

Program Announcement To DOE National Laboratories LAB 99-12

Climate Change Technology Initiative Establishment of Centers for Research on Carbon Sequestration in the Terrestrial Biosphere and the Oceans

The Office of Biological and Environmental Research (OBER) of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announces their interest in receiving proposals in support of the Climate Change Technology Initiative: Establishment of Centers for Research on Carbon Sequestration in the Terrestrial Biosphere and the Oceans.

The concentration of carbon dioxide in the atmosphere is steadily increasing as a result of both land use changes and the combustion of fossil fuels for energy production. Due to the enhanced greenhouse effect caused by the increasing concentration of carbon dioxide and other greenhouse gases in the atmosphere, it is predicted that greater amounts of heat will be retained within the atmosphere, leading to a gradual increase in the surface temperature of the earth.

Reducing the potential risks of human-induced global warming will require the means to slow the rate of increase in atmospheric carbon dioxide levels be found. Possible strategies that might be used to accomplish this include: 1) more efficient use of energy; 2) greater use of energy from sources that emit less carbon; 3) capture and sequestration of carbon dioxide before it is emitted to the atmosphere from power plants and other sources; and 4) increased carbon sequestration by enhancing the natural capacity of the terrestrial biosphere and the oceans to take up and store carbon.

Research on the latter strategy is the subject of this announcement. As defined here, carbon sequestration refers to technology or management approaches or strategies that take advantage of natural processes that absorb atmospheric CO₂ and sequester the carbon in soil, vegetation, and the oceans. Fundamental new research is required, however, to understand the potential capacity of the biosphere to absorb and retain more carbon, to develop efficient and effective approaches and strategies to enhance this potential, and to determine the ecological consequences of this sequestration.

Goals of this DOE Office of Science Research Announcement:

The Office of Biological and Environmental Research, Department of Energy requests proposals from DOE laboratories for the establishment of centers for innovative,

interdisciplinary research on enhancing carbon sequestration in the biosphere. The scientific goals of these centers would be: (1) to advance the fundamental scientific understanding needed to develop and implement approaches or strategies to enhance the natural sequestration capacity of carbon in unmanaged and managed terrestrial ecosystems, including wetlands, and in the oceans; and (2) to improve scientific understanding of what the environmental implications would be of increased carbon sequestration in terrestrial and ocean systems. A center is considered to be an effective vehicle for defining and building the knowledge base needed to develop, design, test, and implement effective, environmentally acceptable ways of increasing carbon sequestration in the terrestrial biosphere or the oceans, entraining the scientific and technical expertise required for the research, maintaining a research focus on critical issues and uncertainties of highest priority, integrating the research across disciplinary areas and scales of study, and promoting and coordinating cooperation among individual researchers and research teams. One or more centers would focus on research to enhance carbon sequestration in the terrestrial biosphere, and an additional center would focus on enhancing the biological sequestration in the oceans. These centers could also serve as focal points for the transfer of fundamental science findings to the applied sequestration research program of the Office of Fossil Energy.

Purpose of the Centers:

Each center that is established will focus, coordinate, manage, and conduct fundamental carbon sequestration research that will lead to the development of ways of changing the processes or components in terrestrial or ocean ecosystems that control the net uptake and sequestration of atmospheric carbon dioxide; will test potential feasibility and effectiveness of applying such approaches over managed and/or unmanaged terrestrial ecosystems or ocean areas; and will focus on those processes or properties of ecosystems for which the alteration or management will offer significant potential for enhancing the net sequestration of carbon in these systems. In addition, the center is expected to conduct appropriate research and integrated analyses needed to understand, predict, and assess the environmental implications, both ancillary benefits and negative effects, of implementing such approaches or strategies as a means of reducing the concentration of atmospheric carbon dioxide.

Proposals should describe the research that would be done by the center and how the research relates to the scientific goals of this announcement. In addition, proposals should include a description of how a proposed center would be organized, managed, and operated to address the needed research. This could include a description of how needed expertise from outside the proposed center, such as academically-based researchers, would be integrated into the research performed at the center, and how

the results of this scientific work could be transferred to the applied research activities of the Carbon Sequestration Program of the Office of Fossil Energy.

