

Sustainable Energy Pathways (SEP)

PROGRAM SOLICITATION

NSF 11-590



National Science Foundation

Directorate for Mathematical & Physical Sciences

Directorate for Engineering

Directorate for Computer & Information Science & Engineering

Directorate for Geosciences

Directorate for Social, Behavioral & Economic Sciences

Full Proposal Deadline(s) (due by 5 p.m. proposer's local time):

February 01, 2012

IMPORTANT INFORMATION AND REVISION NOTES

A revised version of the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), [NSF 11-1](#), was issued on October 1, 2010 and is effective for proposals submitted, or due, on or after January 18, 2011. Please be advised that the guidelines contained in [NSF 11-1](#) apply to proposals submitted in response to this funding opportunity.

Cost Sharing: The PAPPG has been revised to implement the National Science Board's recommendations regarding cost sharing. Inclusion of voluntary committed cost sharing is prohibited. In order to assess the scope of the project, all organizational resources necessary for the project must be described in the Facilities, Equipment and Other Resources section of the proposal. The description should be narrative in nature and must not include any quantifiable financial information. Mandatory cost sharing will only be required when explicitly authorized by the NSF Director. See the PAPP Guide Part I: *Grant Proposal Guide (GPG) Chapter II.C.2.g(xi)* for further information about the implementation of these recommendations.

Data Management Plan: The PAPPG contains a clarification of NSF's long standing data policy. All proposals must describe plans for data management and sharing of the products of research, or assert the absence of the need for such plans. FastLane will not permit submission of a proposal that is missing a Data Management Plan. The Data Management Plan will be reviewed as part of the intellectual merit or broader impacts of the proposal, or both, as appropriate. Links to data management requirements and plans relevant to specific Directorates, Offices, Divisions, Programs, or other NSF units are available on the NSF website at: <http://www.nsf.gov/bfa/dias/policy/dmp.jsp>. See [Chapter II.C.2.j](#) of the GPG for further information about the implementation of this requirement.

Postdoctoral Researcher Mentoring Plan: As a reminder, each proposal that requests funding to support postdoctoral researchers must include, as a supplementary document, a description of the mentoring activities that will be provided for such individuals. Please be advised that if required, FastLane will not permit submission of a proposal that is missing a Postdoctoral Researcher Mentoring Plan. See [Chapter II.C.2.j](#) of the GPG for further information about the implementation of this requirement.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Sustainable Energy Pathways (SEP)

Synopsis of Program:

A sustainable world is one in which human needs are met equitably without harm to the environment, and without sacrificing the ability of future generations to meet their needs. Growing evidence for the role of energy use in global change and awareness of limitations in our energy choices are motivating a search for pathways that are technologically innovative as well as environmentally and economically sustainable at all scales of energy usage. This is a grand challenge to the scientific community that cuts across disciplinary boundaries.

The creation of a secure and prosperous future for humanity depends on the contributions that science, engineering, and education will make towards building sustainable pathways to meet the energy needs of future generations. The dual roles of NSF - to support basic research and education - are ideally suited to stimulate vibrant science and engineering discovery and innovation efforts that will be needed to meet the challenge of building a sustainable energy future.

Sustainable Energy Pathways is part of the NSF-wide initiative on Science, Engineering, and Education for Sustainability (SEES). The Sustainable Energy Pathways solicitation calls for innovative, interdisciplinary basic

research in science, engineering, and education by teams of researchers for developing systems approaches to sustainable energy pathways based on a comprehensive understanding of the scientific, technical, environmental, economic, and societal issues.

The SEP solicitation considers scalable approaches for sustainable energy conversion to useful forms, as well as its storage, transmission, distribution, and use. The following Topic Areas illustrate the broad scope of sustainable energy interest areas of this solicitation: Energy Harvesting & Conversion from Renewable Resources; Sustainable Energy Storage Solutions; Critical Elements & Materials for Sustainable Energy; Nature-Inspired Processes for Sustainable Energy Solutions; Reducing Carbon Intensity from Energy Conversion & Use; Sustainable Energy Transmission & Distribution; Energy Efficiency & Management.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- Zeev Rosenzweig (MPS/Co-Chair), Co-Chair, MPS/CHE, telephone: (703) 292-7719, email: SEP@nsf.gov
- George Maracas (ENG/Co-Chair), Co-Chair, ENG/ECCS, telephone: (703) 292-8339, email: SEP@nsf.gov
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- Carol Bessel (MPS/CHE), telephone: (703) 292-4906, email: SEP@nsf.gov

