Program Announcement
To DOE National Laboratories
LAB 06-15

Basic Research
for Solar Energy Utilization

A change was made to this Notice on April 19, 2006. The guidance for the preparation of laboratory proposals has been revised.

SUMMARY: The Office of Basic Energy Sciences (BES) of the Office of Science (SC), U.S. Department of Energy (DOE), in keeping with its mission to assist in strengthening the Nation's scientific research enterprise through the support of fundamental science and the experimental tools to perform basic research, announces its interest in receiving proposals for basic research in the area of solar energy utilization. This Notice solicits innovative basic research proposals to establish the scientific basis that underpins the efficient *capture, conversion, and utilization* of solar energy in a cost-effective manner. We seek to support outstanding fundamental research programs that will lead to key discoveries and conceptual breakthroughs to make sunlight as the practicable solution to meet our compelling need for clean, abundant sources of energy.

DATES: Potential researchers are **REQUIRED** to submit a brief preproposal through appropriate Laboratory channels. Preproposals referencing Program Announcement LAB 06-15 must be received by DOE by 4:30 p.m., Eastern Time, June 5, 2006. Preproposals will be reviewed for conformance with the guidelines presented in this Notice and suitability in the technical areas specified in this Notice. A response to the preproposals encouraging or discouraging formal proposals will be communicated to the researchers by August 11, 2006. **Complete guidance on the content and format of the preapplication is provided in the SUPPLEMENTARY INFORMATION section below.**

Only those preproposals that receive notification from DOE encouraging a formal proposal may submit full proposals. No other formal proposals will be considered. Formal proposals in response to this Notice must be received by November 14, 2006.

ADDRESSES: Preproposals referencing Program Announcement LAB 06-15 should be sent as PDF file attachments via e-mail to: solarenergy@science.doe.gov with "Program Announcement LAB 06-15" as the subject. No FAX or mail submission of preproposals will be accepted.

NOTE: Each FFRDC may submit up to three preproposals as lead institution; the first three preproposals received from an FFRDC as lead institution will be considered to be that institution's official submission. BES reserves the right to encourage, in whole or in part, any, all, or none of the preproposals submitted, and may issue further guidance on the scope of the full proposal submissions of those encouraged.

Formal Proposals

This section pertains only to those proposers that have been encouraged to submit a full proposal. A complete formal FWP in a single Portable Document Format (PDF) file must be submitted through the DOE ePMA system (https://epma.doe.gov) as an attachment. To identify that the FWP is responding to this program announcement, please fill in the following fields in the "ePMA Create Proposal Admin Information" screen as shown:

Proposal Short Name:
Fiscal Year:
Proposal Reason:
Program Announcement Number: Lab 06-15 *
Program announcement Title: Basic Research for Solar Energy Utilization, DOE Research Program Announcement *
Proposal Purpose:
Estimated Proposal Begin Date:
HQ Program Manager Organization:

* Please use the wording shown when filling in these fields to identify that the FWP is responding to this Program Announcement.

In order to expedite the review process, please submit a CD and two copies of the proposal using the following, by U.S. Postal Service Express Mail, any commercial mail delivery service, or when hand-carried to:

U.S. Department of Energy
Office of Science
Office of Basic Energy Sciences, SC-22.1
19901 Germantown Road
Germantown, MD 20874-1290
ATTN: Program Announcement LAB 06-15

FOR FURTHER INFORMATION CONTACT: Eric A. Rohlfing, Office of Basic Energy Sciences, Chemical Sciences, Geosciences and Biosciences Division, SC-22.1, telephone: (301)903-8165, E-mail: eric.rohlfing@science.doe.gov or Aravinda Kini, Office of Basic Energy Sciences, Materials Sciences and Engineering Division, SC-22.2, telephone: (301) 903-3565, E-mail: aravinda.kini@science.doe.gov

SUPPLEMENTARY INFORMATION: In April 2005, BES sponsored a workshop to identify basic research needs for effective solar energy utilization. Over 200 workshop participants, from academia, national laboratories, government and industry in the US and abroad, critically assessed the state-of-the-art and limitations of current technologies for producing a significant fraction of our primary energy source from sunlight. The workshop report, entitled *Basic Research Needs for Solar Energy Utilization* (http://www.sc.doe.gov/bes/reports/files/SEU_rpt.pdf) detailed a broad array of key scientific challenges and research avenues to address these challenges. This Notice solicits innovative basic research proposals to establish the scientific basis that underpins the efficient *capture, conversion, and utilization* of solar energy in a cost-effective manner. We seek to support

outstanding fundamental research programs that will lead to key discoveries and conceptual breakthroughs to make sunlight as the practicable solution to meet our compelling need for clean, abundant sources of energy. As in the workshop report, three broad areas that encompass many of the priority research directions will be the subject of this solicitation. They are:

