

Maine Energy Education and Research Plan



DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Maine EPSCoR

A Program of the Maine Science and Technology Commission

September 28, 1992

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Research Excellence Partnership
(Maine EPSCoR Steering Committee)

E.J. Lovett, III, Ph.D., Maine Medical Center Research Institute, Chair
Judith Bailey, Ph.D., University of Maine
Steven Ballard, Ph.D., University of Maine
Richard Bowers, Ph.D., University of Maine System
Penn Estabrook, Maine Department of Marine Resources
Sondra Everhart, Foundation for Blood Research
Edward Gilfillan, Ph.D., Bowdoin College
Brian Hodgkin, Ph.D., University of Southern Maine
Lewis Incze, Ph.D., Bigelow Laboratory
Barbara Kent, Ph.D., Mt. Desert Island Biological Laboratory
Miles Theeman, Affiliated Health Care
Jay Vreeland, Ph.D., S.D. Warren Research

Maine DOE EPSCoR Planning Committee

Clarice Yentsch, Ph.D., Bigelow Laboratory, Chair
Walter Anderson, Ph.D., Maine Geological Survey
Steven Ballard, Ph.D., University of Maine
Ed Gilfillan, Ph.D., Bowdoin College
Richard Hill, Ph.D., University of Maine
Tom Keller, Ph.D., Department of Education
Richard Stebbins, Ph.D., University of Southern Maine
Calvin Vary, Ph.D., Maine Medical Center Research Institute

Maine EPSCoR Program Staff

Terry Shehata, Ph.D., Director
Beverly Hawk, Ph.D., Program Manager
Barbara Manning, Program Manager
Tracy Perez, Program Manager

This document was written by Beverly Hawk, DOE EPSCoR Program Manager, with the oversight and assistance of Terry Shehata, Barbara Manning, Tracy Perez, and Jeanne Mathews. A special thanks is extended to the many members of Maine's research and education community who contributed their time to the planning process. Maine EPSCoR is a program of the Maine Science and Technology Commission.

Table of Contents

| | Page |
|---|-------------|
| Maine ESPCoR Committee Membership and Staff | i |
| Table of Contents | ii |
| List of Appendices | iii |
| 1. Summary | 1 |
| 2. Background | 2 |
| 2.1 Science and Technology Plan for Maine | 2 |
| 2.2 Maine EPSCoR | 3 |
| 2.3 NSF Statewide Systemic Initiative (SSI) | 4 |
| 2.4 DOE Activities in Maine | 5 |
| 3. DOE EPSCoR Planning in Maine | 7 |
| 3.1 Goal and Objectives | 7 |
| 3.2 Planning Process | 7 |
| 4. Action Plan | 9 |
| 4.1 Overview | 9 |
| 4.2 Strengthening Educational Opportunities | 9 |
| 4.3 Individual Researchers | 11 |
| 4.4 Communication Networks | 11 |
| 4.5 Research Strengths Targeted for Support | 11 |
| 4.5.1 Energy and the Environment | 12 |
| 4.5.2 Energy Technology Research | 13 |
| 4.5.3 The Gulf of Maine and Its Watershed | 13 |
| 4.5.4 Human Genome | 14 |
| 4.5.5 Renewable Energy | 14 |
| 4.6 Continued Programmatic Development | 14 |
| 5. Support | 16 |
| Appendices | |

Appendices

- A. Organizational Charts and Maps
- B. EPSCoR Report One: Research Assets
- C. Federal Research Support for Maine
- D. DOE EPSCoR Planning Process: Datebook, Objectives, Participants.
- E. EPSCoR Report Two: The Development of Human Resources and Public Awareness
- F. EPSCoR Report Three: Descriptions of Targeted Research Areas
- G. Request for Proposals
- H. Researcher Inventory
- I. Maine Science and Technology Commission Documents
 - 1. Vision Statement
 - 2. Faculty Enhancement Program Solicitation
 - 3. Maine Research and Internships for Teachers and Students (MERITS) brochure
 - 4. Survey of Select R&D Strengths in Maine.
- J. Other Relevant Documents
 - 1. Common Core of Learning
 - 2. Maine Energy Education Project Needs Assessment, Commission on Comprehensive Energy Planning.

1. SUMMARY

Maine EPSCoR has developed a five year plan to further improve Maine's research and education capacity in the field of Energy. The initiatives of this Energy Education and Research Plan are integrated with other major science policy initiatives in the state, specifically the state's Science and Technology Strategic Plan (1992), the NSF Statewide Systemic Initiative (1992), and the Report of the Maine Commission on Comprehensive Energy Planning.

