The Experimental Program to Stimulate Competitive Research

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THE EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH

Committee to Evaluate the Experimental Program to Stimulate Competitive Research (EPSCoR) and Similar Federal Agency Programs

Committee on Science, Engineering, and Public Policy

Policy and Global Affairs

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Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Academies' Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the process.

We wish to thank the following individuals for their review of this report:

Wendy Baldwin, Population Reference Bureau; Robert Barnhill, Society for Advancement of Chicanos and Native Americans in Science; William Brinkman, Princeton University; Frank Calzonetti, University of Toledo; Steve Kelley, University of Minnesota; Jorge José, Indiana University; W. Henry Lambright, Syracuse University; Sally Mason, University of Iowa; Kathie Olsen, Science Works; Thomas Peterson, University of California; Juan Rogers, Georgia Institute of Technology; Gary Strobel, Montana State University; James Turner, Association of Public and Land-Grant Universities; and Yonghong Wu, University of Illinois.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Georgine Pion, Vanderbilt University and Louis Lanzerotti, New Jersey Institute of Technology. Appointed by the National Academies, they were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Preface

"The [NSF] Director shall contract with the National Academy of Sciences to conduct a study on all Federal agencies that administer an Experimental Program to Stimulate Competitive Research or a program similar to the Experimental Program to Stimulate Competitive Research."

America COMPETES Reauthorization Act of 2010 *(111th Congress, 2009–2010, April 22, 2010), http://www.govtrack.us/congress/bills/111/hr5116.*

In examining the Experimental Program to Stimulate Competitive Research (EPSCoR) mission, the committee explored both the program's original justification and its evolution and expansion since 1979. Special attention was given to the assertion that EPSCoR has increasingly expanded its original mandate (building research capacity required to compete for federal research and development funds) to encompass activities designed to bolster science education, workforce diversity, and economic development.

To better understand current program operations, the committee examined EPSCoR's structure at both the agency and state levels. Beyond collecting information on individual agency policies, the committee invited 10 representatives from the states to brief the committee in person and requested information from all the states.

The committee conducted four meetings. The first was devoted to testimony from the directors of all the federal agency EPSCoR programs and the second to testimony from representatives of 10 state EPSCoR programs. The third examined assessment methodologies and featured presentations by two experts in evaluation who have done work on the EPSCoR programs. The fourth focused on the committee's findings and recommendations.

In reviewing program impacts, the committee examined the extent to which EPSCoR has affected the success rate of institutions in attracting research funds, has strengthened the research infrastructure of participating states, and has improved the prospects for sustaining gains in research capacity. In those cases where identifying either appropriate metrics or relevant data proved challenging, the committee attempted to comment on EPSCoR's impact based on the available information.

A detailed evaluation of every agency program in every state was far beyond the scope of what the committee could accomplish. Therefore, it focused on assessing the fundamental mission of the programs and the appropriateness of the approaches being taken to fulfill this mission.

The report concludes with findings and recommendations that the committee hopes will offer insights and directions on how EPSCoR programs can be strengthened and improved as part of a larger effort to enhance the nation's overall research enterprise.

Contents

Summary

Science and engineering talent can be found among young people in every state,[1] and the long-term health of the U.S. research enterprise depends on providing opportunities for these young people to develop their talents no matter where they may live or attend college. Participation in research is an essential component in science and engineering education.

Consequently, students in all parts of the country must have the chance to participate in high-quality research, and it is in the national interest that federal funding be provided to universities in every state to ensure that these research opportunities are available. The committee asserts that the nation needs a robust supply of researchers to keep expanding the frontiers of knowledge, and all states need citizens capable of understanding and applying new developments in science and engineering to their work, whether in industry, health care, education, environmental protection, or other fields of endeavor critical to the nation's well-being.

The primary federal programs designed to ensure that all states are capable of participating in the nation's research enterprise fall under the general rubric of the Experimental Program to Stimulate Competitive Research (EPSCoR). The National Science Foundation (NSF), Department of Energy (DOE), Department of Agriculture (USDA), and National Aeronautics and Space Administration (NASA) have active EPSCoR programs. The National Institutes of Health (NIH) have a related program called Institutional Development Awards (IDeA).

In addition to pursuing the original mission of enabling universities in every state to be able to compete for federal research funding, EPSCoR programs have over the years added other goals, such as enhancing innovation to stimulate economic development and entrepreneurship and expanding the diversity of the science and engineering workforce. The broadening of the EPSCoR mission has increased the difficulty of assessing the program's effectiveness.

Sizable differences in population, geography, history, and culture present daunting challenges to any effort to attain uniform results nationwide.

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[1] In this context, "state" refers to the 50 states of the United States, as well as its territories. See Box 1-2: Notes on Terminology for more information.

The addition of broader social goals to the EPSCoR mission—as compelling and justified as these broader social goals may be—dilutes the program's ability to advance its primary goal of strengthening research capability and providing research opportunities for postsecondary students.

The breadth and increasing complexity of the EPSCoR program objectives have made it difficult to develop a rigorous assessment system with quantitative metrics to evaluate short-term and, more important, long-term progress. In addition, neither Congress nor the agencies have required this type of assessment, so there has been little incentive to do so.

Nevertheless, there is evidence that the EPSCoR programs have provided significant benefits to participating states—and thus to the nation. Under the America COMPETES Reauthorization Act of 2010,[2] Congress requested that the National Academy of Sciences examine EPSCoR with funding from NSF. The committee's charge was to assess the effectiveness of NSF's EPSCoR program and similar programs administered by other the federal agencies, including the extent to which these programs achieved their respective goals and states used these awards to improve their science and engineering research, education, and infrastructure.[3]

For at least two reasons, the committee could not assess the effectiveness of EPSCoR with the necessary rigor needed to fully address Congress's charge. First, the overall mission of EPSCoR and its counterparts has broadened over time and to varying degrees, depending on the respective federal agency. In addition to the changes in the overall environment for conducting research, this may have affected the program's overall progress in achieving its goals. Second, data of sufficient quality on program operations and expected outcomes are not currently available and would have required more time and resources to collect than were at the Committee's disposal.

Therefore, the committee focused on better understanding the extent to which the overall structure and policies have affected the program's ability to achieve its overall mission and major goals.