1. **Solar to Electric Conversion**
2. **Solar Fuels Production**
3. **Solar Thermal Energy Utilization**

The following provides further information under each of these three areas to illustrate the scope of applications solicited under the Notice.

Solar to Electric Conversion

The challenge in converting sunlight to electricity via photovoltaic solar cells is to dramatically reduce the cost/watt of delivered solar electricity by dramatically improving the conversion efficiency. Devices that operate above the existing performance limit will require the discovery of new materials and new pathways for solar to electric conversion. Revolutionary approaches will be needed to minimize thermalization and recombination of photo-generated carriers. These breakthroughs will come from a broad range of research activities in both materials and topologies, which includes research in single- crystal, polycrystalline, amorphous, and nanostructured inorganic and organic materials; an understanding of the electronic structure of these materials; and their implementation in single and multiple junction solar cells. These cells could potentially take advantage of optical frequency shifting, multiple exciton generation, and hot carrier generation. Basic research is essential for identifying new materials and processes to make efficient solar generated electricity a reality. High priority research directions include:

- ***New concepts in solar electric conversion.*** Nano-structured architectures that can efficiently absorb the full spectrum of wavelengths in solar radiation offer the potential to revolutionize the technology used to produce solar electricity. New phenomena, such as multiple exciton generation offer the potential for photovoltaic (PV) cells to go beyond the Shockley-Queisser limit. Structures that are defect tolerant or have the capability to self repair are desired. The use of these materials in multiple junction cells can lead to dramatic advances in PV conversion efficiencies. Advances in nanoscale characterization using electron, neutron, and x-ray scattering and spectroscopy and integration of these probes with studies of photo-induced charge separation and transport will be essential to understand the structure/property relationships in these materials.
- ***Organic and hybrid organic/inorganic conversion systems.*** The current state-of- the-art organic efficiency is considerably less than inorganic based systems. Significant challenges must be overcome to introduce novel cell designs and organic components that create highly efficient and durable solar cells. In order to make advances, the fundamental problems of light absorption and charge separation and transport in organic complexes must be addressed for the organic environment of these solar cells. To increase the operational understanding of these solar cells, new experimental approaches will be needed to correlate the chemical and physical properties of the active components and layers with their performance in operating PV devices. The combination of organic and inorganic materials could also provide new opportunities for the fabrication of high

efficiency PV cells. Many, but not all, of these hybrids are materials systems that, along with organic solar cells, contain complex interfaces e.g. organic metal and organic/semiconductor. The interfaces create additional challenges that require advanced molecular design and an understanding of electronic interactions at an organic/inorganic interface.

- ***Photoelectrochemical solar cells.*** The photoelectrochemical configuration of photo-excited semiconductor with a redox medium is simple in form and fabrication, but the exploitation of photoelectrochemical cells for electrical power production awaits breakthrough advances in photoelectrode lifetimes and the employment of novel, low-cost solids and electrolytes. Breakthroughs in combinations of sensitizers and redox couples are needed to move into higher solar conversion efficiencies. Enhanced absorption in the infra-red spectrum by sensitizing dyes and quantum dots will be necessary. It is also necessary to understand the relation between the efficacy of the regenerating agent and the configuration of the mesoporous semiconductor network. Novel mesoscopic electrode designs, derived from nanostructured and nanoporous solids, are also needed. New surface chemistries and unique designs for assembling these mesoporous solids at low temperatures are sought where the electrode retains a high conductivity. Highly ordered interdigitated passageways for charge transport may be possible as are self-assembled forms of these solid networks.
- ***Novel nanoscale and self-assembled materials.*** New techniques, tools, and design principles are needed to allow optimized, photovoltaic materials and photonic structures to be fabricated over large-area substrates. Studies of nucleation and growth of novel materials can involve kinetically or thermodynamically driven self-assembly of tailored building blocks, or they may rely upon construction of the active layers and devices using carefully controlled vapor or solution-based deposition methods.
- ***Theory, modeling, and simulation.*** Solar energy systems exploit complex and multi-scale phenomena associated with molecules, materials, and their interplay with the system architecture. New theoretical, modeling, and computational tools which span many decades in space, time and structure are required to guide and interpret experiment and assist in the design of molecules, materials and systems. Improved theory and methods for electron transfer and charge separation, excited- states, their properties and their potential energy surfaces need to be developed and validated. Enhanced capabilities for excited states must enable accurately predicted band-gaps, lifetimes and band offsets generally, but especially in materials that are realistic candidates for solar energy systems.