Technical Areas of Interest:

A. Sequestration in the Terrestrial Biosphere: Carbon pools in the natural biogeochemical cycle are immense and quantitative estimates of the natural sequestration of carbon in various locations of the terrestrial biosphere are improving in accuracy. The feasibility of various options for enhancing sequestration, however, is only beginning to be explored. Further, the science needed to develop approaches to enhance the net sequestration of carbon in the terrestrial biosphere has not been seriously explored; the potential for revolutionary scientific discovery in this area is vast, including ways of modifying natural biological and physical processes in terrestrial ecosystems to enhance their carbon sequestration rate and capacity.

Any strategy or approach to enhance the net sequestration of carbon in the terrestrial biosphere requires that it lead to increases in the quantity of carbon fixed in plants, soil and roots. At the same time, either of these two requirements would need to be accomplished in a way that is environmentally acceptable and optimizes the uses of available lands.

There are multiple potential approaches and strategies to increase the quantities of carbon in soil and plant biomass. Experimental approaches to enhance and quantify carbon fluxes and storage products are covered here. Approaches to modify plant processes at scales ranging from the cellular to the molecular are a focus in a parallel announcement at http://www.er.doe.gov/production/grants/lab99_11.html for Federally Funded Research and Development Centers and at http://www.er.doe.gov/production/grants/fr99_11.html for the private sector (organizations such as: colleges and universities, non-profit organizations, for-profit commercial organizations, foreign organizations, state and local governments, and unaffiliated individuals). The following are examples of technical areas relevant to carbon sequestration in the terrestrial biosphere. These examples are provided only to illustrate the kinds of issues on which a center might consider proposing to focus some of its research. While physiological scale processes are the focus of this announcement, relevant molecular or cellular scale processes will not be excluded. Where appropriate, proposals submitted in response to either this announcement or to those referenced above will be considered jointly.

Examples of relevant research areas to the issue of enhanced carbon sequestration by the terrestrial biosphere.

1. Increasing the net fixation of atmospheric carbon dioxide by terrestrial plants with emphasis on physiology and rates of photosynthesis of vascular plants, retention of carbon by ecosystems and enhancing the translocation of carbon to soil.

Research might focus on:

- intrinsic rates of carboxylation and changes in carbon balance of vascular plants.
- native plant species that exhibit rapid growth under a wide range of environmental conditions.
- ways that above- and below-ground partitioning of fixed carbon can be modified by manipulating nutrients, water and other environmental variables.
- understanding root architecture for optimal below ground productivity and transformation of plant biomass, including lignified materials, into soil organic matter.
- biotechnological approaches to increase the availability or supply of nutrients that otherwise limit plant productivity.

2. Reducing the emission of CO₂ from soils due to heterotrophic oxidation of soil organic carbon.

Research might focus on:

- defining and producing optimal mix of organisms and substrates for slowing oxidation of plant residues in soil.
- isolating and defining the environmental and biochemical factors that control the oxidation rate of soil carbon and how these factors could be modified to slow the rate.

3. Increasing the capacity of deserts and degraded lands to sequester carbon.

Research might focus on:

- plant phenotypes that can thrive in degraded lands and deserts and sequester significant quantities of carbon in soil.
- the potential of introducing under-utilized native plant species with inherent acid, salinity, and/or drought tolerance to both sequester carbon in and reclaim degraded lands.

- innovative approaches of using CO₂ by-products to improve soil quality and enhance productivity and carbon sequestration of marginal lands and degraded ecosystems.

B. Sequestration in the Oceans: The ocean represents a large potential sink for sequestration of anthropogenic CO₂ emissions. Two strategies for enhancing carbon sequestration in the ocean have been proposed. One strategy is the enhancement of the net oceanic uptake from the atmosphere by fertilization of phytoplankton with micro- or macronutrients. A second strategy is the direct injection of a relatively pure CO₂ stream to ocean depths greater than 1000 m. Sources of CO₂ might include power plants, industries or other sources. The long term effectiveness and potential environmental consequences of ocean sequestration by either strategy, however, are as yet unknown.

Examples of relevant research areas to the issue of enhanced carbon sequestration by the oceans.

1. Environmental consequences of long term ocean fertilization.

Research might focus on:

- examining changes in structure and function of marine ecosystems including community structure of phytoplankton and zooplankton, ocean food webs and trophodynamics, resulting from ocean fertilization.
- examining changes in natural oceanic biogeochemical cycles (carbon, nitrogen, phosphorus, silicon, and sulfur) resulting from carbon sequestration.