The plan was developed with the support of U.S. Department of Energy and State of Maine funds. The planning process was led by the Maine DOE EPSCoR planning committee of Maine EPSCoR. Researchers, educators, and business people assisted the committee in the development of the plan. This plan draws from priorities established by focus groups, the strengths and weaknesses revealed by the resource assessment, and the suggestions offered in the solicited research and education briefs.

The plan outlines strategies for the improvement of energy education, communication networks, support of individual research, and the formation of collaborative research groups in targeted areas. Five energy-related areas have been targeted for possible development of collaborative research groups: Energy Technology Research, Energy and the Environment, the Gulf of Maine and Its Watershed, the Human Genome, and Renewable Energy. The targeted areas are not boundaries limiting the extent of collaborations to be pursued but represent research themes through which the state's resources can be combined and improved.

Sources of support for the programs advocated by this plan include private and public institutions and federal agencies with an interest in science, education and energy. One source of funding for the plan is the Department of Energy's EPSCoR program which is expected to issue a solicitation in Fall 1992.

The strategies described in this plan will continue to develop as a result of new collaborations formed by the planning process. Maine EPSCoR, with input from the DOE EPSCoR Planning Committee, will continue to update this plan.

2. BACKGROUND

Throughout the United States changes are taking place in the relationship of science to society. Citizens, as well as policy makers, are increasingly aware of the critical role science plays in addressing the pressing issues facing our world, especially energy issues. There is a recognized need for improvement in science education that includes an expansion of science education beyond K-12 to all citizens, support of basic and applied science, and a reassessment of the relationship of research to education. In addition, increased transfer of research knowledge to American businesses is seen as critical to the nation's economic well being.

Maine is an active participant in this transformation. This change is evidenced by the creation of the Maine Science and Technology Commission in 1988, the development of the State's Science and Technology Strategic Plan, the NSF Statewide Systemic Initiative (SSI), and current EPSCoR programs. These initiatives provide leadership and direction for Maine's scientific community and will have a lasting impact on the science and engineering infrastructure of the state.

Maine DOE EPSCoR would expand these activities to further emphasize energy education and research. Maine's history and resources have brought the state a unique perspective on energy issues.

- o Citizens of Maine face a long winter and many have low incomes with which to purchase the energy to survive it.
- o Maine is at the end of the nation's natural gas pipeline and relies heavily on heating oil.
- o Maine is at the end of the nation's rail, highway, and air transportation corridors.
- o Maine's land cover is 98% forested, creating extraordinary interest and expertise in renewables.
- o Maine has 3,000 miles of coastline and, thus, both interest and expertise regarding energy wastes, global warming and the role of coastal ocean processes.

The State of Maine offers a laboratory for a variety of topics of critical interest to energy research, such as, coastal ocean processes and energy waste, renewable resources, heat efficiency in a cold climate, and transportation efficiency. There is also the opportunity to develop educational initiatives to strengthen scientific competency for all age groups and to train a skilled labor force for energy related activities.

2.1 Science and Technology Strategic Plan for Maine

The initiatives of this Energy Research and Education Plan are part of a larger state process of scientific and technological transformation. In response to a directive from the state legislature the Maine Science and Technology Commission has developed a statewide Science and Technology Strategic Plan, to be published in the fall of 1992. The plan was developed with the active participation of industry leaders, state university presidents and faculty members, laboratory

scientists, and state officials. The principals of Maine DOE EPSCoR participated in this planning process. The document outlines promising opportunities to meet Maine's most pressing needs. The Science and Technology Strategic Plan will shape research, education, and industrial priorities in the state for the next decade. Strategies of the plan are:

- 1. Target Areas of Economic Opportunity,**
- 2. Increase Business Access to Proven Technologies,**
- 3. Strengthen Maine's Capacity for Research and Innovation,**
- 4. Expand Access to Equity Capital for New Enterprise Development, and**
- 5. Improve Science and Technology Education and Job Training.**

Two of these strategies (#3 and #5) address the state's research and education infrastructure and are further developed in this Energy Education and Research Plan.

