to engage and develop "junior" members of the EFRCs.

Communication among EFRCs and between EFRCs and the public: Comment

Communication among EFRCs could be encouraged by BES, especially between color-coded groups. This might occur through Directors' meetings or in venues such as the Summit.

However, no Directors or PI meeting has occurred in the period Q2 FY11-Q2 FY13. We suggest that some interaction occur annually.

Annual Reports: Findings

Each year, the Directors received clear instructions concerning the expected content and format of annual reports, which they followed well. The quality of technical content in the reports for years 2010 and 2011 is excellent. The reports include standard required elements, such as statements of current and pending support, information about the relationship and any overlap with EFRC projects, cost status and any change in work plan, schedule or personnel. In 2012, Directors were asked to omit technical content because the annual report followed closely on the Science Review. This was a wise decision, saving unnecessary work on the part of EFRCs.

Concerning specific details of note: The tracking of “alumni” (postdocs and graduate students who have moved on) in the spread sheet accompanying the report is very useful. The written report contains information on patents and disclosures, but there is no summary of this in the spreadsheet. Similarly, summary numbers on publications and invited talks are not in the spreadsheet.

Annual Reports: Comment

Given that the data are already collected, it would be beneficial to the community to make summary information on numbers of publications, patents, etc. easily accessible through the Annual Report or other mechanisms.

Peer Management Reviews: Findings

The management reviews were carried out relatively early in the EFRC five-year cycle and thus were more directed at the initial start-up phase of the centers. This timing was, in part, a consequence of the fact that the EFRC program was new, with little experience to build on, and the early review and feedback was to ensure the centers got off to a robust start. The choice of management reviewers was in general very good and, in some cases, the reviews were excellent. Clearly DOE was able to draw on very high-quality scientists for this process. Note, however, that getting reviewers for the large number of centers at the same time, as was required for this first round of funding, was extremely difficult, and thus in many cases it was necessary to reach abroad for reviewers.

The management review process appeared to the committee to be very well organized and operated. In particular, the problems of each reviewed EFRC that were identified by the review committee were then stated to the Director of that EFRC. The response to each of these findings was generally well documented, and in most cases detailed written responses were made and included in the folder. In a few cases, however, it was apparent that the PI made only a perfunctory response. The committee believes that for such a major review, it should be obligatory to send a full formal response letter to DOE and not reply through a brief email exchange.

Peer Management Reviews: Comment

The early and friendly management reviews by BES were effective and should be continued. From the point of view of judging management effectiveness, we suggest that some measure or indication of scientific output should be included in one slide for the review. This slide could include significant findings, number of papers, major talks, etc. BES should consider combining the management and science reviews for centers that are renewed.

Peer Science Reviews: Findings

The scientific reviews were very well implemented and effective in communicating strengths and weaknesses to centers. Recommendations and action items were clearly conveyed in the feedback letter.

Because of travel restrictions, the reviews were held at various locations across the country, with the center personnel and reviewers meeting at hotels. Although there is some advantage for the reviewers to meet at the home institution of the center, the choice of a more central neutral location did not detract from the reviewing process. Because most centers involve multiple institutions, it was logistically easier for everyone to meet at a neutral place, and the reviewers did not need to travel to multiple sites.

The reviews were conducted in a well-organized manner. The directors of the centers were given detailed instructions for preparation of the review document and the review itself. There was a helpful FAQ document that addressed relevant issues. Each review followed a set schedule for the day, and each center was allowed to bring 12-18 people. There was ample time for technical presentations, a poster session with 5-8 posters, and small group discussions in which the groups were usually divided into management, PIs, and postdocs/graduate students. This process worked very well, and all aspects of each center were examined.

The reviewers were of mixed quality in terms of scientific stature, but we realize that the pool of potential reviewers was limited. This problem was less severe than for the procurement stage because the number of centers is much smaller than the number of proposals. The reviews themselves were detailed and thorough.

Shortly after the review, BES sent a Feedback letter to the director of the center, providing both BES comments and reviewer comments. The letter listed “Recommendations” and “Action Items” for the center and requested a response within 30 days. The BES comments were helpful and direct. They did not provide an overall rating, but they clearly delineated the positive and negative aspects of the centers and clearly stated what steps needed to be taken in a list of “Action Items.” Most centers responded in detail to both the BES and reviewer comments. Subsequently, BES sent the director a close-out letter thanking the director for the response and providing brief feedback to the response.