Solar Fuels Production

Because of the day/night variation of the solar resource, the practical use of solar energy faces two overarching technological challenges: economically converting sunlight into useful energy, and storing and dispatching that converted energy to end users in an economical, convenient form. There must be a means to cost-effectively convert this energy into forms useful for transportation, residential and industrial applications. The ability to use sunlight to produce CH_4 or H_2 from abundant, non-toxic resources such as CO_2 and water would revolutionize the economical, environmentally sound production of fuels. There are two key challenges in cost-effective formation of solar fuels. One is to replicate the essential components of the

photosynthetic machinery to store chemical energy outside of a natural organism or plant. The other is to construct entirely man-made chemical components that, as an assembly, absorb sunlight and convert the energy into chemical fuels such as CH4 and H2. Examples of topical areas in which innovative research is needed include:

- ***Natural photosynthetic systems.*** The resolution of fundamental structural design principles in natural photosynthesis provides a means to accelerate the discovery of synthetic architectures that embody mechanistic principles used in biology. Design principles must be established for known and new natural photosynthetic systems in order to maximize the efficiencies of solar energy capture, conversion, and storage and enable the assembly of efficient biomimetic systems. Meeting these challenges will involve the understanding and control of the weak intermolecular forces governing molecular assembly in natural photosynthesis as well as the determination of the rules that underlie the biological mechanisms for repair and photoprotection.
- ***Bioinspired molecular assemblies.*** The challenge in bioinspired systems is to use the principles and architectures found in natural photosynthetic systems to prepare molecular assemblies that integrate light absorption, charge separation, and transport in an effective way. This innovation will involve the construction of tailored environments, composed of polymers, membranes, and gels, for organization of the antenna and donor-acceptor reaction center components (smart matrices). Bioinspired molecular systems with a pathway for fuels production must couple these single photon events to multiple redox equivalents in order to accumulate photon-initiated redox equivalents at particular molecular site. A resolution of the structural and electronic dynamics will be required over the full time scale of energy capture and conversion, which will involve the use of ultrafast spectroscopies and atomic level microscopies as well as new, emerging methods for dynamic molecular structure determination. Advanced tools and techniques that are available (or being conceived) at DOE-BES supported synchrotron and neutron facilities and Nanoscale Science Research Centers may be useful in this regard.
- ***Defect tolerant and self-repairing conversion.*** To ensure that complex biomimetic systems maintain their efficiency over long lifetimes, it is necessary to understand the repair and photoprotection mechanisms in photosynthesis and to be able to translate these mechanisms into a structure and an operating mechanism for biomimetic photosystems. Within an artificial photosynthetic system, the structural features of the protein matrix provide for redundancy as well as enhanced stability of photoreactants. A challenging and general approach to self- repair will require the design of smart molecules that seek out damage sites within a modular artificial photosynthetic system, recognize the damage site, and execute a structural repair. This approach requires building into molecules the self- autonomous features that are common in biology, but have not yet been developed for non-living systems. These investigations may also impact the development of defect-tolerant organic and inorganic PV materials.
- ***Solar hydrogen production.*** Photoelectrochemical water splitting for hydrogen production represents an advanced alternative to combining PV cells with an electrolysis system. Discovery of photoelectrodes that have appropriate light absorption characteristics, are stable in aqueous solutions, and possess catalytic activity for multi-electron reactions is essential to produce hydrogen. Combinatorial or high-throughput methods and advanced computational methods will be useful in this regard. Emphasis

must also be placed on the configuration of discovered electrodes for optimal light absorption by use of visible-absorbing dyes, carrier collection and electrocatalysis by band gap engineering, and optimizing interfaces.