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.050 --- Geosciences
- 47.070 --- Computer and Information Science and Engineering
- 47.075 --- Social Behavioral and Economic Sciences

Award Information

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 15 to 20 (subject to the availability of funds and quality of proposals)

Anticipated Funding Amount: \$34,000,000 About \$34M is expected for the FY2012 competition, pending availability of funds. The award size is expected to be up to \$500,000/year for up to four years per proposal. Innovative proposals of a more limited scope that still meet the SEP fundamental considerations, but requiring a lesser level of investment, are also encouraged.

Eligibility Information

Organization Limit:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

PI Limit:

A minimum of three investigators is required, the Principal Investigator (PI) and two or more co-PIs from the lead or participating institutions who are eligible to serve as PI or co-PI on NSF proposals submitted through their respective institutions. These investigators should represent more than one scientific discipline in order to ensure an interdisciplinary approach to sustainable energy.

Limit on Number of Proposals per Organization: 3

Eligible institutions may submit no more than three (3) proposals as the lead organization in response to this solicitation for FY 2012.

Limit on Number of Proposals per PI: 1

Any individual may appear as Principal Investigator (PI), co-PI, or other senior personnel on only one proposal in response to this solicitation. This limitation includes proposals submitted by a lead organization, any sub-award submitted as part of a proposal, or any collaborative proposal. If an individual is listed as a PI, co-PI, or senior personnel on more than one proposal, all of those proposals will be returned without review.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- Letters of Intent: Not Applicable
- Preliminary Proposal Submission: Not Applicable
- Full Proposals:
 - Full Proposals submitted via FastLane: NSF Proposal and Award Policies and Procedures Guide, Part I: Grant Proposal Guide (GPG) Guidelines apply. The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg.
 - Full Proposals submitted via Grants.gov: NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov Guidelines apply (Note: The NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)

B. Budgetary Information

- Cost Sharing Requirements: Inclusion of voluntary committed cost sharing is prohibited.
- Indirect Cost (F&A) Limitations: Not Applicable
- Other Budgetary Limitations: Not Applicable

C. Due Dates

- Full Proposal Deadline(s) (due by 5 p.m. proposer's local time):
February 01, 2012

Proposal Review Information Criteria

Merit Review Criteria: National Science Board approved criteria. Additional merit review considerations apply. Please see the full text of this solicitation for further information.

Award Administration Information

Award Conditions: Standard NSF award conditions apply.

Reporting Requirements: Standard NSF reporting requirements apply.

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I. INTRODUCTION

Sustainability is defined by the *National Science Board* as meeting present needs without compromising the ability of future generations to meet their own needs ¹. Growing evidence for the role of energy use in global change and awareness of limitations in our energy choices are motivating a search for pathways that are technologically innovative and environmentally and economically sustainable at all scales of energy usage. This is a grand challenge to the scientific community that cuts across disciplinary boundaries, because sustainability has many perspectives that cannot be addressed by individual disciplines.

The creation of a secure and prosperous future for humanity depends on the contributions that science, engineering, and education will make towards building sustainable pathways to meet the energy needs of future generations. These sustainable energy pathways must be secure, preserve essential ecosystems, and provide the lowest possible energy and economic costs without adverse environmental and societal consequences. Sustainable and clean energy sources also have significantly lower greenhouse gas emissions, reduce U.S. dependence on domestic and imported fossil fuels, and are affordable and available in sufficient quantity to make meaningful, enduring impacts.

NSF is poised to stimulate the vibrant science and engineering discovery and innovation efforts that will be needed to meet the challenge of building a sustainable energy future. NSF support will increase the fundamental knowledge base needed to address the challenge of creating sustainable energy solutions, and build human capacities to imagine, design, create, and put into practice future sustainable energy systems. In recognition of this opportunity, the *National Science Board* has recommended that "NSF should continue to increase emphasis on innovation in sustainable energy technologies and education as a top priority" ¹.