The first EPSCoR program began more than three decades ago at the National Science Foundation, which is mandated in its founding legislation not only to promote national excellence in science but also to avoid its "undue concentration." When several members of Congress complained that a small number of states were receiving a disproportionate share of NSF research funding, the agency responded by creating its EPSCoR program. It began in 1979 by distributing $1 million among five states with demonstrated subcompetitive ability to attract National Science Foundation research and development (R&D) funds to help them develop strategies to enhance their research competitiveness. NSF subsequently provided support to implement

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[2] America COMPETES Reauthorization Act of 2010 *(111th Congress, 2009–2010, April 22, 2010), http://www.govtrack.us/congress/bills/111/hr5116.*

[3] The complete statement of task and congressional mandate can be found in Appendix C.

these strategies for 5 years. The expectation was that when the funding came to an end, these states would be capable of competing successfully for research funding from NSF's general merit-based grant pool. Instead, those states are still receiving EPSCoR funds, and the program has expanded to include many more states.

NSF EPSCoR's annual budget now stands at roughly $150 million, and eligibility for the program has spread across 32 jurisdictions, including 29 states and 3 territories (Puerto Rico, Guam, and the Virgin Islands). In addition, NIH, DOE, USDA, and NASA together provide approximately $325 million in funding per year. The NIH and USDA have different eligibility criteria, and a slightly different group of states participate in these programs. The Department of Defense (DOD) and the Environmental Protection Agency (EPA) also operated programs for several years, but these agencies have terminated funding.

In retrospect, the initial NSF EPSCoR goal seems politically astute but unrealistic. Several million dollars of funding and 5 years of effort were clearly not going to transform a state's research capacity or make it competitive with other states that had invested and/or received tens of millions of dollars over decades to build their research capacities. Indeed, EPSCoR has been in operation for more than 30 years and, over this period, the program has invested several billion dollars in capacity-building activities, yet the same 10 states that received the highest level of research funding in 1977 still top the list. Moreover, more than half of all states now receive EPSCoR funds, and no state that has participated in the program has permanently "graduated" from it. Analysis also shows EPSCoR-eligible states received roughly the same percentage of total federal research funding in 2012 that they had received in 1979 (see Figure S-1).

EPSCoR programs and EPSCoR states have devoted considerable time and resources to building research capacity. Yet, the states that have been the nation's traditional leaders have also invested in their research capacity—deriving considerable funds from both public and private sources. As a result, historically successful states continue to do well in competing for research support. It should also be noted, however, that the EPSCoR states have not lost ground, and it is clear that virtually all have improved their research capacity in absolute, if not relative, terms. Nevertheless, because EPSCoR funding constitutes a relatively small percentage of each EPSCoR state's total research funding, the precise role that the programs have played in this effort is difficult to determine.

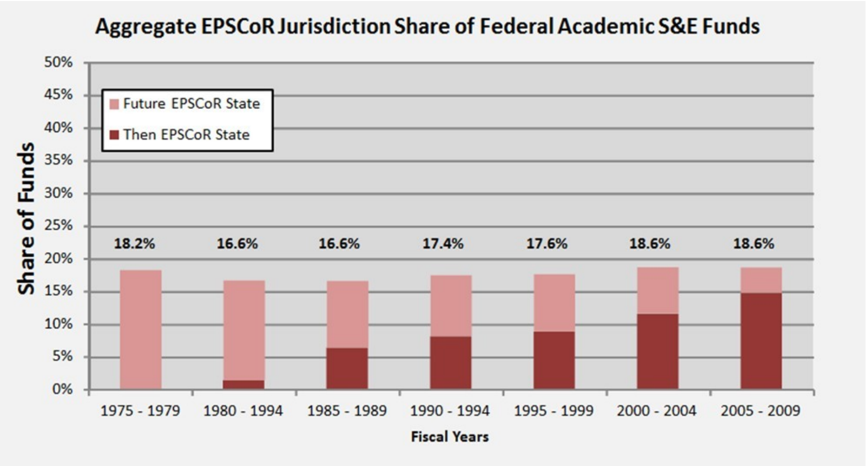

Figure S-1. The share of federal academic science and engineering funds received by EPSCoR states has remained largely the same since the inception of the EPSCoR program. [SOURCE: NSF Survey of Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions via WebCASPAR].

The reason for the growth in the number of participating states is that the criterion for eligibility has been relaxed over time. NSF EPSCoR permits any state that receives less than a set percentage of NSF funding to be eligible for the program, and that percentage has been increased over time. All the other agencies except NIH and USDA closely follow the NSF lead. NIH initially admitted states where the success rate of research proposals was less than 20 percent, but it is now proposing a shift to a system that would admit all states that fall below the median in total NIH research funding. When total funding is the criterion for eligibility, state population becomes the dominant factor in determining a state's eligibility. NSF admits any state that receives less than 0.75 percent of its funding. Sixteen states have less than 0.75 percent of the U.S. population. To lose their eligibility and graduate from the program, each of these states would have to receive a percentage of research funding that exceeds its share of the nation's population. Indeed, several states have less than 0.25 percent of the nation's total population, and it will be virtually impossible for these states to ever reach 0.75 percent of total funding.

If one is aiming for equity among all the states, it might therefore make more sense to look at per capita federal research spending in each state. Indeed, the ranking of states by per capita funding differs significantly from the ranking by total funding, and several current EPSCoR states appear in the top 10 on this list. Although the committee is not recommending that per capita research funding be the sole criterion, it does believe that per capita funding should be a primary consideration.

The committee also believes that a state's commitment to research—expressed in visible and concrete terms—should be one of the main criteria for competitive federal support. Unless a state invests its own energy and resources in improving its research capacity, the federal commitment will not have the desired effect of creating an enduring foundation for excellence. As a result, the committee recommends that all EPSCoR funding should require some level of state matching funds and that the level of state commitment should be a key criterion in awarding competitive grants.

All decisions about where to invest research resources are difficult, and all involve trade-offs. For the EPSCoR programs, the worry is that the agencies are compromising their commitment to merit review of research proposals. But the trade-off is relatively modest. Less than $500 million in a total federal academic research budget of more than $30 billion is devoted to EPSCoR. Determining its absolute value, however, is inherently difficult. The committee learned of many individuals from EPSCoR states who have produced important research results and many institutions in those states that have graduated successful scientists and engineers.

The committee also found that there has not been a rigorous quantitative assessment of the EPSCoR programs that would document their value. The assessment that will have to be done should include: (1) identifying the data needed to address the important questions posed by Congress; (2) selecting and executing an appropriate evaluation design; and (3) collecting, analyzing, and interpreting the necessary data. Judgments could then be made regarding the extent to which EPSCoR was efficiently implemented, how well it achieved its stated goals, and its overall effectiveness in advancing the ultimate mission of enhancing and broadening research capacity. Such a study could in no way have been accomplished within the timeline and resources available to the committee.