- ***Photocatalytic fuels formation.*** Practical solar fuel formation requires construction of catalytic systems for the formation of energy rich fuels, such as the reduction of CO2 to CH4. The performance of the current generation of catalysts is far from that required for a solar fuels production system of the desired breakthrough efficiency goals, so that development of a new generation of fuel-forming catalysts is necessary. All methods for producing solar fuels must involve coupling of photo-driven single electron steps with fuel forming multi- electron transfer processes. A greater understanding is required, therefore, of the mechanisms of complex coupled reactions, excited-state bond making and breaking processes, and proton-coupled electron transfer reactions. These events can also occur in catalytic reactions at interfaces and surfaces. Experimental efforts must be coupled with theoretical investigations of the rates and mechanisms of multi-electron/multi-atom transfer reactions. Discovery of highly efficient, non-noble metal catalysts is also highly desirable.
- ***Theory, modeling, and simulation.*** Significant theoretical challenges are raised by the complex nature of supramolecular assemblies with their varied host architectures and their relation to light-initiated electronic and nuclear dynamics in the photosystem. New, multi-scale theoretical/computational methods are critically needed to account for the complexities of excited-state energetics applied across multiple spatial length scales relevant to supramolecular structures within complex host architectures and on the range of time scales encompassing solar-energy capture, conversion, and storage. New theoretical methods are essential for establishing predictive methods to accelerate the design of efficient systems for solar fuels production.

Solar Thermal Energy Utilization

High efficiency thermoelectric and thermophotovoltaic converters coupled to solar concentrators have the potential to generate electricity with significant increase in conversion efficiency. Currently, terrestrial thermoelectric and thermophotovoltaic systems are based on combustion heat, with the novel area of solar-based thermoelectric and thermophotovoltaic being little explored. Fundamental research is needed in the following areas:

- ***Thermoelectrics.*** Thermoelectric materials that can independently reduce phonon transport without deteriorating electronic transport offer great promise in significant enhancement in thermoelectric conversion efficiency. Bulk materials that exhibit nanoscale sub-structure and nanocomposites may offer a revolutionary approach to achieving high performance thermoelectricity. A comprehensive understanding of the role of interfaces in low-dimensional systems is needed to provide theoretical guidance on designing new generations of thermoelectric materials with significant ZT enhancement through quantum- confinement effects. Novel theory, modeling and simulation efforts are especially sought to provide the theoretical framework to assist the design of advanced thermoelectric materials that decouple electron transport from phonon transport.

- ***Thermophotovoltaics.*** One of the major challenges of spectral control for thermophotovoltaics (TPV) system is given by the high operating temperatures. Metallic and dielectric materials with low diffusion rates and evaporation rates are needed. New device concepts should be explored, such as microgap TPV. Novel materials and approaches in photonic crystals, plasmonics, phonon-polariton interactions, and coherent thermal emission are sought to exploit the spectral design and control required in TPV systems.
- ***Thermal storage.*** Thermal storage materials require high latent heat density and sufficiently high thermal conductivity for enhanced thermal energy charge and discharge processes. Present thermal storage materials are limited by the lack of reversibility of structural transformations in extended solids. The unique characteristics of solid-solid structural transformations in nanoscale materials offer great promise in overcoming the barriers. Basic research is needed to develop a comprehensive understanding governing the hysteresis and kinetics of the structural transitions in nanoscale materials with the goal of designing thermal storage materials and transitions that will perform under the appropriate conditions for solar thermal applications.

Program Funding

It is anticipated that up to $20 million annually will be available for multiple awards for this notice. Initial awards will be in Fiscal Year 2007, and proposers may request project support for up to three years. All awards are contingent on the availability of funds and programmatic needs.

Preproposal

The preproposal should consist of a description of the research proposed to be undertaken by the proposer and a clear explanation of its relevance and impact on improved utilization of solar energy. The preproposal must be submitted electronically to solarenergy@science.doe.gov as two files:

(1) A cover page in Excel format downloadable from: http://www.science.doe.gov/bes/Solar_preapp_cover.xls. The information to be entered on the cover page includes: Program Announcement Number; Lead Principal Investigator name, address, email address, telephone number, and fax number; project title; name and institution of all co-Principal Investigators and/or senior collaborators (excluding postdocs and graduate students); selection of one primary and multiple secondary submission categories (see below); budget request for each project year; and total budget request for the project. Please do not alter the overall format of the cover- page Excel file, i.e., do not move or merge cells, as this will significantly slow the processing of the preproposal.