The imperative to build a sustainable energy future is primarily based on three urgent priorities that should collectively drive the transformation towards a sustainable energy economy: 1) promote national and economic security by increasing U.S. energy independence; 2) enhance environmental stewardship and reduce energy and carbon intensity; and 3) generate continued economic growth through innovation in energy technologies and expansion of sustainable energy relevant jobs. Given these priorities, NSF has established the following goals with respect to building a sustainable energy future:

- Create *fundamental knowledge* to characterize and understand existing energy systems and their limitations and form a basis to imagine, invent, and deploy novel energy systems;
- Explore *alternative energy sources and technologies* that can sustain a high quality of life for Earth's inhabitants;
- Investigate *novel pathways for human energy futures* built on a comprehensive understanding of risks and stressors associated with environmental, biospheric, and societal responses associated with new energy pathways;
- Develop *human capital* to address the trans-disciplinary challenge of building a sustainable energy future;
- Foster the critically important *public understanding* of sustainable energy.

Sustainable Energy Pathways is part of the NSF-wide initiative on Science, Engineering, and Education for Sustainability (SEES) ². Fundamental to all sustainability research is the simultaneous consideration of social, economic, and environmental systems and the long-term viability of those systems. Concepts that underlie the science of sustainability include complex adaptive systems theory, emergent behavior, multi-scale processes, as well as the vulnerability, adaptive capacity, and resilience of coupled human-environment systems. An important research goal is to understand how patterns and processes at the local and regional scales are shaped by - and feed into - processes and patterns that manifest at the global scale over the long term. These topics guide research to explore alternate ways of managing the environment, migrating from finite resources to renewable or inexhaustible resources, and applying technology to improve human well-being. Conceptual frameworks for sustainability, including general theories and models, are critically needed for such informed decision-making.

SEES activities span the entire range of scientific domains at NSF and aim to: 1) support interdisciplinary research and education that can facilitate the move towards global sustainability; 2) build linkages among existing projects and partners and added participants in the sustainability research enterprise; and 3) develop a workforce trained in the interdisciplinary scholarship needed to understand and address the complex issues of sustainability.

In this spirit, the Sustainable Energy Pathways (SEP) solicitation aims to support novel, fundamental research that will require an integrated approach encompassing topics ranging from energy resource characterization to the science and technology needed to develop and efficiently utilize a resource, to the social and environmental impact of widespread adoption of that energy resource.

References

¹. *Building a Sustainable Energy Future: U.S. Actions for an Effective Energy Economy Transformation*, National Science Board, NSB 09-55, August 3, 2009.

². *NSF 11-022, Dear Colleague Letter for the Science, Engineering and Education for Sustainability (SEES) NSF-Wide Investment Area*, January 4, 2011.

II. PROGRAM DESCRIPTION

The Sustainable Energy Pathways solicitation will support interdisciplinary efforts by teams of researchers to address the challenges of developing efficient pathways towards a sustainable energy future. *The overarching theme of the solicitation is "sustainability" in all of its facets.* Pathways to sustainable energy, from their starting points to ending points, should use renewable sources of

energy, or at least work to reduce the carbon intensity associated with our current dependence on carbon-based energy and fuels. These pathways should also employ energy efficient, economically, socially, and behaviorally viable processes that minimize adverse environmental or societal impacts.

This solicitation calls for innovative, basic research in science, engineering, and education for developing systems approaches to sustainable energy pathways based on a comprehensive understanding of the scientific, technical, environmental, economic, and societal issues. In this context, the development of the proposed sustainable energy pathway should be guided by all three fundamental considerations given below:

Scientific knowledge & technological innovation, which can include, but are not limited to, a) characterization and fundamental understanding of molecular and material properties, chemical processes, devices, and sustainable energy resources; b) discovery of new catalysts, materials, and sustainable energy resources; c) data analysis, modeling, simulation, and multi-scale design enabled by advanced computational methods; and d) development of new analytical methods, instrumentation, and novel processes and systems needed to enable sustainable energy research.

Environmental, societal and economic imperatives, which can include, but are not limited to, fundamental understanding of the environmental, ecological, social, behavioral, and economic science issues relevant to sustainable energy resources, processes and systems via experimental, theoretical, and observational investigations.