Concrete funding decisions were made by BES in consequence of the Management and Science Reviews. For six centers for which important unresolved concerns were identified, funding was reduced. In these cases, the close-out letter reiterated the areas that were of concern and pointed out that these issues would be emphasized in BES’s continuing oversight. This clear statement of

the problems gives the centers ample warning to fix the concerns prior to the renewal proposal. In addition, several of these issues had been pointed out in the previous Management Review, and the initial Feedback letter expressed disappointment in several cases that concerns detailed in the 2010 Management Review were echoed in the Science Review. Thus, these centers were given two opportunities to respond to the problems.

A few centers were given an increase in funding as a result of an exceptional scientific review. In one case, the funds were directed toward a particular project within the center to accelerate that area of research. This type of reward system seems appropriate.

II. Impact and Standing of the EFRCs

Impact of the EFRC awards: Findings

The accomplishments of EFRC PIs place them among the leaders in energy research. These researchers span a wide range of scientific disciplines and types of research organizations. They are on the whole highly productive and disseminate their research results widely. They are impacting the private sector, especially in the establishment and support of energy-related startup companies.

EFRCs are providing education and training for approximately 2000 graduate students and postdoctoral fellows. This is another major contribution of the centers.

Among the primary products of the EFRCs are publications in the professional literature. These publications, which disseminate the results vary widely, play a central role in the development of the field. The EFRC researchers have been very productive, with a total of approximately 3,400 publications to date. More remarkable is the range of fields in which the researchers publish their results, a reflection of the diversity of approaches required to address the complexity of advanced energy systems. The publications have appeared in approximately 60 journals; the following examples reflect the diversity of the fields impacted: *Physical Review B* and *Physical Review Letters*, *Nature Chemistry*, *Science*, *Biofuels*, *ACS Nano*, *Angewandte Chemie*, *Proceedings of the National Academy of Sciences*, *Journal of the Optical Society of America*, *Electrochimica Acta*, *Biochemistry*, *The International Journal of Mass Spectrometry*, *Energy and Environmental Science*, *Plant Signaling Behavior*, *The Journal of Aerosol Science*, *The American Mineralogist*, *The International Journal of Hydrogen Energy*, *The Journal of Nuclear Materials*, and *Green Chemistry*.

Another important area of impact is in the private sector, through the involvement of many of the EFRCs with well-established and startup companies in the energy sector. Companies involved with the EFRCs include, for example, American Superconductor, Lifecel Technology LLC, Universal Display Corporation, Global Photonic Energy Corporation, Topsoe Fuel Cell, ZT Plus Inc, Philips Lumileds Lighting, General Motors, and the Sharp Corporation.

Other products of EFRCs are invention disclosures, patent applications and licenses executed. EFRCs have announced the disclosure of 71 inventions, 211 patent applications and 8 license agreements.

National and International Standing of EFRC: Findings

One of the indications of the quality of the EFRCs is that among the PIs there are many (approximately 65) who have been the recipients of national and international awards. The awards have been given by a remarkably diverse group of organizations, among which five are international; examples of the awarding organizations are the ACS, the NSF, ORNL, the MRS, IEEE, UNESCO, R&D 100, The University of Rome, and the Humboldt Foundation. One PI is a recipient of the Franklin Medal. In addition, many (more than 250) are Fellows in their respective professional organizations, ranging from the ACS, APS and MRS, and some are members of the National Academy of Sciences and the National Academy of Engineering; one PI is president of the MRS. Among the younger members of the EFRCs, a significant number (12) are recipients of DOE Early Career Awards. Thus, although as in any large research program there are both stronger and weaker team members, the EFRC program clearly funds the research of leaders in the field of basic energy research.

National and International Standing of EFRC: Comments

The EFRC procurement process overall resulted in the funding of research having high scientific impact in areas relevant to the DOE BES mission. These multidisciplinary research centers focus on key scientific and technological grand challenges of central interest to BES. The number of proposals characterized by outstanding novelty, scientific depth, and involvement of principal investigators with high stature exceeded the number of possible awards. The quality of the selected proposals is borne out by the production of impactful science described in the recent (January 2013) Congressional report on the EFRCs and in science highlights and stories available on the EFRC website.