2.2 Maine EPSCoR

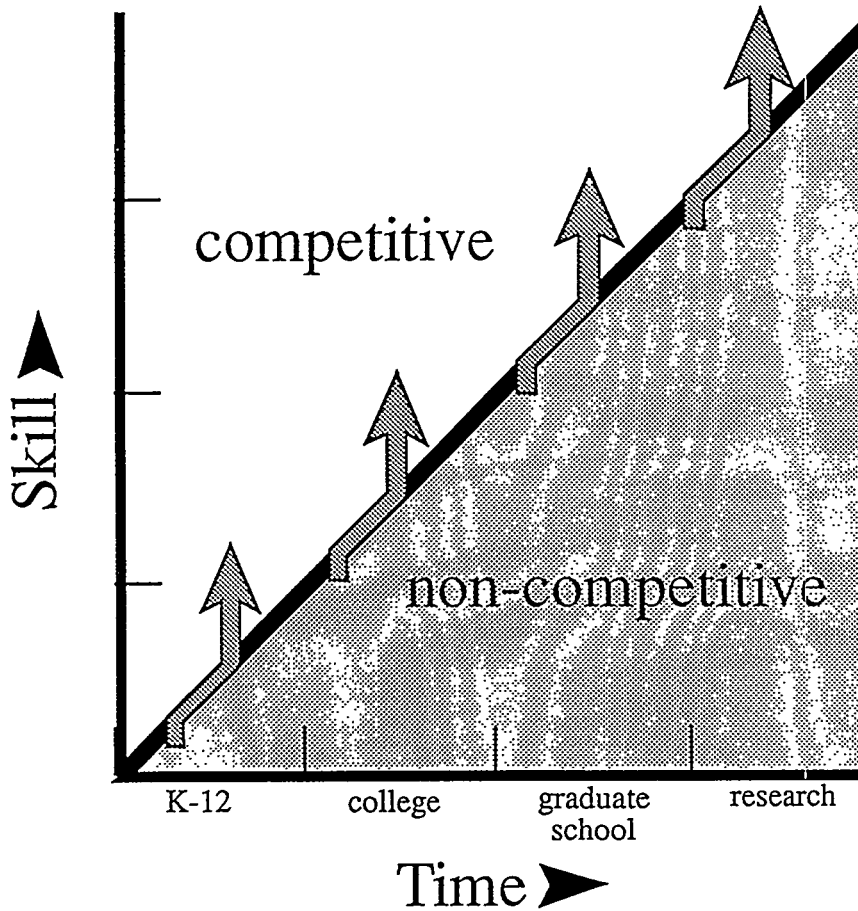
The Maine Experimental Program to Stimulate Competitive Research (Maine EPSCoR) is administered by the Maine Science and Technology Commission (MSTC), a state agency created with the mandate to enhance industrial innovation and research excellence in Maine. The Research Excellence Partnership (REP), in its advisory role to the MSTC, serves as the steering committee for Maine EPSCoR. (Organizational charts are presented in Appendix A.)

The mission of Maine EPSCoR is to provide leadership in strengthening science and engineering capacity in order to enrich the economic and intellectual vitality of the state. In pursuit of this mission Maine EPSCoR endeavors to:

- o Foster excellence in targeted science and engineering areas,
- o Strengthen science and engineering human resources,
- o Develop mutually beneficial relationships among private and public research, commercial, and educational activities, and
- o Increase public awareness and support for the goals, activities, and benefits of the research and education community.

Maine EPSCoR is a source of seed funding for the continued development of the state's research infrastructure. (A description of Maine's research infrastructure is presented in Appendix B.) With federal, state, and institutional funds, Maine EPSCoR is strengthening research efforts in the areas of global climate change, marine molecular biology, and wood sciences and engineering.

Maine EPSCoR, in conjunction with the National Aeronautics and Space Administration (NASA), also supports the Maine Space Grant Consortium. Comprised of educational institutions, research laboratories, state agencies, and businesses, the Consortium develops interrelated educational, research, and public service programs involving aerospace science and its applications. The Consortium is committed to improving science and engineering education, strengthening research capacity, promoting the transfer and sharing of aerospace capacity, developing a cross-institutional infrastructure, and helping Maine become nationally competitive in aerospace research and education.



Improving Competitiveness Through EPSCoR

In education and research, the gap between competitive and non-competitive is not always great. EPSCoR programs offer the non-competitive the opportunity to work with the competitive. By providing support at crucial junctures in career development, Maine EPSCoR enhances the quality of education and research in the state.

As described in sections 4.2 and 4.3, Maine EPSCoR has also supported individual researchers in a variety of fields and provided internships for high school and undergraduate students.