Education and workforce development, which can include, but are not limited to, the integration of education and training into the proposed research to enable a future workforce with the knowledge and skills needed for functioning in interdisciplinary energy fields, K-12 and undergraduate student engagement with sustainable energy topics, public understanding and engagement with issues for working towards a sustainable energy future, and the promotion of diversity into these proposed activities.

In order to meaningfully weave these three fundamental considerations into a sustainable energy pathway, the following must be incorporated into the narrative of the proposal:

Vision. The proposal must contain a concise description of the Vision for the proposed "Sustainable Energy Pathway" that may focus on one or more of the "Topic Areas" listed at the end of this section. The proposed pathway may embrace some or all facets of a sustainable future energy system, ranging from the assessment and harvesting of the energy resource, its conversion to useful forms, and ultimately, its sustainable management from natural, engineering, and human perspectives. This Vision must be compatible with the overarching theme of sustainability, based on careful consideration of the scientific, technical, environmental, economic, and societal aspects of sustainability. This pathway, as proposed, must not present insurmountable barriers in any of these aspects.

Integration. The proposed research must approach fundamental research from an interdisciplinary perspective that integrates science and engineering. The proposal must describe a synergistic, systems approach by which the team addresses the science and engineering challenges, informed by the environmental, societal, and economic imperatives, of developing the proposed sustainable energy pathway.

Collaboration. The proposal *must* include a management plan that discusses (a) the roles, qualifications, and synergy of the multi-disciplinary team assembled to accomplish the research and education plans of the proposed project; (b) the leadership structure for the team; and (c) the integration of the proposed activities among members of the team. International or industrial collaborations that strengthen the proposed project activities are also encouraged.

This solicitation will support research on potentially transformative approaches to sustainable energy pathways, but not incremental advances in current technologies, or deployment of existing technologies. Proposals which could be submitted to existing programs or currently active solicitations at NSF are not appropriate for this solicitation. Principal investigators are also advised that the proposed research must be distinct from ongoing research supported by any of their current federally funded awards in energy related areas. Investigators with questions about the responsiveness of their proposed ideas to this solicitation are strongly encouraged to consult one of the cognizant program directors prior to proposal preparation.

Topic Areas

The SEP solicitation considers scalable approaches for sustainable energy conversion to useful forms, as well as its storage, transmission, distribution, and use. The following Topic Areas include many of the priority areas of research identified by the National Science Board¹ and illustrate the broad scope of sustainable energy interest areas of this solicitation: Energy Harvesting & Conversion from Renewable Resources; Sustainable Energy Storage Solutions; Critical Elements & Materials for Sustainable Energy; Nature-Inspired Processes for Sustainable Energy Solutions; Reducing Carbon Intensity from Energy Conversion & Use; Sustainable Energy Transmission & Distribution; Energy Efficiency & Management.

It is expected that computational sciences will play a pivotal role in all aspects of sustainable energy system pathways mentioned above. This research would require novel hardware and software, new sensing, reasoning and knowledge extraction capabilities, advances in data management, analytics and visualization techniques, and distributed computing and communication systems that can scale to millions of nodes and yet meet stringent constraints on availability, robustness, security and timeliness. Furthermore, these solutions themselves must be highly energy and resource efficient so that they have a small carbon footprint and can effectively control physical systems in difficult environments without manual intervention.

In addition, NSF encourages proposals that take a broad view of achieving sustainable energy pathways by considering the social, behavioral, and economic considerations that are required to achieve advances in two or more of the priority areas listed below. Some of the questions that are worth consideration are the ways that economic incentives or governance structures vary across different sustainability pathways, the spatial development of various approaches, or the social networks that lead to decisions whether to adopt a new technology or not. In the case of proposals with this focus, researchers from the social, behavioral or economic sciences would lead the project, with strong interdisciplinary participation from researchers from other areas of science and engineering.

¹. **Sustainable Energy Resource Characterization, Harvesting, Conversion, Storage, and Impacts**

- *Energy Harvesting and Conversion from Renewable Resources:* A mix of resources and technologies is essential to pave the way to a sustainable energy future. Interests under this topic area include, but are not limited to: characterization of resources; exploration of potentially transformative approaches for efficient and environmentally benign processes to harvest and convert renewable resources to energy and fuels; analysis of whole life-cycle costs for renewable energy

generation; and understanding of the environmental and societal impacts of large-scale deployments of renewable energy systems.