The Directors of the selected proposals are, as a group, highly recognized and accomplished scientists; however, there is a strikingly low level of ethnic and gender diversity. It is the perception of the COV based on an examination of a subset of the EFRCs that this lack of diversity extends to the PIs of the EFRCs as well. BES is aware of this, and we encourage the staff to continue to make efforts to increase the diversity of EFRC PIs and directors.

Fuels from Sunlight Energy Innovation Hub COV PANEL REPORT

BES COMMITTEE OF VISITORS (COV)
Reviewing the EFRCs and JCAP Hub

I. Efficacy and Quality of Processes Used for Hub Selection and BES Management Oversight

BES Processes to solicit, review, recommend, and document proposal actions

Solicitation, Review and Recommendation Processes: Findings

The solicitation process for the Fuels from Sunlight Energy Innovation Hub resulted in a significant pool of strong proposals. The information provided to potential proposers was adequate.

Overall, the Fuels from Sunlight Energy Innovation Hub review process placed an appropriate priority on the scientific and technical quality of the proposals. The panels selected for both the initial and final reviews were judged to be excellent. The merit review process was thorough and appropriately critical, and the award to the Joint Center for Artificial Photosynthesis (JCAP) was consistent with its ranking by reviewers as being the clear leader in both the first (virtual) and the second (reverse site visit) review panels.

The JCAP proposal presented a compelling, insightful assessment of the scientific and technical challenges faced by those proposing to create a practical solar-fuels device, including a coherent and focused approach to addressing these challenges. Although the JCAP proposal necessarily focused on a specific device concept, it presented innovative, interdisciplinary approaches to advance the underlying science and drive it toward technological solutions. The proposal reviewers praised the strength of the technical approach and the quality of the scientists assembled to lead and conduct the efforts.

The BES staff carefully documented the procedures and actions taken throughout the process of soliciting and selecting the Fuels from Sunlight Energy Innovation Hub. BES detailed its policies and procedures for these activities in the Funding Opportunity Announcement (FOA), Merit Review Evaluation Plan (MREP), MREP Implementation Plan and DOE Oversight Plan for JCAP. These documents are dense with technical detail, yet clear and thorough. The COV recognizes the substantial benefits regarding analysis and management of future Hub submissions that will accrue from the recently implemented information management system (PAMS) to help organize proposal and award documents. The relative strengths and weaknesses of the proposals identified by the reviewers were effectively distilled and used to inform the proposal selection as described in the Summary Memos generated at the end of the first (virtual) and second (reverse site visit) review panels.

Procurement Process: Comment

To be successful, a research program of the magnitude of a Hub requires visionary science leadership as well as strong project or operational leadership to oversee the all aspects of the project. In addition to senior project level scientific and operational leadership positions, managers who oversee individual projects are required to help integrate scientific and operational aspects of the Hub. Clear articulation of these requirements are needed in the solicitation, along with strong guidance indicating that all operational and scientific managers and key research staff are expected to commit substantial percentages of their efforts to the project. This guidance, along with priority placed on evaluation of management plans during the merit review process, will help to ensure the success of a Hub.

BES Management processes for JCAP

Communication between BES and JCAP: Findings

There has been extensive communication between BES and JCAP. More than 36 visits of DOE personnel, including program managers, safety, audit and security representatives and high level DOE officials to JCAP have been recorded since January of 2011. Some of these include multi-day visits of several program managers for annual reviews held to assess management and/or technical progress.

Although monthly phone calls have been held to report progress, their minutes do not record actions or follow-up of action items from prior calls. Furthermore, no record of DOE visits to JCAP (trip reports) has been provided, other than dates. As a result, action items and trip agendas have not been documented.

Communication between BES and JCAP: Comment

The COV believes that more formal records of phone calls and meetings between JCAP and DOE should be maintained with documented action items and records of follow-up to enhance communications and track progress.