(2) A PDF file containing a narrative section not to exceed 3 pages (including text and figures) describing the research objectives, approaches to be taken, the institutional setting, and a description of any research partnership if appropriate; and brief, one-page, vitae for each Principal Investigator.

As noted above, the preproposal must identify primary and secondary submission categories for the purposes of appropriate peer review. Applicants should identify their preproposal by indicating the number and title of the primary and secondary submission categories on the cover page. The submission categories are:

Solar Research Submission Categories:

1. **New concepts in solar electric conversion**
2. **Organic and hybrid organic/inorganic conversion systems**
3. **Photoelectrochemical solar cells**
4. **Natural photosynthetic systems**
5. **Bioinspired molecular assemblies**
6. **Defect tolerant and self-repairing conversion**
7. **Solar hydrogen production**
8. **Photocatalytic fuels formation**
9. **Solar thermal energy utilization**
10. **Novel nanoscale and self-assembled materials**
11. **Theory, modeling, and simulation**

Each preproposal must indicate a *single* primary research category from among this list; the applicant(s) may also check any number of secondary research areas.

The purpose of this self-identification into research categories is solely for the purposes of grouping like proposals for peer review.

Full Proposal

The Department of Energy will accept Full Proposals by invitation only, based upon the evaluation of the preproposals. After receiving notification from DOE concerning successful preproposals, researchers may prepare formal proposals. DOE is under no obligation to pay for any costs associated with the preparation or submission of proposals.

Full proposals adhering to DOE Field Work Proposal format are to be prepared and submitted consistent with policies of the investigator's laboratory and the local DOE Operations Office.

The instructions and format described below should be closely followed. Laboratories may submit proposals directly to the SC Program Office listed above. A copy should also be provided to the appropriate DOE Operations Office. Program Announcement LAB 06-15 must be referenced on all submissions and inquiries about this program

OFFICE OF SCIENCE
GUIDE FOR PREPARATION OF SCIENTIFIC/TECHNICAL PROPOSALS
TO BE SUBMITTED BY NATIONAL LABORATORIES

Proposals from National Laboratories submitted to the Office of Science (SC) as a result of this program announcement will follow the Department of Energy Field Work Proposal process with additional information requested to allow for scientific/technical merit review. The following

guidelines for content and format are intended to facilitate an understanding of the requirements necessary for SC to conduct a merit review of a proposal. Please follow the guidelines carefully, as deviations could be cause for declination of a proposal without merit review.

1. Evaluation Criteria

Proposals will be subjected to formal merit review (peer review) and will be evaluated against the following evaluation criteria listed below in descending order of importance.

Scientific and/or technical merit of the project;

Appropriateness of the proposed method or approach;

Competency of the personnel and adequacy of the proposed resources;

Reasonableness and appropriateness of the proposed budget;

Basic research that is relevant to improved utilization of solar energy.

The external peer reviewers are selected with regard to both their scientific expertise and the absence of conflict-of-interest issues. Non-federal reviewers may be used, and submission of a proposal constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

2. Summary of Proposal Contents

3.1 Field Work Proposal (FWP) Format (Reference DOE Order 5700.7C) (DOE ONLY)
3.2 Proposal Cover Page
3.3 Proposal Abstract
3.4 Table of Contents
3.5 Management Plan

Sections 3.6-3.13 are to be completed for each subtask in the proposal.
Up to 4 tightly integrated subtasks are allowed in each proposal.
Multiple subtasks should be presented as follows:
First Subtask: Sections 3.6.1, 3.7.1,..., 3.12.1, 3.13.1
Second Subtask: Sections 3.6.2, 3.7.2, ..., 3.12.2, 3.13.2
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3.6 Subtask Title and Abstract
3.7 Budget and Budget Explanation
3.8 Narrative
3.9 Literature Cited
3.10 Other Support of Investigators and Collaborations

3.11 Biographical Sketches
3.12 Description of Facilities and Resources
3.13 Appendix (All appended material must be separate from the proposal, e.g., in electronic folders containing multiple PDF files of publications.)