- **Energy Storage Solutions:** High-performance energy storage systems at all scales of energy use, ranging from portable devices, to transportation systems, to large-scale generation of electricity, will be needed for a sustainable energy future. Interests under this topic area include, but are not limited to: discovery of new earth-abundant materials for long-lasting components of energy storage systems; the exploration and understanding of innovative sustainable energy storage processes that are safe, efficient, and environmentally benign; new approaches for modeling and analysis of energy storage and consumption patterns; and life-cycle analysis for energy storage.
- **Critical Elements & Materials for Sustainable Energy:** Many current energy processes and devices, including photovoltaics for electricity generation, batteries for electricity storage, or energy transmission systems, contain materials and elements which are rare or widely dispersed in the earth's crust, and/or cannot be produced in large enough quantity at reasonable cost to meet anticipated demand. Interests under this topic area, include, but are not limited to: alternative materials for sustainable energy processes and devices, including natural analogues that may inform the development of sustainable materials; new sources of critical elements in U.S., and cost-effective, environmentally benign concentration mechanisms for these elements; and alternative sustainable processes or devices that use earth-abundant elements obtained by cost-effective and environmentally benign methods.
- **Nature-Inspired Processes for Sustainable Energy Solutions:** Physical, chemical and biological processes occur throughout the natural environment, often at ambient conditions through low-energy routes that do not need or generate toxic materials. In this regard, Nature can serve as an inspiration for the development of future sustainable energy solutions. Interests under this topic area, include, but are not limited to: fundamental understanding of the physical and chemical phenomena for natural processes that efficiently harvest energy and convert it to useful forms without needing or generating toxic materials; exploration of innovative approaches to harness natural or nature-inspired processes for sustainable energy systems; and innovative use of this foundational knowledge to explore environmentally benign, efficient, and low-energy routes for the manufacture of useful chemicals, materials and devices.
- **Reducing Carbon Intensity from Energy Conversion and Use:** In spite of continued advances in exploiting alternative energy sources, carbon-based fuels will remain as a significant portion of U.S. and global energy portfolios for decades to come. Therefore, building a sustainable energy future will require significant advances in mitigating impacts of carbon dioxide emissions and the social acceptance of the measures to be taken. Interests under this topic area include, but are not limited to: fundamental research to develop sustainable methods for carbon capture; exploration of innovative and efficient approaches to convert carbon dioxide to fuels, chemicals, and value-added products; fundamental research directed towards a deeper understanding of the physics and chemistry of unconventional geologic and ocean reservoirs for carbon sequestration targets; evaluation of the potential environmental and ecological impacts (including possible co-benefits) of carbon capture and sequestration, as well as the safety challenges and the economic viability of these approaches for the reduction of greenhouse gases.

Energy Transmission, Distribution, Efficiency, and Use

- **Transmission and Distribution.** With energy conversion infrastructure becoming increasingly distributed and heterogeneous, there are numerous logistics and technical challenges in energy transmission and distribution to locations of use that need to be addressed. Interests under this topic area include, but are not limited to: the discovery and design of long-lasting, environmentally benign materials that can be prepared from abundant resources for efficient energy transmission systems; and innovative design of transmission and distribution infrastructure, which must consider a wide variety of factors including land use, environmental impact of the infrastructures, costs, safety and regulatory issues, social acceptability, economical aspects, physical and control system security and robustness, and integrated approaches for prevention, alerting, and response mechanisms to ensure system immunity to large scale threats.
- **Energy Efficiency and Management.** Regardless of the energy sources, sustainability demands that we use the energy as efficiently as possible. Efficient energy usage in homes and commercial buildings, transportation systems, industrial/manufacturing systems, large Information Technology systems, and critical infrastructure requires integration and coordination among multiple heterogeneous energy production and consumption systems. Interests under this topic area include, but are not limited to: energy analysis of sustainable energy systems; the discovery and design of new materials for increasing energy efficiency of devices, buildings, and transportation systems; innovative and sustainable approaches to intelligent management of energy flows; and matching of supply and consumption sides via adaptations on both sides. Research on energy efficiency and management must also consider societal needs, human behavior and attitudes, privacy and security issues associated with sharing of usage patterns, robustness against cyber-attacks and disaster scenarios, cost, convenience, and environmental impacts.