With these caveats and restrictions in mind, the committee has arrived at the following findings and recommendations.

FINDINGS AND RECOMMENDATIONS

The committee supports the continuation of programs that support the proposition stated in the America COMPETES Act:

"The Nation requires the talent, expertise, and research capabilities of all States in order to prepare sufficient numbers of scientists and engineers, remain globally competitive and support economic development."

America COMPETES Reauthorization Act of 2010 *(111th Congress, 2009–2010, April 22, 2010), http://www.govtrack.us/congress/bills/111/hr5116.*

Findings

- **The talent necessary to succeed in science and engineering resides in all states.** Thus, it is in the national interest for the federal government to support efforts to develop and utilize this talent to enhance national research capacity.

- **EPSCoR programs are a part of a broader national and global research enterprise.**
- **Congressional changes in state eligibility requirements and congressional mandates to agencies to create EPSCoR-like programs have resulted in multiple and often competing objectives and policy directives by participating agencies**.
    - Current eligibility criteria have led to more than half the states being included, blurring the programs' objectives and reducing the likelihood of their success.
    - Patterns of eligibility do not align well with other indicators of capacity, such as state population or number of research-intensive universities. As a result, outcomes are difficult to assess, especially on a comparative basis.
- **EPSCoR programs have enhanced the nation's human capital** by strengthening research infrastructure and by training many future scientists and engineers in states where, in some cases, training opportunities had been scarce and largely inadequate prior to the program's arrival.
- **There is some evidence that the EPSCoR programs have not been a good fit for the mission agencies**. For example, EPA and DOD terminated their EPSCoR programs. However, the mission agencies are the major source of engineering research funding and therefore critical to engineering education.
- **State-level commitments to enhancing research capacity are uneven** across the participating states. The effectiveness of state committees in NSF EPSCoR states is also uneven.
- **There is considerable variation** in agency programs, review processes, and the role and composition of state committees. Further, the NIH IDeA program does not formally involve the state committee in its implementation, although informal interactions do occur.
- **The aggregate share of federal R&D to eligible states has not changed significantly** over the course of the program. There is also considerable variation among states in their progress toward a more competitive posture. In the aggregate, eligible states continue to be less successful in garnering NSF funding than are other states.
- **Nearly all participating states report positive cultural change** in attitudes toward science and engineering as a consequence, at least in part, of EPSCoR programs. Similarly, they also report positive organizational, policy, and program changes that have enhanced their research environment. Further, there is evidence that research capacity in eligible states has increased (although not enough in most cases to change their relative standings). There is anecdotal evidence that EPSCoR programs

have contributed to this result, but the magnitude of their contribution is difficult to determine.

- **The evaluation efforts of the EPSCoR-type programs leave much to be desired**. To date, such efforts have relied on incomplete and inconsistent assessment of program designs and on metrics that do not allow for comparisons of effectiveness.

Recommendations

The committee recommends that the federal government continue to promote the development of research capacity in every state so that all citizens across the nation have the opportunity to acquire the postsecondary education, skills, and experience they need to pursue productive and successful careers in science, technology, engineering, and mathematics (STEM) fields and to contribute fully to the nation's research enterprise.

With that in mind, the committee recommends the following actions to create a more focused program with greater impact.

- **EPSCoR programs should concentrate on the programs' core elements**:
    - To enhance research excellence through competitive processes.
    - To enhance capacity for postsecondary training in STEM fields.

- **EPSCoR programs should be restructured to combine beneficial aspects of current programs**:
    - The NIH and NSF EPSCoR programs should pursue a "blended" funding strategy with two tracks:
        - A competitive-grant track that provides fewer and larger grants that are evaluated first for scientific merit and that are intended to produce focal points of research excellence and research opportunities for junior as well as senior faculty.
        - A smaller-scale, infrastructure investment or statewide investment track that works with state committees to ensure that every state has the capacity to provide advanced education and research experience.

    - DOE, NASA, and USDA should develop strategies to help meet the mandate laid out in the America COMPETES Act that all mission agencies support postsecondary education in STEM disciplines.

- **The EPSCoR programs, working through the EPSCoR Interagency Coordinating Committee (EICC), should develop and enforce a realistic framework for state eligibility and graduation from the program**:

- The 0.75 percent criterion fails to account for population and other critical aspects of research capacity and competitiveness. New graduation and eligibility criteria should be developed and implemented that could consider:
  - Population.
  - State commitment.
  - Proposal success rates per research-university faculty member.
  - Total research funding.
  - Progress to date and future opportunities for progress.
  - Financial need.

- **The committee recommends that the agencies, cooperating through the EICC, reset the guidelines and that all states must reapply for eligibility after the expiration of their current EPSCoR grants.**

- **The proposal review for prospective EPSCoR projects should be made more rigorous to:**
  - Ensure that reviews of the scientific merit of the proposals are conducted by the most highly qualified panels of experts in the field of study. Scientific merit should be the first consideration in any assessment of a proposal's strength and value. Specifically, all proposals should be reviewed in a two-step, sequential process.
    - First, a review of the proposal's scientific merit—a "science score."
    - Second, a review of the proposal's potential (state, agency, societal) impacts—a "program score."
  - Require some level of matching contribution for all research awards to ensure that the state is involved and committed to the project.
    - Sources dedicated as matching funds can be from the state, the university, the private sector, or other sources.

- **The evaluation process conducted during and after an EPSCoR project's implementation should be made more rigorous by:**
  - Developing and implementing an effective third-party evaluation design that is reliable and valid and that is consistent with other federal evaluation approaches, such as those developed by the Office of Management and Budget.

In conclusion, the committee recommends that the newly refocused federal programs be renamed to better reflect their mission and to remove "experimental," which is now a misnomer.

1
Mission, Evolution, and Context

"…it shall be an objective of the Foundation to strengthen science and engineering research potential and education at all levels throughout the United States and avoid undue concentration of such research and education, respectively…"

National Science Foundation (NSF) Act of 1950 *(Pub. L. 507-81st Congress, as amended)*

"It would be clearly understood from the beginning that no support would be provided beyond five years through this [EPSCoR] program, as scientists in the funded states should then be able to compete more successfully for support from NSF and other agencies."