2.1 How to Submit

A complete formal FWP in a single Portable Document Format (PDF) file must be submitted through the DOE ePMA system (https://epma.doe.gov) as an attachment. To identify that the FWP is responding to this program announcement, please fill in the following fields in the "ePMA Create Proposal Admin Information" screen as shown:

Proposal Short Name:
Fiscal Year:
Proposal Reason:
Program Announcement Number: Lab 06-15 *
Program announcement Title: Basic Research for Solar Energy Utilization, DOE Research Program Announcement *
Proposal Purpose:
Estimated Proposal Begin Date:
HQ Program Manager Organization:

* Please use the wording shown when filling in these fields to identify that the FWP is responding to this Program Announcement.

In order to expedite the review process, please submit a CD and two copies of the proposal using the following, by U.S. Postal Service Express Mail, any commercial mail delivery service, or when hand-carried to:

U.S. Department of Energy
Office of Science
Office of Basic Energy Sciences, SC-22.1
19901 Germantown Road
Germantown, MD 20874-1290
ATTN: Program Announcement LAB 06-15

3. Detailed Contents of the Proposal

Proposals must be readily legible, when printed and must conform to the following requirements: the height of the letters must be no smaller than 10 point with at least 2 points of spacing between lines (leading); the type density must average no more than 17 characters per inch; the margins must be at least one-half inch on all sides. Figures, charts, tables, figure legends, etc., may include type smaller than these requirements so long as they are still fully legible.

Number pages consecutively at the bottom of each page throughout the document. Start each major section at the top of a new page with the section number and title, for example, "2 Table of Contents." Do not use unnumbered pages.

3.1 Field Work Proposal Format (Reference DOE Order 5700.7C) (DOE ONLY)

The Field Work Proposal (FWP) is to be prepared and submitted consistent with policies of the investigator's laboratory and the local DOE Operations Office. The format described below should be closely followed. Additional information is also requested to allow for scientific/technical merit review.

Laboratories may submit proposals directly to the SC Program office listed above. A copy should also be provided to the appropriate DOE operations office.

3.2 Proposal Cover Page (No special form is required.)

The proposal cover page must contain the following information.

Title of proposed project
FWP Number(s) corresponding to the proposed project (if available for new proposals)
BES Program announcement title (if applicable)
Name of laboratory
Name of principal investigator (PI) (Lead PI only)
Position title of PI
Mailing address of PI
Telephone of PI
Fax number of PI
Electronic mail address of PI
Name of official signing for laboratory*
Title of official
Fax number of official
Telephone of official
Electronic mail address of official
Requested funding for each year; total request

If other institutions are participating in the project, include a table listing institutions, lead investigator at each institution, and requested funding for each institution at this point on the cover page.

Use of human subjects in proposed project:

If activities involving human subjects are not planned at any time during the proposed project period, state "No"; otherwise state "Yes", provide the IRB Approval date and Assurance of Compliance Number and include all necessary information with the proposal should human subjects be involved.

Use of vertebrate animals in proposed project:

If activities involving vertebrate animals are not planned at any time during this project, state "No"; otherwise state "Yes" and provide the IACUC Approval date and Animal Welfare Assurance number from NIH and include all necessary information with the proposal.

Signature of PI, date of signature
Signature of official, date of signature*

*The signature certifies that personnel and facilities are available as stated in the proposal, if the project is funded.

3.3 Proposal Abstract

Provide an abstract to convey an overall vision and the long-term goals and objectives of the proposed research. Describe what the specific research proposed is intended to accomplish, the approach to be taken, and the integration and synergy of the various subtasks. Discuss the potential scientific impact and significance of the proposed research. Indicate how the proposed research addresses the scientific/technical areas specifically described in the call. The maximum length for the abstract is one page.

3.4 Table of Contents

Provide the initial page number for each of the sections of the proposal.

3.5 Management Plan

The plan, up to 5 pages, needs to describe the overall strategy in developing and managing the proposed research program. Describe the overarching scientific goals that link the groups and researchers together. Include an overview of the functions and responsibilities of key personnel and the relationships among the subtasks. Clearly illustrate the integration, synergy, and coordination among the subtasks.

Describe any distinguishing strengths of conducting this particular research at your DOE laboratory, such as the synergisms among the investigators of a large interdisciplinary team; the ability to utilize unique DOE facilities at the laboratory; the benefits of collocation with researchers from other DOE programs; the ability to rapidly reconfigure your research thrust to respond to new challenges; and your successes at working with other research performers on transferring results to targeted research and development. Cite specific examples to illustrate such distinguishing strengths.