III. AWARD INFORMATION

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 15 to 20 (subject to the availability of funds and quality of proposals)

Anticipated Funding Amount: \$34,000,000 About \$34M is expected for the FY2012 competition, pending availability of funds. The award size is expected to be up to \$500,000/year for up to four years per proposal. Innovative proposals of a more limited scope that still meet the SEP fundamental considerations, but requiring a lesser level of investment, are also encouraged.

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

IV. ELIGIBILITY INFORMATION

Organization Limit:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

PI Limit:

A minimum of three investigators is required, the Principal Investigator (PI) and two or more co-PIs from the lead or participating institutions who are eligible to serve as PI or co-PI on NSF proposals submitted through their respective institutions. These investigators should represent more than one scientific discipline in order to ensure an interdisciplinary approach to sustainable energy.

Limit on Number of Proposals per Organization: 3

Eligible institutions may submit no more than three (3) proposals as the lead organization in response to this solicitation for FY 2012.

Limit on Number of Proposals per PI: 1

Any individual may appear as Principal Investigator (PI), co-PI, or other senior personnel on only one proposal in response to this solicitation. This limitation includes proposals submitted by a lead organization, any sub-award submitted as part of a proposal, or any collaborative proposal. If an individual is listed as a PI, co-PI, or senior personnel on more than one proposal, all of those proposals will be returned without review.

Additional Eligibility Info:

None

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via Grants.gov or via the NSF FastLane system.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov. The complete text of the NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: (http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. Chapter II, Section D.4 of the Grant Proposal Guide provides additional information on collaborative proposals.

The standard NSF Grant Proposal Guide (GPG) or NSF Grants.gov Application Guide instructions for proposal preparation apply, with the following additions.

a. Cover Sheet:

- FastLane Users: Proposers must identify this program solicitation number in the program announcement/solicitation block on the Cover Sheet and select "Sustainable Energy Pathways" from the FastLane org. unit pull-down list. The project title must begin with "SEP:" If any proposals are submitted by different institutions as a collaborative group, they all should have the same title and begin with the designation "SEP Collaborative:".
- Grants.gov Users: The program solicitation number will be pre-populated by Grants.gov on the NSF Grant Application Cover Page. Refer to Section VI.1.2 of the NSF Grants.gov Application Guide for specific instructions on how to designate the NSF Unit of Consideration. The project title must begin with "SEP:".

Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

b. Project Description: In addition to the requirements of the standard NSF Grant Proposal Guide (GPG) or NSF Grants.gov Application Guide instructions, the narrative Project Description limit has been extended to 17 pages in order that it include the following required elements:

Vision. The proposal must contain a concise description of the Vision for the proposed "Sustainable Energy Pathway" that may focus on one or more of the "Topic Areas" listed in the Program Description section. The proposed pathway may embrace some or all facets of a sustainable future energy system, ranging from the assessment and harvesting of the energy resource, its conversion to

useful forms, and ultimately, its sustainable management from natural, engineering, and human perspectives. This Vision must be compatible with the overarching theme of sustainability, based on careful consideration of the scientific, technical, environmental, economic, and societal aspects of sustainability. This pathway, as proposed, must not present insurmountable barriers in any of these aspects.

Integration. The proposed research must approach fundamental research from an interdisciplinary perspective that integrates the natural sciences and engineering. The proposal must describe a synergistic, systems approach by which the team addresses the science and engineering challenges, informed by the environmental, societal, and economic aspects, of developing the proposed sustainable energy pathway.

Collaboration. The proposal *must* include a management plan that discusses (a) the roles, qualifications, and synergy of the multi-disciplinary team assembled to accomplish the research and education plans of the proposed project; (b) the leadership structure for the team; and (c) the integration of the proposed activities among members of the team. International collaborations that strengthen the proposed project activities are also encouraged.

Proposals not following these instructions will be returned without review.

c. Single Copy Documents:

- Single Copy Documents are used by NSF staff, but are not available to reviewers.
- Required: A single, alphabetically ordered List of conflicts of all people, in the academic or professional community, who have collaborated with (within the last 48 months), or have been a Ph.D. advisee or advisor of, any personnel involved in the proposed project, including all advisory boards must be provided. In this list, include the name of each conflicted individual and that individual's institution or company.
- Optional: Suggested Reviewers and Reviewers Not to Include.

d. Supplementary Documents: For proposals involving collaborations with researchers not listed as co-PIs, proposers should include letters confirming the collaborations. The letters must be very brief and containing no statements of support or reference. Details about collaborative work to be done under this project should be included within the 17-pages of the Project Description, not in the letters of collaboration.