2.3 NSF Statewide Systemic Initiative

Maine is one of 22 states awarded 5-year, \$10 million NSF Statewide System Initiative (SSI) grants to improve mathematics and science education at the K-16 levels. Eight of the SSI states are also EPSCoR states.

Maine's SSI proposal, Maine: A Community of Discovery, is an initiative designed to fundamentally change educational opportunities, performance, and aspirations in mathematics and science for all Maine students. Vehicles for change include systemic planning and assessment programs, educational laboratories known as Beacon Schools and Colleges, community education programs, technical employment opportunities for secondary and college students, progressive institutes and workshops for teachers, increased use of communications technology, and direct participation of professional mathematicians and scientists in the educational process. Beacon Schools, unlike traditional magnet schools, serve as models for in-house and visiting teams of teachers, student teachers, mathematics and science facilitators, school administrators, policy-makers, parents, and community members.

The Maine Mathematics and Science Alliance serves as the policy making body for Maine's NSF Statewide Systemic Initiative. A non-profit organization, the Alliance was formed to carry out systemic change in mathematics and science education at the K-16 level. The Alliance membership, which includes the MSTC, Maine Department of Education, the Maine Coalition for Excellence in Education, the Maine Aspirations Foundation, and individual school administrators, teachers, business leaders, state policy makers, and professional mathematicians and scientists, represents a vital partnership in educational restructuring.

2.4 Department of Energy Activities in Maine

Department of Energy facilities, programs and personnel have contributed to the quality of energy education and research in Maine. Many individuals, businesses, and institutions in the state have been directly affected by Department of Energy research and education programs. The state is the beneficiary of DOE research grants to:

- o The UMaine Darling Center for Research for work concerning the role of coastal ocean processes in the carbon cycle.
- o The UMaine Industrial Process Control Sensor Systems Program for the development of sensors to monitor particle size distribution in industrial slurries.
- o The UMaine Laboratory for the Study of Surface Science Technology for the study of the adhesion of metals to ceramics.
- o The Jackson Laboratory for improved mutagen testing systems in mice.

Two Maine businesses have received major grants from the DOE: Hague International for research on a high pressure, coal-fired ceramic air heater for gas turbine applications and

Passamaquoddy Technologies for its innovative clean coal technology program. Grants have also been awarded to Brackett Research, Frank Hochmuth Company, and Pepin Associates for energy research. (A summary of federal support for research in Maine appears in Appendix C.) Through these DOE research activities, individual Maine researchers have developed professional ties to DOE laboratories, developed their own research, and improved education and research in the state in other ways.

DOE programs have also improved education in the state. Maine high school students have been selected for summer internship programs at Argonne National Laboratory, Brookhaven National Laboratory, Fermi National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, and Pacific Northwest National Laboratory. High school science teachers and college undergraduates have also benefitted by research opportunities offered at these laboratories.

DOE laboratories, programs, and facilities are fertile resources for Maine's researchers and educators. Although no DOE Laboratories are located in Maine, DOE involvement in the state has demonstrated a potential role of its programs and facilities in the development of the state's education and research infrastructure. The Department of Energy Experimental Program to Stimulate Competitive Research (DOE EPSCoR) offers Maine the opportunity to further develop these ties to DOE and improve the quality of education and research.

3. DOE EPSCoR Planning in Maine

3.1 Goal and Objectives

The goal of the Maine DOE EPSCoR Planning process is to improve energy education and research for the benefit of the state and the nation. In pursuit of this goal, Maine DOE EPSCoR seeks to reduce isolation, to provide continuity and a framework for creativity, to improve quality, and to promote sustainability.

The objectives of the Maine DOE EPSCoR planning process are to:

- o inventory existing research and research related assets,
- o identify a set of priority areas for energy research development,
- o develop strategies to enhance Maine's human resource base,
- o develop strategies for linking appropriate communities and institutions to enhance involvement and knowledge transfer, and
- o integrate Maine DOE EPSCoR strategies with other major science policy initiatives in the State.

3.2 Planning Process

The planning process, supported with funding from DOE EPSCoR and the State of Maine, was and will continue to be an opportunity to evaluate the state's energy research and education needs and opportunities. The products of the planning activities in the state are greater awareness of DOE educational and research opportunities, networks among researchers, and a general plan to improve energy education and research in Maine.