As appropriate for the research described in the proposal, describe the role of any advisory committee, executive committee, program committee, or their equivalent. Identify any plans for administering educational programs and outreach activities associated with the proposed research. Plans for administering shared facilities should be described under Section 3.12, Description of Facilities and Resources.

If the proposal consists of multiple subtasks, an overall budget summary should be provided here, which sums to the individual budgets for each subtask (see Section 3.7 for details)

Sections 3.6-3.13 are to be completed for each subtask in the proposal.
Up to 4 tightly coordinated subtasks are allowed in a proposal.
Multiple subtasks should be presented as follows:
First Subtask: Sections 3.6.1, 3.7.1,..., 3.12.1, 3.13.1
Second Subtask: Sections 3.6.2, 3.7.2, ..., 3.12.2, 3.13.2
.

3.6 Subtask Title and Abstract

Provide an abstract for the subtask that is no more than 250 words. No more than 4 subtasks are allowed in the proposal. Give the broad, long-term objectives and what the specific research proposed is intended to accomplish. Indicate how the proposed research addresses the BES scientific/technical area specifically described in the announcement.

3.7 Budget and Budget Explanation

A budget, conforming to the guidelines given below, is required for the entire project period, which normally will be three years, and for each Fiscal Year. You optionally may utilize DOE's budget page, Form 4620.1, for providing the equivalent budget information (Form 4620.1 is available at the following web site: http://www.science.doe.gov/grants/budgetform.pdf). Modifications of this form are permissible to comply with institutional practices. A written justification of each subtask is to follow the budget pages. For personnel, this should take the form of a one-sentence statement of the role of the person in the project. Provide a justification of the need for each item of permanent equipment. Budgets should also be provided for each research partner from a different institution who is funded under the FWP. Any other significant support received should be shown in Section 3.10.

***Total Budget and Level of Effort*:** Provide the total budget for the project, not counting equipment requests. List the names of the principal investigator and other key personnel and the estimated number of person-months or percentage of time for which DOE funding is requested. Proposers should list the number of postdoctoral associates and other professional positions included in the proposed work and indicate the number of full-time-equivalent (FTE) person-months. For graduate and undergraduate students and all other personnel categories such as secretarial, clerical, technical, etc., show the total number of people needed in each job title and their level of effort. The budget explanation should define concisely the role of each position in the overall project.

***Equipment*:** Provide the total equipment budget requested. DOE defines equipment as "an item of tangible personal property that has a useful life of more than two years and an acquisition cost of $25,000 or more." Special purpose equipment means equipment that is used only for research, scientific or other technical activities. Items of needed equipment should be individually listed by description and estimated cost, including tax, and adequately justified. Allowable items ordinarily will be limited to scientific equipment that is not already available for the conduct of the work.

3.8 Narrative

The narrative comprises the research plan for the FWP subtask. Each proposal is allowed up to four tightly coordinated subtasks. The narrative for each subtask should not exceed 15 pages. The majority of the narrative should address the Proposed Work. At the beginning of each subtask section, name the senior personnel who will participate, and state the proposed number of postdoctoral and undergraduate and graduate student participants. The narrative should contain the following subsections:

***Background and Significance*:** Briefly sketch the background leading to the present proposal, critically evaluate existing knowledge, and specifically identify the gaps that the project is intended to fill. State concisely the importance of the research described in the proposal. Explain the relevance of the project to the research needs identified by BES. The section must also contain one paragraph addressing how the proposed research will address one or more of the four BES long-term program measures used by the Office of Management and Budget to rate the BES program annually; these measures may be found at : http://www.sc.doe.gov/bes/BES_PART_Performance_Measures.pdf. Describe the role and intellectual contribution of each senior researcher in the subtask, and briefly outline the resources available or planned to accomplish the research goals. The need for a collaborative/laboratory approach involving several investigators and the means of achieving this should be clearly established. Include references to relevant published literature, both to work of the investigators and to work done by other researchers.

***Preliminary Studies (Optional)*:** Use this section to provide an account of any preliminary studies that may be pertinent to the proposal. Include any other information that will help to establish the experience and competence of the investigators to pursue the proposed project. References to appropriate publications and manuscripts submitted or accepted for publication may be included. Copies of such publications or manuscripts may be included in the Appendix (Section 3.13).