B. Budgetary Information

Cost Sharing: Inclusion of voluntary committed cost sharing is prohibited

Budget Preparation Instructions:

- The total budget (including indirect costs) can be up to \$500,000 per year for up to 4 years.
- Required Costs: Include costs of travel for at least two of the investigators in each of the 1st and 3rd year of the award period to the Washington, D.C. area to participate in biennial grantees' meetings.
- This program will support the costs of US-based scientists and their students. International collaborators are encouraged to seek support from their respective funding organizations. Funding guidelines for involving international collaborators allow the following expenses to be included in the NSF budget:
- Travel expenses for US scientists and students participating in exchange visits integral to the project.
- Project-related expenses for international partners to engage in research activities while in the United States as project participants.
- Project-related expenses for US participants to engage in research activities while abroad.

C. Due Dates

- Full Proposal Deadline(s) (due by 5 p.m. proposer's local time):
February 01, 2012

D. FastLane/Grants.gov Requirements

- For Proposals Submitted Via FastLane:

Detailed technical instructions regarding the technical aspects of preparation and submission via FastLane are available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

Submission of Electronically Signed Cover Sheets. The Authorized Organizational Representative (AOR) must electronically sign the proposal Cover Sheet to submit the required proposal certifications (see Chapter II, Section C of the Grant Proposal Guide for a listing of the certifications). The AOR must provide the required electronic certifications within five working days following the electronic submission of the proposal. Further instructions regarding this process are available on the FastLane Website at: <https://www.fastlane.nsf.gov/fastlane.jsp>.

- For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: http://www07.grants.gov/applicants/app_help_reso.jsp. In addition, the NSF Grants.gov Application Guide provides additional technical guidance regarding preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program where they will be reviewed if they meet NSF proposal preparation requirements. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with the oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal.

A. NSF Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board (NSB)-approved merit review criteria: intellectual merit and the broader impacts of the proposed effort. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two NSB-approved merit review criteria are listed below. The criteria include considerations that help define them. These considerations are suggestions and not all will apply to any given proposal. While proposers must address both merit review criteria, reviewers will be asked to address only those considerations that are relevant to the proposal being considered and for which the reviewer is qualified to make judgments.

What is the intellectual merit of the proposed activity?

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of the prior work.) To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

Examples illustrating activities likely to demonstrate broader impacts are available electronically on the NSF website at: <http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf>.

Mentoring activities provided to postdoctoral researchers supported on the project, as described in a one-page supplementary document, will be evaluated under the Broader Impacts criterion.

Additional Solicitation Specific Review Criteria

In addition to the standard NSF review criteria of Intellectual Merit and Broader Impacts identified in the Grant Proposal Guide, proposals submitted in response to this solicitation will be evaluated on the following additional criteria:

- The extent to which the proposal articulates a vision for the proposed "Sustainable Energy Pathway" that embraces the overarching theme of sustainability, and integrates scientific knowledge & technological innovation, as well as environmental, societal, & economic aspects, into the proposed activities to explore this vision.
- The extent to which multiple disciplines are synergistically engaged in developing collaborative, interdisciplinary approaches to pathways for future sustainable energy systems. The breadth, synergy, and effectiveness of the interdisciplinary engagement is expected to be reflected the research plan, as well as in the expertise and roles of the Principal and Co-Principal Investigators involved in the project, and their plan for management of the proposed activities.
- The extent to which education and workforce development are integrated into the proposed activities, and the effectiveness and potential impact of the proposed educational activities in stimulating student interest as well as promoting public understanding of and engagement with issues for achieving a sustainable energy economy.

NSF staff also will give careful consideration to the following in making funding decisions:

Integration of Research and Education

One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

Integrating Diversity into NSF Programs, Projects, and Activities

Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review.

Reviewers will be asked to formulate a recommendation to either support or decline each proposal. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF is striving to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director accepts the Program Officer's recommendation.