Richard C. Atkinson, Director, National Science Foundation, Memorandum to Members of the Science Board, Subject: Program Plan for Experimental Program to Stimulate Competitive Research, January 4, 1978

Under the America COMPETES Reauthorization Act of 2010,[4] Congress mandated that the U.S. National Academy of Sciences (NAS), with funding from the National Science Foundation (NSF), examine the Experimental Program to Stimulate Competitive Research (EPSCoR). The charge—as defined by Congress and NSF—required NAS to assess the effectiveness of EPSCoR and similar federal agency programs, such as the Institutional Development Awards (IDeA) at the National Institutes of Health (NIH), in improving national research capabilities, promoting an equitable distribution of research funding,

[4] America COMPETES Reauthorization Act of 2010 *(111th Congress, 2009–2010, April 22, 2010), http://www.govtrack.us/congress/bills/111/hr5116.*

and integrating their efforts with other initiatives designed to strengthen the nation's research capacity (see Box 1-1).[5]

Box 1-1
Charge in Brief

The America COMPETES Reauthorization Act of 2010 requests that the U.S. National Academy of Sciences pursue the following information concerning the EPSCoR program:

- Delineation of the policies of each federal agency with respect to the awarding of grants to EPSCoR states.
- Effectiveness of each program toward achieving its respective goals.
- Recommendations for improvements for each agency to achieve EPSCoR goals.
- Assessment of the effectiveness of EPSCoR states in using awards to develop science and engineering research and education, as well as science and engineering infrastructure within their states.
- Any other issues that address the effectiveness of EPSCoR as NAS considers appropriate.

SOURCE: America COMPETES Reauthorization Act of 2010 (111th Congress, 2009–2010, April 22, 2010), *http://www.govtrack.us/congress/bills/111/hr5116.*

In response, the NAS formed a committee to evaluate the EPSCoR program, which is in fact a group of quite different programs operating in several federal agencies and serving more than thirty states and other jurisdictions. Given the complexity of the program, the first task of the committee was to determine what it could expect to accomplish with the available time and resources.

To comply with the 2010 America COMPETES Reauthorization Act and ensure that a full understanding of the programs was available to the committee from the beginning, the committee held its first meeting once all the agencies completed a congressionally mandated summary of its program and then devoted that meeting to hearing presentations from the directors of all of the active programs. Learning of the diversity of the programs, their evolution over time, and the lack of consensus surrounding eligibility and graduation convinced the committee that it would have to begin by examining the fundamental mission and structure of the program.

A review of the scholarly literature about EPSCoR revealed a lack of comprehensive data collection and rigorous evaluation. The committee realized

[5] The complete statement of task and congressional mandate can be found in Appendix C.

that it would not be possible to conduct a review and summary of existing evaluations because there simply is not an adequate research base to review.[6] While recognizing the desirability of having a detailed assessment of state-level activities, the committee decided that such an assessment was far beyond what it could hope to accomplish. However, the committee identified a number of key areas that could benefit from better data and more thorough evaluation.

1. Distribution of EPSCoR funds by objective. Testimony from some EPSCoR participants raised a concern about the program expanding its mission beyond building research capacity and thus diluting its effectiveness. (Financial data on the allocation of EPSCoR funds for various purposes within each state is necessary to address these issues.
2. Distribution of EPSCoR funds by institution within each state. The Committee was unable to obtain financial data on the distribution of EPSCoR funds among institutions within each state, or changes in these patterns over time. These data are needed to determine if the program has been "captured" by one or two institutions within a state, or conversely if funding was spread thinly across all institutions rather than focused on the most successful programs.
3. Research competitiveness performance of EPSCoR recipients. The single major test of the impact of the EPSCoR program on research competitiveness is the longitudinal performance of the individual faculty or clusters of faculty who receive EPSCoR support. The Committee saw little evidence that such data were systematically collected and therefore could not determine how effective the program was in enhancing the research capacity of specific individuals or teams.
4. Disaggregated data by state and institution. The only data available to the committee were state level and institutional totals. As noted repeatedly in the report, these data cannot be used to assess the impact of EPSCoR programs on the recipients and subsequently on the overall research capacity of the state.

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[6] The evaluation literature relevant to this report is:

- COSMOS Corporation, A Report on the Evaluation of the National Science Foundation Experimental Program to Stimulate Competitive Research (Arlington, VA: NFS, 1999).
- J. Scott Hauger and Celia McEnaney, eds., Strategies for Competitiveness in Academic Research (Washington, DC: AAAS, *http://www.aaas.org/spp/rcp/policy/strategies_book.shtml, 2000*).
- Julia Melkers and Yonghong Wu. 2009. "Evaluating the Improved Research Capacity of EPSCoR States: R&D Funding and Collaborative Networks in the NSF EPSCoR Program," Review of Policy Research 26(6), 761-782.
- Yonghong Wu, "Tackling Undue Concentration of Federal Research Funding: An Empirical Assessment on NSF's Experimental Program to Stimulate Competitive Research (EPSCoR)," Research Policy 39(6), 835-841. (2010).
- Abigal Payne, "Earmarks and EPSCoR: Shaping the Distribution, Quality, and Quantity of University Research", in Shaping Science and Technology Policy, edited by David Guston and Daniel Sarewitz (Madison,WI: University of Wisconsin Press),149-172 (2006).

5. Comparative variations across states. All states were able to provide anecdotal evidence of some benefit from the program, but there is a need to develop some comparative outcome measures to determine which state or agency approaches are most effective so that these best practices can be shared to enhance overall program effectiveness.

To learn what it could about state activities, the committee invited EPSCoR officials from ten states to brief the committee during its second meeting. States were selected to represent large and small states, physical sciences and biomedical sciences, long-term and more recent participants, and different regions of the country. The committee also consulted printed and online information about other states and information from the EPSCoR/IDeA Foundation – a non-profit set up to promote the science and technology research enterprises of EPSCoR and IDeA eligible states. All of the states provided interesting information about how they used funds from the various EPSCoR programs and anecdotal evidence of success, but they did not have readily available the type and amount of standardized quantitative data that would make it possible to evaluate and compare the effectiveness of state efforts.

Given the ambiguity over common factors such as eligibility and mission between agencies and the scarcity of rigorous data and scholarly assessment literature, the committee decided early in its deliberations that it would focus on evaluating core concerns. It addressed fundamental questions about what the program could realistically hope to achieve, how it aligned with the larger national goals of nurturing and enhancing research capacity, and the criteria for eligibility. Reaching understanding and agreement on these underlying questions is a prerequisite for developing a coherent program with achievable goals that could be rigorously evaluated and improved. The committee recognizes the need for evidence-based assessment of federal agency program design and management and of state implementation and believes that such assessments can be rigorously conducted, but it concluded that such a detailed assessment was beyond the scope of what it could accomplish. With this report, the committee aims to establish the foundation on which such an assessment must be built.