Acting in an advisory capacity to the Maine EPSCoR Program, the Maine DOE EPSCoR planning committee developed this strategy document. The committee was comprised of representatives from Maine's business, research, and education communities. (A roster of its participants and a datebook record of events is available in Appendix D.) At a series of monthly meetings, leaders of Maine's research and education community: (1) assessed the strengths and weaknesses of the state's scientific infrastructure (see Appendices B, E, F, and H); (2) established priorities for the State of Maine in energy education and research; and (3) developed a plan of action to improve energy education and research in Maine. One hundred and thirty (130) researchers, educators, and business people in energy-related fields assisted the committee in the development of this plan, an extraordinary level of participation for a state the size of Maine.

Focus groups at Maine DOE planning sessions and at the State EPSCoR meeting discussed the strengths and weaknesses of the state's education and research infrastructure in the field of energy. They brought expertise from their academic disciplines, knowledge of their business environments, experience in public education, and a commitment to Maine's competitiveness in

these areas. Special care was taken to secure the participation of individuals already associated with DOE education and research programs. Of the many ideas generated, the planning committee emphasized projects that would:

- o integrate existing resources in a new way to make the whole equal to more than the sum of its parts;
- o develop research and education assets to be competitive at the national level;
- o improve public awareness and understanding of energy issues;
- o increase the number and diversity of people in the state's human resource base skilled in energy areas; and
- o increase ties of Maine researchers, educators, and students to DOE laboratories, personnel and programs.

With these priorities as a guide, the planning committee solicited project briefs from researchers in university and private laboratories, educators from all levels, members of private research and education organizations, and representatives of industry research and development divisions. The nearly 100 briefs submitted focused on the development of the state's science education base, research needs of manufacturers, and promising areas of scholarly research.

The Maine DOE EPSCoR planning committee viewed these briefs in the context of the priorities stated above and created a plan for the development of energy education and research in Maine.

4. ACTION PLAN

4.1 Overview

To enhance Maine's capabilities in energy research and education, Maine DOE EPSCoR plans to seed fund promising collaborative and individual research, to provide educational opportunities for a variety of students, and to continue to develop innovative programs to meet on-going needs. The research areas described in this plan were selected for their importance to the State of Maine in terms of research excellence, potential for human resource development, and effective use of existing assets. All Maine DOE EPSCoR activities will include provisions for the recruitment and involvement of under-represented groups. Funding of research clusters and/or individual researchers would be based on an intensive merit review process contingent upon the availability of federal, state, and/or institutional funds.

4.2 Strengthening Educational Opportunities

Investment in science and technology serves the public good. One important aspect of public investment in science and technology is the development of the state's human resource base. (See Appendix E for detail.) Maine's plan, therefore, begins with strategies for the further development of our human resources, including: (1) public awareness and understanding of energy issues, (2) K-12 science education, (3) research experiences for students, and (4) diversity of Maine's human resource base in energy areas.

Scientific competency is a critical need for our country. Many frontiers in science are beyond the reach of students due to the lack of adequate materials and teacher training. Another part of this problem is the ever widening gap between the classroom and the research laboratory. Students perceive science to have little relevance to their daily lives. Consequently, interest in science diminishes as students matriculate.

Educational opportunities for undergraduate and graduate students in science and engineering in Maine's colleges and universities are also limited. The opportunities that do exist at these institutions need to be enhanced and publicized to attract students from within Maine and elsewhere. To overcome these educational barriers Maine DOE EPSCoR would:

- o enhance linkages between Maine DOE EPSCoR and SSI,
- o provide hands-on laboratory experiences for high school and undergraduate students, emphasizing the participation of DOE-funded researchers,
- o increase awareness of national DOE educational programs,
- o improve technical college curricula in energy studies,
- o support public energy education programs,
- o develop energy related scholarships for undergraduate students.

To strengthen research opportunities for Maine students and to further develop an educational foundation that is able to produce a well-trained, technical workforce to meet the needs of Maine's business community, Maine EPSCoR and the Maine Mathematics and Science Alliance, in its leadership capacity for SSI, established a new program in 1992 entitled Maine Research Internships for Teachers and Students (MERITS). This program places high school and undergraduate students interested in science and engineering in a laboratory or field research setting for the summer. (See brochure, Appendix I.) During this initial year, Maine EPSCoR placed undergraduates at five companies pursuing environmental-related research and development and eleven high school students in the labs of not-for-profit organizations.

Several avenues are now being considered for expanding this successful MERITS program. Support for teachers and/or teacher-student teams will be available in 1993, as will funding for a variety of research areas at the undergraduate level. Maine DOE EPSCoR would expand the number of students and teachers working in energy-related areas. Particular attention will be given to involving DOE-funded researchers.