A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

In all cases, after programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications and the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award letter, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award letter; (4) the applicable award conditions, such as Grant General Conditions (GC-1); * or Research Terms and Conditions * and (5) any announcement or other NSF issuance that may be incorporated by reference in the award letter. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at http://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period. (Some programs or awards require more frequent project reports). Within 90 days after expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report will delay NSF review and processing of any future funding increments as well as any pending proposals for that PI. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through FastLane, for preparation and submission of annual and final project reports. Such reports provide information on activities and findings, project participants (individual and organizational), publications, and other specific products and contributions. PIs will not be required to re-enter information previously provided, either with a proposal or in earlier updates using the electronic system. Submission of the report via FastLane constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- Zeev Rosenzweig (MPS/Co-Chair), Co-Chair, MPS/CHE, telephone: (703) 292-7719, email: SEP@nsf.gov
- George Maracas (ENG/Co-Chair), Co-Chair, ENG/ECCS, telephone: (703) 292-8339, email: SEP@nsf.gov
- Linda S. Sapochak (MPS/DMR), telephone: (703) 292-4932, email: SEP@nsf.gov
- Tong Ren (MPS/CHE), Program Director (MPS/CHE), telephone: (703) 292-4938, email: SEP@nsf.gov
- Ram B. Gupta (ENG/CBET), telephone: (703) 292-2407, email: SEP@nsf.gov
- Richard J. Fragaszy (ENG/CMMI), telephone: (703) 292-7011, email: SEP@nsf.gov
- Stephen S. Harlan (GEO/EAR), telephone: (703) 292-7707, email: SEP@nsf.gov
- Anjali S. Bamzai (GEO/AGS), Program Director (GEO/AGS), telephone: (703) 292-8527, email: SEP@nsf.gov
- Krishna Kant (CISE/CNS), Program Director (CISE/CNS), telephone: (703) 292-8950, email: SEP@nsf.gov
- Antoinette WinklerPrins (SBE/BCS), telephone: (703) 292-4995, email: SEP@nsf.gov
- Tobias Fischer (GEO/EAR), telephone: (703) 292-4742, email: SEP@nsf.gov
- Graham M. Harrison (OD/OISE), telephone: (703) 292-7252, email: SEP@nsf.gov
- Alphonse T. DeSena (EHR/DRL), telephone: (703) 292-5106, email: SEP@nsf.gov
- Michael Reksulak (SBE/SES), (SBE/SES), telephone: (703) 292-7266, email: SEP@nsf.gov
- Thyagarajan Nandagopal (CISE/CNS), telephone: (703) 292-4550, email: SEP@nsf.gov
- Carol Bessel (MPS/CHE), telephone: (703) 292-4906, email: SEP@nsf.gov

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: fastlane@nsf.gov.

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

SEP is supported by the Directorate of Engineering (ENG), Directorate for Computer & Information Science & engineering (CISE), Directorate for Geosciences (GEO), Directorate for Mathematical & Physical Sciences (MPS), Directorate of International Science & Engineering (OISE), Directorate for Social, Behavioral, & Economic Sciences (SBE), and the Directorate for Education and Human Resources (EHR). Inquiries can be sent to SEP@nsf.gov.

FAQs (Frequently Asked Questions) are now available at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf12032

IX. OTHER INFORMATION

The NSF Website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this Website by potential proposers is strongly encouraged. In addition, National Science Foundation Update is a free e-mail subscription service designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF Regional Grants Conferences. Subscribers are informed through e-mail when new publications are issued that match their identified interests. Users can subscribe to this service by clicking the "Get NSF Updates by Email" link on the [NSF web site](#).

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this new mechanism. Further information on Grants.gov may be obtained at <http://www.grants.gov>.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements

to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See Grant Proposal Guide Chapter II, Section D.2 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at <http://www.nsf.gov>

- Location: 4201 Wilson Blvd. Arlington, VA 22230
- For General Information (NSF Information Center): (703) 292-5111
- TDD (for the hearing-impaired): (703) 292-5090
- To Order Publications or Forms:
Send an e-mail to: nspubs@nsf.gov
or telephone: (703) 292-7827
- To Locate NSF Employees: (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, [NSF-50](#), "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and [NSF-51](#), "Reviewer/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton
Reports Clearance Officer
Division of Administrative Services
National Science Foundation
Arlington, VA 22230

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