2. Effectiveness of ocean fertilization on a large scale.

Research might focus on:

- understanding the biological pumping of carbon to deep waters, the export of particulate organic carbon and particulate inorganic carbon to the deep sea, and mineralization or dissolution of all forms at depth.
- determining how micronutrients (such as iron) and macronutrients (such as nitrogen and phosphorus) regulate the biological pump in the ocean.
- determining to what extent increased carbon fixation in surface waters will result in an increase in carbon sequestered in the deep ocean, and how long it will remain sequestered. One approach might be the use of coupled physical, chemical and biological models.

3. Environmental consequences of direct injection of CO₂ into the ocean in midwater or deep sea habitats.

Research might focus on:

- understanding the effects of sustained release of concentrated CO₂ on biogeochemistry and ecosystem structure and function.
- determining the effects of changes in pH and CO₂ on organisms from midwater and deep sea habitats.
- understanding the longer-term fate of carbon which is added to the ocean including the carbonate chemistry of mid- and deep-ocean water.

4. Effectiveness of direct injection of CO₂ for carbon sequestration.

Research might focus on:

- addressing weaknesses in Ocean General Circulation Models (OGCMs), specifically western boundary currents, ocean bottom currents and sub-grid scale processes, and test models using natural or experimental tracers.
- coupling near-field with far-field effects of CO₂ injection, for example, couple plume modeling with basin and global scale ocean circulation models.

DATES: Formal proposals submitted in response to this announcement must be received by 4:30 P.M., E.S.T., March 16, 1999, in order to be accepted for merit review and to permit timely consideration for award in FY 1999.

ADDRESS: Formal proposals must be sent to: U.S. Department of Energy, Office of Science, Office of Biological and Environmental Research, SC-74, 19901 Germantown Road, Germantown, MD 20874-1290, ATTN: Program Announcement LAB99-12. The above address for formal proposals also must be used for transmission by U.S. Postal Service Express Mail, any commercial mail delivery service, or when hand carried by the proposer. An original and seven copies of the proposal must be submitted.

FOR FURTHER INFORMATION CONTACT: Dr. John Houghton, Environmental Sciences Division, SC-74, Office of Biological and Environmental Research, Office of Science, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290, telephone: (301) 903-8288, E-mail: john.houghton@oer.doe.gov, fax: (301) 903-8519.

Program Funding

It is anticipated that up to a total of \$3,000,000 will be available for awards in this area during FY 1999, contingent upon availability of appropriated funds. Multiple year funding of awards is expected, and is also contingent upon availability of funds, progress of the research, and continuing program need.

The instructions and format described below should be followed. Reference Program Announcement LAB99-12 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 criteria which are listed 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

The evaluation will include program policy factors such as the relevance of the proposed research to the terms of the announcement, the uniqueness of the proposer's capabilities, and demonstrated usefulness of the research for proposals in other DOE Program Offices as evidenced by a history of programmatic support directly related to the proposed work.

2. Summary of Proposal Contents

Field Work Proposal Format (Reference DOE Order 5700.7C) (DOE ONLY)
Proposal Cover Page
Table of Contents
Abstract
Narrative
Literature Cited
Budget and Budget Explanation
Other support of investigators
Biographical Sketches
Description of facilities and resources
Appendix

2.1 Number of Copies to Submit

An original and seven copies of the formal proposal/FWP must be submitted.

3. Detailed Contents of the Proposal

Proposals must be readily legible, when photocopied, and must conform to the following three 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.

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. 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

The following proposal cover page information may be placed on plain paper. No form is required.

Title of proposed project
SC Program announcement title
Name of laboratory

Name of principal investigator (PI)
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
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.

3.4 Abstract

Provide an abstract of no more than 250 words. Give the broad, long-term objectives and what the specific research proposed is intended to accomplish. State the hypotheses to be tested. Indicate how the proposed research addresses the SC scientific/technical area specifically described in this announcement.

3.5 Narrative

The narrative comprises the research plan for the project and is limited to 25 pages. It 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 which 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 the Office of Science. Include references to relevant published literature, both to work of the investigators and to work done by other researchers.

Preliminary Studies: 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.

Research Design and Methods: Describe the research design and the procedures to be used to accomplish the specific aims of the project. Describe new techniques and methodologies and explain the advantages over existing techniques and methodologies. As part of this section, provide a tentative sequence or timetable for the project.