Chapter 1 lays out the historical context in which these programs arose and evolved and discusses the current state of the national and international research enterprise. Chapter 2 discusses some of the core themes in the different agency programs, focusing on NSF EPSCoR and NIH IDeA, and gives an overview of the diversity of the states involved. Chapter 3 examines the state of assessments of the EPSCoR program. Chapter 4 presents the committee's finding and recommendations. In addition, Appendix A provides descriptions of the agency EPSCoR programs, and Appendix B provides information on a diverse sample of state programs.

THE ORIGIN OF EPSCOR

In the 1950 legislation creating the National Science Foundation (NSF), Congress called on NSF to pursue strategies and tactics "to strengthen research and education in science and engineering throughout the United States and to *avoid undue concentration of such research and education*."[7] In 1978 the National Science Board, which oversees NSF, approved the creation of the Experimental Program to Stimulate Competitive Research (EPSCoR) to further this mandate and to increase support for states that had received relatively small shares of NSF funds (see Box 1-2). Over the next three decades, EPSCoR, which had been devised as an experimental program that would cease operations after 5 years, would be implemented by seven federal agencies. Moreover, eligibility would be broadened to include more than 33 states and territories.

Box 1-2
EPSCoR's NSF Endorsement

In a 1978 memorandum to the National Science Board, NSF Director Richard C. Atkinson contended that NSF should continue to focus its funding activities on rewarding scientific excellence through a review process dedicated to transparency, competition, and "recognizable" merit.

However, he also urged the board to launch an "experimental" program "to stimulate competitively meritorious research in regions that are not able to compete successfully." He observed that "significant national, as well as local, benefits would be derived from each states' participation in the national scientific enterprise."

EPSCoR programs have proven to be immensely popular among their advocates. Today, many university officials claim that EPSCoR has played a more significant role than any other federal program in strengthening research capacities, changing their state's research culture for the better, and elevating the importance of science as a fundamental driver of economic growth.

THE EPSCOR COMPROMISE

At the time of its creation, EPSCoR was competing against several alternative schemes designed to level the research playing field. Some

[7] Initial funding for EPSCoR was authorized in P.L. 95-392 (H. Rept. 95-1265), Department of Housing and Urban Development (HUD)-Independent Agencies Appropriations Act, 1979. Italics in text have been added for emphasis.

legislators from states lagging in scientific investment, for example, proposed a minimum level of research funding for each state. Others suggested increasing the role of directed spending (earmarks) in funding science and technology efforts, thereby exempting certain projects from merit-based review.[8]

NSF officials were concerned that such funding strategies would compromise NSF's long-standing emphasis on scientific excellence, open competition, transparency and merit. In this sense, EPSCoR emerged as a defensive measure against actions that were viewed as more intrusive and disruptive to NSF principles and objectives. In advocating for EPSCoR, the National Science Board largely sought to insulate NSF's research grant program from potential political interference.

MAKING EPSCOR OPERATIONAL

EPSCoR embraced several principles[9] designed to encourage scientific excellence while fostering greater equity in the distribution of federal funds. NSF officials, for example, explicitly required that EPSCoR grant awards be based on a peer-review process. Since proposal success would be determined, in part, on the applicant's ability to clearly articulate research goals and to devise a realistic plan for achieving the proposal's objectives, the application process itself was viewed as a capacity-building exercise.

Participating states were also required to demonstrate a commitment to scientific advancement by establishing science and technology governing committees.[10] By guiding the proposal application process, NSF believed that the governing committees would help ensure that NSF funding was sensitive to the state's overall strategy for research capacity building and that it would be designed to forge strong links between science and economic development. In addition, NSF officials required "significant" cost sharing and called for discontinuing the program in states that failed to make satisfactory progress toward achieving EPSCoR's goals.[11]

For all these reasons, NSF EPSCoR represented an innovative attempt to use federal-state relationships as a means of building research capacity in eligible states.

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[8] House Committee on Science and Technology, Subcommittee on Science, National Science Board: Science Policy and Management for the NSF, 1968–1980, Rpt. 98th Congress, 1st Session, Jan. 1983.

[9] These principles included peer review, state governing committees and science and technology plans, and cost- sharing.

[10] NSF Memorandum to Members of the National Science Board, Office of the Director, "Program Plan for Experimental Program to Stimulate Competitive Research," January 4, 1978.

[11] Measures calling for achieving satisfactory progress toward the programs' primary goals were vaguely defined at the time EPSCoR was created and never clarified or enforced by the federal agencies.

An Experimental Program

Even in the eyes of its strongest advocates, EPSCoR was considered "experimental" in the sense that it would "test" deeply held principles in the scientific community.[12] For a scientific culture dedicated to the principles of unfettered competition, it was an open question whether a program designed to assist less successful players could produce scientific excellence and increase research competiveness. EPSCoR's proponents therefore made the argument for short-term support to a limited number of states. In the words of W. Henry Lambright, professor of public administration and political science at Syracuse University, "EPSCoR was not intended as an entitlement, but rather as a catalyst."[13] EPSCoR was thus designed as an initiative that would reinforce the scientific community's abiding principle of merit-based competition and not serve as a substitute for it.

In EPSCoR's inaugural year, NSF approved planning grants for seven states, each totaling about $125,000. Five of these states—Arkansas, Maine, Montana, South Carolina, and West Virginia—were subsequently recognized as EPSCoR eligible[14] and given additional EPSCoR funding in fiscal year (FY)1980 to begin programmatic research capacity building activities.

EPSCOR EXPANSION

Expansion of Agency Participation

Since 1979, EPSCoR programs have been introduced in seven federal agencies (see Figure 1-1). While all of these programs are intended to improve the scientific capacity and competitiveness of institutions in eligible states, they are also dedicated to advancing each agency's mandate and mission. The Department of Energy (DOE) EPSCoR program, for example, focuses on materials and chemical science, geology, high energy and nuclear physics, fusion energy, and other topics in DOE's research agenda. The EPSCoR program in the Department of Agriculture (USDA) seeks to lay the groundwork for improving agriculture, food, and environmental science. The National Institutes of Health (NIH) Institutional Development Awards (IDeA) program concentrates on biomedical research. (See Box 1-3 for notes on terminology used in this report.)