Annual and Quarterly Reports: Findings

Internal milestones are maintained and reported by JCAP and include (a) Project Development milestones which focus on the establishment and launch of labs, instrumentation procurement and hiring and (b) Annual Research Milestones which aim to track progress towards the goal of the project. The former, which are operational milestones, are reported in each progress report at a sufficient level of detail. The latter milestones are “loosely termed milestones that are not associated with specific dates”. These are maintained by JCAP and are monitored internally during project meetings, budget meetings, and other meetings; however, the Annual Research Milestones are not consistently reported in the quarterly or annual reports, nor is there any apparent documentation of these milestones. Furthermore, the technical progress reports provide a significant level of detail with regard to what was done and what was observed with little or no evaluation of the impact (positive or negative) on the goals of JCAP.

Self-assessment, evaluation of impact, and progress toward the stated goals are missing from the quarterly and annual reports. This type of information is needed in the reports, and less technical detail regarding what was done would be appropriate. Also missing is any discussion of integration of the projects and assessment of progress towards the overall goals of the Hub, especially the development of a device for solar fuel production.

Annual and Quarterly Reports: Comments

Research goals/milestones are critically needed to monitor progress of the research program. Although some projects lend themselves to fixed dates for deliverables, fundamental research is more difficult to manage with respect to a date. Nevertheless, annual assessment of progress in all projects is needed to monitor progress towards the goal of the Hub and facilitate integration of the research.

Periodic reports should provide a *synthesis, critical assessment and evaluation* of technical progress in terms of overall goals of the project as defined by the annual research plan of the Hub. Such information would allow staff, managers, governance boards, and BES to assess progress and plan any necessary redirection of the projects.

Annual and Quarterly Reports: Recommendation

The COV recommends that research goals/milestones be defined annually for a project of this magnitude and that progress should be tracked against these goals/milestones on a quarterly basis. The quarterly and annual reports should include critical self-assessment, evaluation of impact of the ongoing research, and assessments of progress toward the stated goals. Management actions in response to the assessments of progress should also be included in these progress reports.

2011 Reverse-Site Management Peer review and 2012 On-Site Science and Management Review: Findings

The information provided to the reviewers during the 2011 and 2012 reviews was adequate. The reviewers were all highly regarded, well-known, and well-established experts from industry, academia, and national labs with some level of experience with large research operations. There were several members of the panel who participated in both the 2011 and 2012 reviews: these panel members provided an extremely important element of continuity to the process.

The depth and detail of the written reviews provided by the panel after the 2011 review were particularly impressive. The reviewers were able to identify areas in which JCAP was clearly on-track to succeed and also provided candid comments and suggestions concerning aspects of JCAP that warranted additional attention at that early stage of development of the Hub. The summary memo provided by BES after the 2011 review appropriately reflected the reviewers' comments. The COV believes that the guidance letter could have emphasized the need to more fully integrate activities across the two sites, but in general the guidance letter was thorough and clear with respect to action items requiring attention by the JCAP team. The COV viewed the JCAP response to the BES Guidance Letter as not sufficiently comprehensive and observed that many action items were not completed.

After the 2012 review, the reviewers again provided specific and constructive comments. The summary memo and guidance letter produced by BES accurately reflected the concerns raised by all of the reviewers. Specific comments included suggestions that the JCAP team consider several important changes that the review panel and BES deemed critical to the success of the Hub. Both the summary memo and guidance letter clearly articulated these recommendations. The initial response from JCAP in November 2012 to the review was deemed inadequate by BES, and JCAP was asked to resubmit.

2011 Reverse-Site Management Peer review and 2012 On-Site Science and Management Review: Comments

BES should consider providing the reviewers with appropriate additional information so that the annual reviews can lead to optimally constructive evaluations of the Hub. The additional information might include general guidance on the objectives of these interim reviews and how they differ from normal peer reviews conducted for funding decisions. Because of the unique nature of these interim reviews, it would also be useful for the reviewers to have synopses of the prior interim reviews and the responses from the Hub to assess how effective the response was.

The JCAP team did not fully respond to the recommendations articulated in either the 2011 or the 2012 review. As noted above, the initial response from JCAP in November 2012 to the review was deemed inadequate by BES, and JCAP was asked to resubmit. The COV viewed this action by BES to be a positive reflection of the degree to which BES was engaged in efforts to help the Hub succeed. Follow-up by the Hub's governance board, as well as DOE, is needed to ensure that the Hub management fully responds to the reviewers' comments and implements real changes in a timely manner.