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".

3.6 Literature Cited

List all references cited in the narrative. 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.

3.7 Budget and Budget Explanation

A detailed budget is required for the entire project period, which normally will be three years, and for each fiscal year. It is preferred that DOE's budget page, Form 4620.1 be used for providing budget information*. Modifications of categories are permissible to comply with institutional practices, for example with regard to overhead costs.

A written justification of each budget item 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 detailed justification of the need for each item of permanent equipment. Explain each of the other direct costs in sufficient detail for reviewers to be able to judge the appropriateness of the amount requested.

Further instructions regarding the budget are given in section 4 of this guide.

* Form 4620.1 is available at web site:

<http://www.er.doe.gov/production/grants/forms.html>

3.8 Other Support of Investigators

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 active and pending other support is required for all senior 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, and level of effort devoted to the project.

3.9 Biographical Sketches

This information is required for senior personnel at the laboratory submitting the proposal and at all subcontracting institutions. The biographical sketch is limited to a maximum of two pages for each investigator.

3.10 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.

3.11 Appendix

Include collated sets of all appendix materials with each copy of the proposal. Do not use the appendix to circumvent the page limitations of the proposal. Information should be included that may not be easily accessible to a reviewer.

Reviewers are not required to consider information in the Appendix, only that in the body of the proposal. Reviewers may not have time to read extensive appendix materials with the same care as they will read the proposal proper.

The appendix may contain the following items: up to five publications, manuscripts (accepted for publication), abstracts, patents, or other printed materials directly relevant to this project, but not generally available to the scientific community; and letters from investigators at other institutions stating their agreement to participate in the project (do not include letters of endorsement of the project).

4. Detailed Instructions for the Budget (DOE Form 4620.1 "Budget Page" may be used)

4.1 Salaries and Wages

List the names of the principal investigator and other key personnel and the estimated number of person-months for which DOE funding is requested. Proposers should list the number of postdoctoral associates and other professional positions included in the proposal and indicate the number of full-time-equivalent (FTE) person-months and rate of pay (hourly, monthly or annually). 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 total salaries needed. Salaries requested must be consistent with the institution's regular practices. The budget explanation should define concisely the role of each position in the overall project.

4.2 Equipment

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 \$5000 or more." Special purpose equipment means equipment which 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. General purpose office equipment normally will not be considered eligible for support.

4.3 Domestic Travel

The type and extent of travel and its relation to the research should be specified. Funds may be requested for attendance at meetings and conferences, other travel associated with the work and subsistence. In order to qualify for support, attendance at meetings or conferences must enhance the investigator's capability to perform the research, plan extensions of it, or disseminate its results. Consultant's travel costs also may be requested.

4.4 Foreign Travel

Foreign travel is any travel outside Canada and the United States and its territories and possessions. Foreign travel may be approved only if it is directly related to project objectives.

4.5 Other Direct Costs

The budget should itemize other anticipated direct costs not included under the headings above, including materials and supplies, publication costs, computer services, and consultant services (which are discussed below). Other examples are: aircraft rental, space rental at research establishments away from the institution, minor building alterations, service charges, and fabrication of equipment or systems not available off-the-shelf. Reference books and periodicals may be charged to the project only if they are specifically related to the research.

a. Materials and Supplies

The budget should indicate in general terms the type of required expendable materials and supplies with their estimated costs. The breakdown should be more detailed when the cost is substantial.

b. Publication Costs/Page Charges

The budget may request funds for the costs of preparing and publishing the results of research, including costs of reports, reprints page charges, or other journal costs (except costs for prior or early publication), and necessary illustrations.

c. Consultant Services

Anticipated consultant services should be justified and information furnished on each individual's expertise, primary organizational affiliation, daily compensation rate and number of days expected service. Consultant's travel costs should be listed separately under travel in the budget.

d. Computer Services

The cost of computer services, including computer-based retrieval of scientific and technical information, may be requested. A justification based on the established computer service rates should be included.

e. Subcontracts

Subcontracts should be listed so that they can be properly evaluated. There should be an anticipated cost and an explanation of that cost for each subcontract. The total amount of each subcontract should also appear as a budget item.

4.6 Indirect Costs

Explain the basis for each overhead and indirect cost. Include the current rates.