***Proposed Work*:** This section should constitute the major portion of the narrative, and should reflect a well-integrated vision for the project. A clear statement of the work to be undertaken is needed and must include: objectives for the period of the proposed work and expected significance; relation to longer-term goals of the project; and relation to the present state of knowledge in the field, to work in progress by the PIs under other support and to work in progress elsewhere. The Proposed Work should outline the general plan of the proposed work, including the broad design of activities to be undertaken, and, where appropriate, provide a clear description of experimental methods and procedures needed to accomplish the Proposed Work. In addition, it should describe new techniques and methodologies and explain their advantages over what currently exists.

***Subcontract or Consortium Arrangements*:** If any portion of the project described under "Research Design and Methods" is to be done in collaboration with another institution, provide information on the institution and why it is to do the specific component of the project. Further information on any such arrangements is to be given in the sections "Budget and Budget Explanation," "Biographical Sketches," and "Description of Facilities and Resources."

3.9 Literature Cited

List all references cited in the narrative, including titles. Limit citations to current literature relevant to the proposed research. Information about each reference should be sufficient for it to be located by a reviewer of the proposal.

3.10 Other Support of Investigators and Collaborations

Other support is defined as all financial resources, whether Federal, non-Federal, commercial or institutional, available in direct support of an individual's research endeavors. Information on significant levels of active and pending other support is required for all personnel, including investigators at collaborating institutions to be funded by a subcontract. For each item of other support, give the organization or agency, inclusive dates of the project or proposed project, annual funding, level of effort devoted to the project, and a one paragraph scope statement for each such project.

Describe any proposed interactions and collaborations with other institutions and sectors, such as universities, other national laboratories, and industrial institutions. Define the goals of the collaboration, and describe the planned activities. Describe the roles of the senior participants, the mechanisms planned to stimulate and facilitate knowledge transfer, and the potential long-term impact of the collaborations.

3.11 Biographical Sketches

This information is required for each senior personnel at the laboratory submitting the proposal and at all subcontracting institutions. Provide concise vitae, listing professional and academic essentials and complete contact information. List up to ten publications most pertinent to the research. Reference to the information already provided in Section 3.9 may be appropriate. This portion of the biographical sketches is limited to a maximum of two pages for each investigator.

Each biographical sketch should also include the following information on collaborators and other affiliations to help identify potential conflicts or bias in the selection of reviewers:

> ***Collaborators*:** A list of all persons in alphabetical order (including their current organizational affiliations) who are currently or who have been collaborators or co-authors with the individual on a project, book, article, report, abstract or paper during the 48 months preceding the submission of this proposal. Include collaborators on this proposal. If there are no collaborators, this should be so indicated.
>
> ***Graduate and Postdoctoral Advisors*:** A list of the names of the individual's own graduate advisor(s) and principal postdoctoral sponsor(s), and their current organizational affiliations.
>
> ***Thesis Advisor and Postgraduate-Scholar Sponsor*:** A list of all persons (including their organizational affiliations), over the last five years with whom the individual has had an

association as thesis advisor or postgraduate-scholar sponsor. The total number of graduate students advised and postdoctoral scholars sponsored also must be identified.

3.12 Description of Facilities and Resources

Describe briefly the facilities to be used for the conduct of the proposed research. Indicate the performance sites and describe pertinent capabilities, including support facilities (such as machine shops) that will be used during the project. List the most important equipment items already available for the project and their pertinent capabilities. Include this information for each subcontracting institution, if any. Describe any shared facilities and infrastructure to be established, including specific major instrumentation, and plans for the development of instrumentation. Describe plans for maintaining and operating new facilities, including staffing, and plans for ensuring access to outside users. Distinguish clearly between existing facilities and those still to be acquired or developed.

3.13 Appendix

All appended material must be submitted as separate PDF files from the proposal PDF file, e.g., in electronic folders containing multiple PDF files of publications. However, reviewers are not required to consider information in the Appendix. Do not use the appendix to circumvent the page limitations of the proposal. Reviewers may not have time to read extensive appendix materials with the same care as they will read the proposal proper.

Only information that may not be easily accessible to a reviewer should be included, such as publications in print or manuscripts accepted for publication. The appendix may also include letters from investigators at other institutions stating their agreement to participate in the project. Do not include letters of endorsement of the project.