BES should consider mechanisms through which they can more substantively influence the Hub to implement Action Items that result from the interim reviews that they deem most critical for the success of the operation.

2011 Reverse-Site Management Peer Review and 2012 On-Site Science and Management Review: Recommendation

The COV recommends closer follow-up by BES to ensure that recommendations from interim reviews are appropriately addressed and implemented, working closely with the Hub governance board as appropriate. In addition, the Hub team should be asked to assess if actions taken in response to review recommendations were effective.

II. Impact and Standing of JCAP

Impact of the JCAP Award: Findings

The JCAP Hub is still in the early stages of development; thus, substantial resources and effort have been devoted to construction of facilities and initiating key projects. Accordingly, the number of publications in the first two years is small (4 in 2011 and 10 in 2012 [as documented on the JCAP website]). The expectation is that the publications rate will accelerate to reflect the multimillion-dollar investment in JCAP. Because of the limited output thus far, it is still too early

to assess the actual impact; however, significant progress has been made in some areas:

- The working prototype and associated measurement capability (Certified Engineering Model test-bed water splitting reactor system made of existing materials and mostly commercially available components) has the potential for far-reaching impact.
- The validated multiphysics model enables rapid evaluation of new designs for photoelectrochemical water-splitting systems. It has made an impact already in that it was used to optimize the first prototype.
- High-throughput synthetic and characterization capabilities being developed by JCAP have the potential for broad impact across materials design and development as well as producing candidates for artificial photosynthesis catalysts.
- The Artificial Photosynthesis Futures meeting was a worthwhile activity that included ~40 representatives from EFRCs and can lead to increased interactions. Eight EFRCs have begun collaborations with JCAP, an indication of synergy between these two types of BES centers.

The COV judged that the JCAP project fits well within the BES portfolio and is complementary to other funded programs. BES is the primary source of basic research funding in solar energy conversion and catalysis, has program management expertise in this area of science, and has deep knowledge of the key US research investigators in these fields.

JCAP proposed to integrate processes and materials into working sub-systems and device prototypes. JCAP's plans to interact with the existing solar fuels community through benchmarking of catalysts and light absorbers are highlighted as a valuable and unique contribution to the field. Such activities extend and test basic research principles by highlighting key performance and integration issues and promise to accelerate progress in the field.

The JCAP award size and duration (five years) are judged to be sufficient to substantially accelerate the field of solar fuels research to achieve significant impact that can be evaluated to assess the merit for renewal funding. However, the COV wants to emphasize the magnitude of the challenge of managing such a large research enterprise to ensure that it is sharply focused on the goals defined for the 5-year term of the project. The COV also stresses the need to constantly reassess the progress toward those goals. The overall goal of a prototype system/device within a single five-year initial funding term is daunting, as was recognized by DOE and the proposers from the outset; however, the COV also stresses the need for management plans to maintain the focus needed for the success of the Hub.

Impact of the JCAP award: Recommendation

For the promise of the Hub to realize its full potential with significant impact, the COV recommends that BES take steps to ensure full integration and synergy of activities within the Hub to achieve the appropriate focus on the singular goal to be achieved for the funded project period (5 years).

National and International Standing of JCAP: Findings

The unique scope and breadth of JCAP make it the premier center for artificial photosynthesis in

the world. Although there are other strong programs, they typically have strength only in one research topic area and work independently. JCAP intends to integrate expertise and resources across multiple areas of basic science necessary to develop a solar fuels prototype. This integrated systems approach has significant potential to address the challenge of using sunlight to produce fuels. Thus, the potential impact of JCAP for meeting the nation's future energy needs is enormous. In addition, knowledge resulting from JCAP's research has the potential for far-reaching impact on the design and synthesis of new materials that can be used in other areas of importance to DOE's mission in energy and security.

One of the indications of the quality of JCAP is that among the PIs there are many who are world leaders in their respective fields. Fifteen of the 38 PIs are fellows of national and/or international societies (including AAAS, AAASc, ACS, and APS) or are members of the National Academy of Sciences or the National Academy of Engineering. One is a Nobel Laureate. These individuals have the necessary experience to contribute to the overall goals of the Hub.