While programs such as MERITS provide concentrated learning experiences for some Maine teachers and students, energy education for all K-12 students and the general public is also a concern of Maine DOE EPSCoR. Building on the established linkage with the Maine Mathematics and Science Alliance, Maine DOE EPSCoR would strengthen energy scientific literacy at the K-12 level through the SSI's laboratory or "Beacon" schools and other interested school districts. To achieve this, Maine DOE EPSCoR would support the employment of a facilitator to develop and introduce energy curricula statewide and to implement additional statewide programs.

The Maine DOE EPSCoR planning process has increased awareness of DOE educational programs such as the Pre-Freshman Enrichment Program (PREP), a program to increase interest and education in science among students grades 6 to 10, particularly those from groups under-represented in science careers. As a result, several non-profit organizations and educational institutions have expressed their intent to submit PREP proposals in October. These PREP proposals are one example of the increased awareness of DOE programs resulting from the Maine DOE EPSCoR planning process. The activities of Maine DOE EPSCoR will continue to offer an opportunity for Maine educators to learn about DOE programs.

To promote public understanding of energy issues, a competitive funding pool would be established to support innovative energy education programs. The ensuing grants, which would be administered by the Maine Mathematics and Science Alliance or another subcontracting not-for-profit organization, would be available to Maine civic and governmental organizations.

Once a level of scientific competency has been established, Maine must do more to encourage its high school graduates to pursue science and engineering, particularly in energy-related areas, at Maine's colleges and universities. The state's Science and Technology Strategic Plan recommends the establishment of "Maine Outstanding Scientist and Engineer Scholarships," at Maine colleges and universities. Maine DOE EPSCoR will work with other MSTC programs and the business and academic communities to develop this program which would tie academic pursuits with employment in research and development.

Maine's technical colleges also play a key role in public education, providing the training necessary for workers to participate in the nation's increasingly technology based economy. Maine DOE EPSCoR, the Kennebec Valley Technical College, and the Maine Department of Labor would explore the development of a pilot program to upgrade and expand technical college programs in energy related fields. This pilot program is expected to include such areas as nuclear materials handling, radiation effects, and hazardous materials response for emergency services.

By developing programs to strengthen educational opportunities at all levels, Maine DOE EPSCoR will increase the size and diversity of the state's labor force skilled in energy issues.

4.3 Individual Researchers

In the fall of 1989, Maine EPSCoR established the Maine Faculty Enhancement Program to increase Maine's pool of competitive researchers. Through this program, applicants may request up to \$7,500 to spend a summer at a host university, research institution, or business in or out of the State of Maine. (See brochure, Appendix I.) Working with nationally competitive researchers, including researchers at federal laboratories, the supported scientist or engineer strengthens his/her research capabilities and competitiveness. This experience would also be reflected in improved teaching at his or her home institution.

Various avenues for the expansion of this successful program are under evaluation. Additional needs to be met include: the expansion of eligibility criteria to include scientists at nonprofit research institutions, support for research during the academic year, and increased stipends that reflect the longer duration of research projects.

4.4 Communication Networks

Maine EPSCoR seeks to link the state's dispersed science, technical, and engineering communities and institutions. Each of the plan's proposed activities would increase ties among businesses, educators, and researchers. These programs would benefit from an effective communications network. There is also a need for a telecommunications system to connect the K-12 educational community with the post-secondary community and the state's research institutions. A variety of underutilized electronic communications systems now serve the state. Maine DOE EPSCoR will explore, with other organizations, the accessibility of these networks (e.g., MEDUSA, ITV) and training programs needed to increase participation, and thus, more effectively link these communities.

4.5 Research Strengths Targeted for Support

Collaborative research provides an opportunity to overcome many of the existing barriers to research excellence. Collaboration among researchers would: reduce isolation, improve communication between the academic and manufacturing spheres, enhance regional ties, and increase cooperation among science educators at all academic levels.

Maine EPSCoR targets research that could increase Maine's competitiveness for federal research dollars and contribute to the development of the state's science and engineering infrastructure. The gap between a competitive and non-competitive researcher is not always great. Providing appropriate support at crucial junctures in career development can span this distance and contribute

to research competitiveness. Collaborative research is designed to team competitive researchers with those not yet competitive and to extend the ties of researchers to resources outside their own institutions, thus improving science and engineering in the state.

Each target area would be strengthened by projects linked through common methodologies and conceptual approaches, as well as training programs for collaborators and graduate and/or undergraduate students. This collaborative research may also benefit from involvement of nationally competitive researchers, including DOE scientists, on a visiting or permanent basis.