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[12] Due to the large number of variables that are responsible for scientific capacity building, it might be more accurate to refer to EPSCoR as a demonstration project rather than as an experiment. Evaluations of the impact that EPSCoR has had on scientific capacity building among participating jurisdictions are difficult, but not impossible, to devise without a full negative-control experiment. However, such evaluations, due to their complexity, are outside the scope of this study.

[13] W. Henry Lambright, "Building State Science: The EPSCoR Experience," chapter 3 in J. Scott Hauger and Celia McEnaney, eds., *Strategies for Competitiveness in Academic Research* (Washington, DC: AAAS, 2000). Available online at *http://www.aaas.org/spp/rcp/policy/strategies_book/str3.pdf*, p. 2.

[14] See Building on the Past, Preparing for the Future: Innovative Science Across America (Washington, DC: EPSCoR/IDeA Foundation, March 2008).

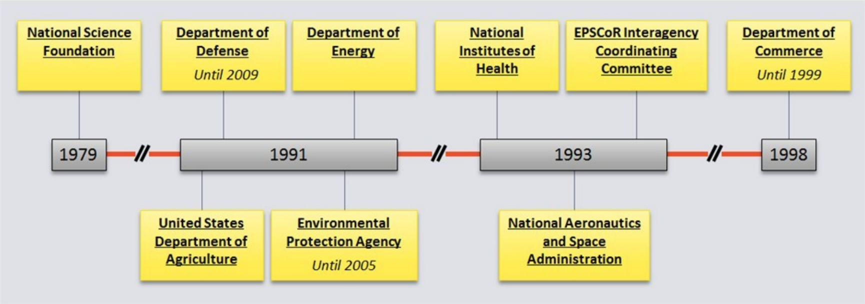

Figure 1-1. Timeline of the introduction of EPSCoR programs. NOTES: EPA and DOD last year based on last year of funding; DOC Last year based on last grant award made. [SOURCES: Darrel Woodard, EPA – 2005 (EPA); *http://www.epscorideafoundation.org/about/agency/dod/ (DoD); http://webharvest.gov/peth04/20041017054756/www.technology.gov/reports/TechPolicy/epscot4sbd.pdf (DOC)]*

Box1-3
Notes on Terminology

There are two points that should be made about the terminology used in this report:

1. The committee was directed by Congress to evaluate "EPSCoR and EPSCoR-like" programs. However, to avoid repeating this cumbersome phrase, the committee decided instead to use the term *EPSCoR* to refer to the entire group of programs, including the IDeA program at NIH. When the report is addressing a specific program, it refers to *NSF EPSCoR*, *NASA EPSCoR, NIH IDeA*, *and so on*.
2. The program was created to help states improve their research capacity, but in the 1990s, congress extended the program to include Puerto Rico, Guam, and the US Virgin Islands. The agencies then began referring to eligible "jurisdictions." Although technically correct, the term is likely to confuse someone not familiar with the structure and jargon of the program. The committee therefore uses the term *states* throughout the report with the understanding that a small amount of funding goes to the three eligible jurisdictions.
3. The report refers to DOE, NASA, USDA, DOD, and EPA as "mission agencies." Although some people consider NIH to be a mission agency, for the purposes of this report the committee grouped it with NSF because of its dominate role in science funding and its board responsibility for maintaining research capacity in biomedical fields.

Expansion of Budget

Funding for EPSCoR has also grown over time (see Figure 1-2). In FY 2012, EPSCoR's overall budget surpassed $480 million. However, this is in comparison to the nation's $33 billion federal expenditures on academic research and development (R&D) in FY 2012. At NSF, EPSCoR's $151 million allocation comprises 2 percent of the agency's $7.1 billion FY 2012 operating budget. Even within the EPSCoR states, the program is relatively small. EPSCoR funds comprise only about 12 percent of federal research funding received by the EPSCoR states.

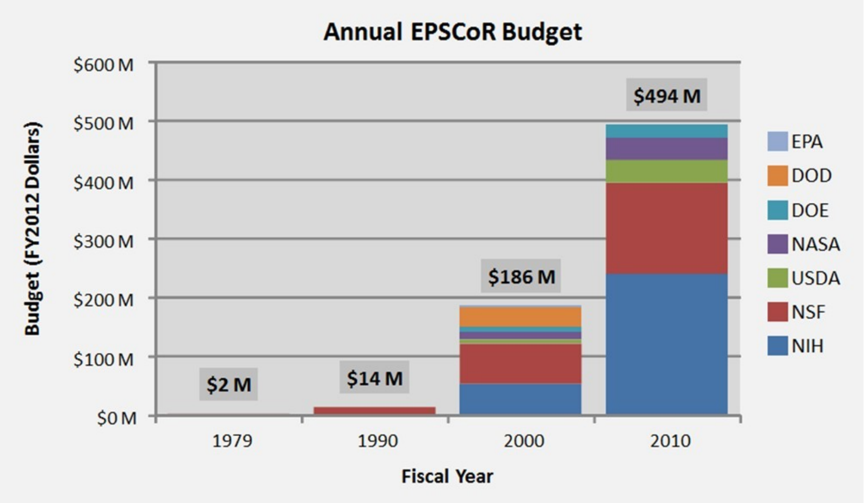

Figure 1-2. EPSCoR budgets have grown significantly since 1979. [SOURCES: NSF S&E Indicators; 1979: Agency NSF Data Excel File - this is the total amount in planning grants; other Years: Page 15829, Congressional Record 107th Congress, Volume 147 - Part II]

Expansion of Eligible States

The number of eligible states has also increased over time. NSF's EPSCoR program had 31 eligible states in FY 2012. Moreover, states that have become eligible for EPSCoR in recent years—including Delaware, Iowa, Missouri, Rhode Island, and Tennessee—have tended to be larger, wealthier, and more "research proficient" than earlier EPSCoR states (see Figure 1-3).

The reason for this growth is largely that the criterion for eligibility has been relaxed over time. In the beginning, NSF used a number of criteria in selecting the states that would be eligible for EPSCoR funding, but Congress mandated a switch to the single and simple criterion of admitting any state that receives less than a set percentage of NSF funding. That percentage increased over time, and the program is now open to any state that receives less than 0.75 percent of NSF funding averaged over a 3-year period.