Research topics identified as possible areas for collaboration are: Energy and the Environment, Energy Technology Research, the Gulf of Maine and Its Watershed, Human Genome, and Renewable Energy. (For detail, see Appendix F.) All of these research areas are expected to be key participants in educational and networking activities of the state. For example, research groups might participate in energy colloquia such as those sponsored by the Margaret Chase Smith and Edmund Muskie policy institutes.

These research areas offer Maine a means to take advantage of opportunities for research and education offered through the DOE laboratory system. Closer relationships with these national laboratories will bring needed expertise and knowledge of DOE priorities and interests. These collaborative relationships will improve the competitiveness of Maine researchers.

The descriptions presented here are confined to their appropriateness for scientific advancement, DOE's mission, and Maine's needs. These targeted research areas are presented in alphabetical order. The descriptions are not boundaries limiting the extent of research collaborations to be pursued, but rather are research themes through which the state's resources can be combined and improved. For this reason, the research topics listed within each collaborative research theme are not an exhaustive list of all possibilities, and participation is not restricted to institutions referenced by name in the descriptions.

4.5.1 Energy and the Environment

Global warming, the depletion of fossil fuels, and nuclear waste disposal are just a few examples of the many issues that have raised public concern regarding the impacts of energy consumption on the environment. The relationship between the two must be considered in the development of both new technologies and public policies.

This research area is interdisciplinary in nature, addressing issues of scientific research, technology management, and policy formation. Research topics examining the relationship between energy choices and environmental outcomes are many. Maine's researchers and their institutions have interest and expertise in topics as varied as alternative energy resources, environmental monitoring (e.g. biosensors), transportation, pollution reduction, the methane cycle, coastal marine and terrestrial systems, and bioremediation. Technology management questions for possible consideration include technological proficiency for industrial managers, the analysis of energy choices and environmental outcomes, and managing the financial consequences of those choices. Public policy studies is a contributor to this interdisciplinary research, as it provides an arena for communication among technical specialists, industry representatives, environmental groups, lawmakers, and administrators.

Maine has long been a leader in the fields of energy conservation, development of renewable fuel resources, and environmental protection. The increased understanding of the environmental consequences of energy technology and the ensuing development of new technological applications resulting from this interdisciplinary research would allow for the development of environmentally-based industries. The collaborations fostered by this research group provide the opportunity to move beyond industry versus environment conflict by working toward the development of environmentally responsible industries.

4.5.2 Energy Technology Research

Concern for energy issues has stimulated research in combustion technology, industrial processes, and materials science. Several public and private research groups have expertise in these energy related areas, as well as ties to DOE. These include: Hague International, the University of Maine's Industrial Process Control Sensor System (IPCoSS) and Laboratory for Surface Science Technology (LASST), and Passamaquoddy Technologies.

Collaborative multidisciplinary research in energy technology would serve as a conduit between these industrial and academic researchers, building upon existing research strengths. Topics for consideration include: high performance paper coatings, steel and wooden structures, advanced polymer processing, composite materials, polymer coatings, energy systems management, sensor technology, and electronic device fabrication.

Beyond improving competitiveness for federal research funding, energy technology research has the potential to benefit Maine's science and engineering infrastructure, manufacturing economy and consuming public.

4.5.3 The Gulf of Maine and Its Watershed

The Gulf of Maine is one of the largest continental shelf seas in the Atlantic, covering an area of approximately 36,000 square miles. On the corner of America's industrial northeast, the Gulf of Maine and its watershed is an active site for energy research. Research on the role of continental margins in global carbon flux is central to DOE's growing Ocean Margins Program. Seven rivers in the Gulf of Maine Watershed are among the most heavily used natural resources in Maine, being used for waste disposal, power generation, transportation, and water supply. The natural resources and intellectual expertise associated with the Gulf of Maine and Its Watershed would contribute to energy research through a collaborative effort.

This research effort would emphasize the development of working relationships between researchers in Maine and those involved in such federal programs as Los Alamos-National Flow Cytometry and Sorting Research Resources, the National Institute for Global Environmental Change, and Brookhaven and Lawrence Livermore National Laboratories. Further research, focusing on such issues as the transport and impact of energy-related pollutants through coastal marine and terrestrial systems, flow cytometry, and ultra-violet radiation would build on current strengths at Bigelow Laboratory for Ocean Sciences, the Mount Desert Island Biological Laboratory, and the University of Maine (Center for Marine Studies, the Darling Center for Research, and faculty from various departments with expertise in estuarine and watershed research).