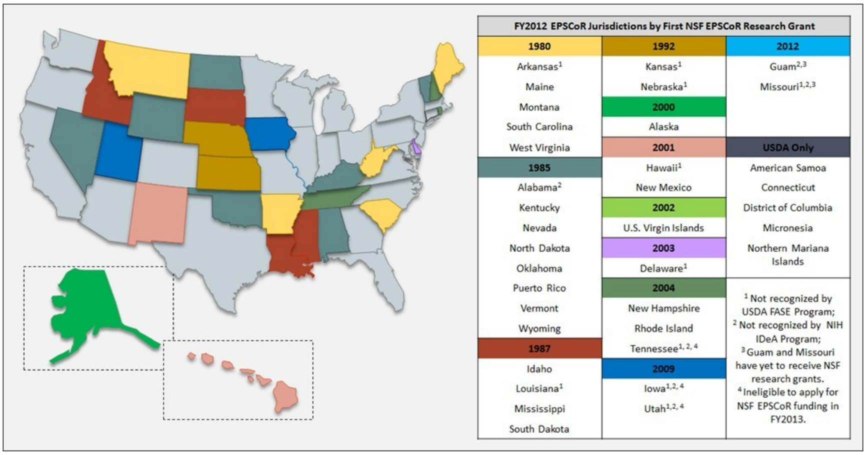

Figure 1-3. Thirty-six states were eligible for EPSCoR funding from one or more agencies in FY 2012. [SOURCES: Presentationtree.com (CONUS); Slideshare.com]

All the other agencies except NIH and USDA[15] have closely followed NSF's lead. NIH originally admitted states where the success rate of research proposals was less than 20 percent. However, it is now proposing a shift to a system that would admit all states that fall below the median in total NIH research funding.

Using total funding as a yardstick raises questions because of the large differences in state populations. In general, comparisons among the states often rely on per capita data, because such data provide metrics that help to standardize comparisons and reveal differences that matter. For example, when assessing a wide range of economic issues among states, what is often significant is not total household income but per capita income. Similarly, when it comes to public safety issues, what is often most significant is crime rates per capita, not total crime rates.

The same may well be true when assessing state research capacity. In fact, the use of total funding as a criterion for eligibility creates a curious challenge for determining state eligibility in EPSCoR. Sixteen states and two jurisdictions have less than 0.75 percent of the U.S. population. To lose their eligibility and "graduate" from the program, each of these states would have to receive a percentage of research funding that exceeds its share of the nation's population. Indeed, several states have less than 0.25 percent of the nation's total population, and it will be virtually impossible for these states to ever reach 0.75 percent of total funding.

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[15] USDA does not rely on the NSF criteria but does use a similar system; states that fall below the 38th percentile (3-year rolling average) are eligible for USDA EPSCoR.

If one chose to examine per capita research funding, which would seem to make more sense if the goal is to achieve equity for all citizens, the list of states not receiving a proportionate share of research funding would look very different (Table 1-1). Under this new requirement, several current EPSCoR states with small populations would no longer be eligible for the program. On the other hand, a substantial number of states with large populations that do not currently participate in the program would be able to do so. Their total research funding would remain high, but on a per capita base, they would not be faring well despite their size.

Table 1-1. Ranking States Based on Per Capita Federal Academic Science and Engineering Support and Assuming 31 EPSCoR Jurisdictions, EPSCoR Eligibility Changes Dramatically

States Ranked According to Per Capita Federal Academic S&E Support				
1. Dist. of Col.	12. New York	23. Oregon	34. Texas	45. New Jersey
2. Maryland	**13. New Hamp.**	**24 Utah**	**35. Virgin Is.**	**46. W. Virginia**
3. Massa.	14. Washington	**25. Alabama**	**36. So. Dakota**	**47. Oklahoma**
4. Connecticut	**15. Alaska**	26. Illinois	37. Virginia	**48. Arkansas**
5 .Hawaii	**16. Iowa**	**27. Tennessee**	38. Indiana	**49. Idaho**
6. No. Dakota	**17. Missouri**	28. Michigan	**39. Kansas**	50. Florida
7. Vermont	**18. Delaware**	**29. Nebraska**	40. Arizona	**51. Nevada**
8. Rhode Is.	19. Wisconsin	30. Minnesota	**41. Wyoming**	52. Am. Samoa
9. Penn.	**20. New Mex**.	**31. Mississippi**	**42. Louisiana**	**53. Maine**
10. N. Carolina	21. California	32. Georgia	**43. Kentucky**	**54. Guam**
11. Colorado	**22. Montana**	33. Ohio	**44. S. Carolina**	**55. Puerto Rico**

NOTE: Boldface denotes FY 2012 NSF-EPSCoR Eligibility. States ranking 25-55 would constitute a new "EPSCoR" cohort based on per capita funding. [SOURCE: NSF Survey of Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions via WebCASPAR]

While the committee believes that per capita research funding is a more sensible eligibility criterion than total funding, it is not recommending that this be the sole criterion. A variety of measures are relevant when considering a state's research capacity. A state might not be winning a significant number of NSF grants, but it could be home to important research programs funded by the DOE or the National Aeronautics and Space Administration (NASA). The composition of state economies also differs significantly (see Box 1-4). A state economy that is rich in resources or agricultural land, for example, has different research needs than one that is based on manufacturing of pharmaceuticals or electronics. Also, the states themselves make decisions about what their priorities are. If a state decides that research is not that important to its economy, it is then questionable as to whether it is a federal responsibility to direct additional research funding to that state.

The committee was not charged with developing new criteria for eligibility, but it finds that the current criteria are not well suited to identify the states where the greatest need and opportunity exist. Further study is needed to determine what mix of criteria—including per capita funding—should be applied to eligibility.

Box 1-4
The States of EPSCoR

EPSCoR states are home to 20 percent of the country's population and workforce. They contain nearly 30 percent of the nation's research institutions and more than 15 percent of the nation's scientific and technological personnel. They bestow 20 percent of the nation's undergraduate degrees in science and engineering and 16 percent of the nation's doctorate degrees in these fields of study. They are home to 20 percent of the country's high-tech industries. Fifty-seven of the *Fortune 500* companies have their corporate headquarters in EPSCoR states. These states are also among the nation's nine most important energy producers. There are only 10 states in the United States that produce more energy than they consume. Nine of these states are eligible to participate in EPSCoR.

Despite all of these attributes, in 2011 EPSCoR states received just 13.6 percent of all NSF research funds. A larger portion of NSF research funds—15 percent—went to just eight of the nation's elite research universities, all located in non-EPSCoR states. Nevertheless, a significant number of EPSCoR states now have at least one research university with capabilities that are comparable to the research capabilities of institutions in non-EPSCoR states.