4.5.4 Human Genome

Genetic research has applications in a variety of fields, such as medicine, agriculture, agronomy, and ecology. Maine is home to many recognized research facilities working on this topic, including: Bigelow Laboratory, Jackson Laboratory, Maine Medical Center Research Institute, the Foundation for Blood Research, Mount Desert Island Biological Laboratory, Eastern Maine Medical Center, the University of Maine and several influential biotechnology industries.

A cooperative approach would unite Maine's researchers to address two relevant areas. First, research collaborations would focus on mouse models for human genetic diseases and the sharing of genetic information that applies to work in physical gene mapping as a basis for the study of mutational events and environmental factors in disease. Second, improving public awareness and understanding of genetic research would provide a sound foundation for public policy decisions resulting from human genome research.

By bringing together Maine's exceptional research resources to work on the effects of radiation on human health, Maine could take advantage of the resources of DOE laboratories in the field of human genetics.

4.5.5 Renewable Energy

Maine has ample supplies of biomass energy resources derived from wood. Wood has been an important source of energy in the past and continues to be a significant part of the State's energy mix. Since 1980 the use of wood for energy has increased almost 150 percent in Maine, despite a decline in wood use in the residential sector. This increase is the result of growth in the use of wood to generate electricity in both cogeneration and stand alone plants. This trend reflects Maine's long experience utilizing indigenous renewable resources to supply power industries, businesses, and homes in Maine. Possible areas for study in biomass include the generation of power, bioconversion of wood to fuels such as ethanol, and biomass energy efficiency.

Another renewable energy resource that could receive the attention of cooperative research is geothermal energy. Global climate studies have raised concerns over the greenhouse gases released through the burning of fossil fuels. The hot dry rocks project at Los Alamos National Laboratory is beginning to demonstrate the feasibility of geothermal resources as an energy alternative. It would be sensible to conduct the groundwork necessary to evaluate geothermal resources in Maine, a state with high dependence on fossil fuels for heating and electricity generation.

A cross-disciplinary study of these areas would bring together many diverse academic and industrial interests to address an issue of great concern to Maine's citizens.

4.6 Continued Programmatic Development

It is highly unlikely that any one program within Maine EPSCoR would ever be able to sufficiently fund all of the potentially competitive research of benefit to Maine's infrastructure. Nor is it likely that all researchers need funding from EPSCoR; researchers could need assistance in other critical

areas. Therefore, Maine DOE EPSCoR, along with the other Maine EPSCoR programs, will undertake a planning process to develop a mechanism for assisting researchers who are not Maine EPSCoR recipients. This may entail small technical assistance grants, assistance with the formation of research clusters, proposal writing support, or other activities, as needed.

Currently underway is a one-year planning process whose purpose is to increase the involvement of women, minorities, and other under represented groups in science and engineering. The planning process is taking place at the state level with representatives from the state's various educational and scientific organizations participating. Maine DOE EPSCoR will continue to be active in this process and will integrate its recommendations into all Maine EPSCoR activities.

5. SUPPORT

Sources of support for the programs advocated by this plan include: the Department of Energy, the Departments of Defense, Education, Transportation, and Agriculture, the Environmental Protection Agency, other federal agencies, the State and private institutions. Maine EPSCoR and the Research Excellence Partnership are committed to the continued pursuit of funds to implement this plan and other related initiatives.

One source of funding for the Energy Education and Research Plan presented here is the Department of Energy's EPSCoR program which is expected to issue a solicitation this Fall. According to the federal DOE EPSCoR Program, the agency will fund up to four states at a maximum level of \$1 million per state for collaborative research and education initiatives. Non-federal 1:1 match will be required. DOE EPSCoR will make awards on an annual basis without any commitment for funding beyond 12 months. However, a continued commitment to grant recipients, up to five years, is anticipated.

The REP will recommend to the Maine Science and Technology Commission the submission of a proposal to the Department of Energy EPSCoR requesting \$1 million a year for five years. The proposal will request support for collaborative research, individual research, communications networking, and educational initiatives described in this plan.

Proposals will be solicited in October for each of the research areas with a maximum award size of \$400,000 per year and three years duration. Only a portion of the \$400,000 cost would come from DOE; state and institutional contributions would be necessary. The REP expects two of these collaborative research proposals to be successful in the peer review process and be selected for inclusion in the state's DOE EPSCoR proposal.