SOURCE: EPSCoR 2030: A Report to the National Science Foundation, prepared by Paul Hill, Principal Investigator (Arlington, VA: NSF Award # EPS-1155975, 2012). The report observes that "Any national research agenda that ignores or diminishes the role of half the states is an agenda that makes a serious omission by excluding highly productive and important components of the nation's R&D capacity."

EPSCOR'S EVOLVING MISSION

The objectives of the NSF EPSCoR program have expanded over time. Whereas the original program mandate focused on building research capacity and competitiveness, the *Federal Register* now recognizes goals related to broadening opportunities for underrepresented populations, promoting a knowledge-based economy, nurturing innovation and spurring "positive change and progression" (see Box 1-5). While many of these objectives represent worthwhile long-term strategies for promoting research competitiveness, they also reflect an expansion of EPSCoR's mandate to better meet the desires and goals of various stakeholders. Yet, it is not clear how they promote EPSCoR's core objective to build research capabilities and competitiveness among research institutions in participating states, especially in the short term.

Box1-5
NSF EPSCoR Missions, Goals, and Objectives

The mission of EPSCoR is to assist the NSF in its statutory function "to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education."

EPSCoR goals are to (1) provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in their R&D capacity and competitiveness; and (2) advance science and engineering capabilities in jurisdictions for discovery, innovation, and overall knowledge-based prosperity.

EPSCoR objectives are to (1) catalyze key research themes and related activities within and among EPSCoR jurisdictions that empower knowledge generation, dissemination, and application; (2) activate effective jurisdictional and regional collaborations among academic, government, and private-sector stakeholders that advance scientific research, promote innovation, and provide multiple societal benefits; (3) broaden participation in science and engineering by institutions, organizations, and people within and among EPSCoR jurisdictions; and (4) use EPSCoR for development, implementation, and evaluation of future programmatic experiments that motivate positive change and progression.

SOURCE: *Federal Register*, Volume 77, Number 154 (Thursday, August 9, 2012).

EPSCoR's broader efforts have been driven by a host of factors. To meet growing national challenges in science education and training, for example, NSF and other federal agencies have pursued measures to increase the diversity of the science, technology, engineering and mathematics workforce and to raise public appreciation for science. Through a combination of direct congressional action and agency interpretations of their mandates, EPSCoR programs have adopted aims related to promoting greater institutional collaboration, aligning scientific research with national needs, fostering workforce diversity, and building a sustainable physical research infrastructure to create a solid foundation for scientific capacity building (see Figure 1-4).

EPSCoR state governing committees have generally embraced this larger agenda as an opportunity to illustrate how program activities positively impact state residents and the state's economy. University administrators, moreover, have found that these additional responsibilities —while they may stretch resources and obscure other core objectives[16]—help to raise the public profile of universities within their communities.

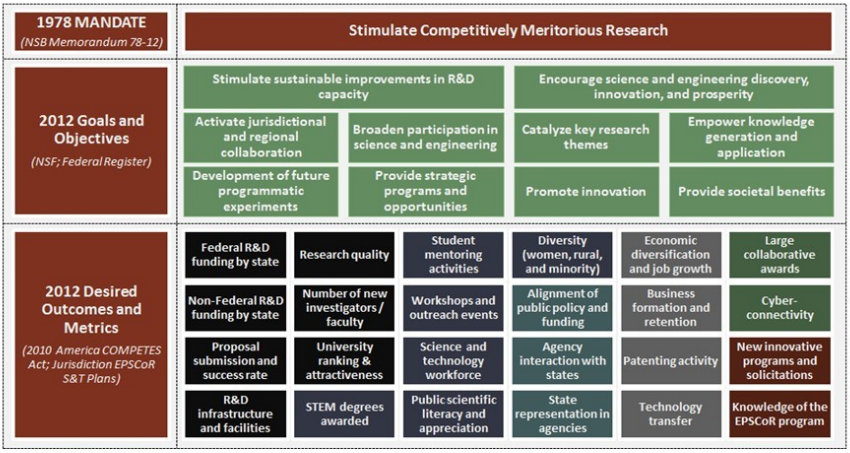

Figure 1-4. Current NSF, congressional, and state goals, objectives, and metrics suggest EPSCoR stakeholders have broadened program targets to suit their individual needs and goals. [SOURCES: NSB Memorandum 78-12; PL 96-44; PL 111-358; 2010 America COMPETES Act Reauthorization; EPSCoR-eligible State S&T Plans]

CHALLENGES TO THE EPSCOR MISSION

Like many federal programs, EPSCoR has evolved over time—and its evolution is likely to continue. In light of declining research budgets and increasing global scientific competition, the critical question for federal EPSCoR managers may not be whether EPSCoR should strictly adhere to its historic mandate but whether the program can meet the critical challenges that stakeholders will face in the years ahead. Since advocates maintain that promoting geographic equity maximizes access to talent and helps maintain U.S. global scientific standing, EPSCoR in its future iterations will likely be called upon to demonstrate its ability to improve the nation's overall competitiveness.

[16] For example, Mary L. Good, Donaghey Professor at the University of Arkansas at Little Rock, has worried that EPSCoR "is beginning to lose sight of what the program was designed to do." See *EPSCoR 2030: A Report to the National Science Foundation*, (Arlington, VA: NSF Award #EPS-1155975, prepared by Paul Hill, 2012).

The committee views EPSCoR programs collectively as a component of the federal research mission that must be understood in the larger context of the nation's scientific needs and goals and its international standing.

The National Competitive Landscape

The landscape for research universities has changed dramatically since EPSCoR's inception. Over the past several decades, the nation's elite research universities have substantially increased their research investments, making it more difficult for other research institutions to narrow the gap in competiveness. Institutions (especially elite private universities) in non-EPSCoR states have become significantly wealthier and stronger than they were 35 years ago.

The number of research institutions competing for funding has increased steadily during the second half of the 20th century to more than 200 research universities. This increase in research universities is testimony, in part, to the commitment of many state leaders and the assistance that they have received from the federal government. A growing number of the nation's research institutions not only pursue active research agendas but are also capable of attracting funding for research in niche areas. Several public universities in EPSCoR states, such as the University of Alabama at Birmingham, the University of Kentucky, the University of Kansas, and the University of Oklahoma, are among the nation's top 100 research universities in terms of federal research funding (also see Box 1-6 for a brief description of North Dakota's aspirations).

In attempting to improve their scientific standing and to increase—or even maintain—their share of federal funding, EPSCoR participants must therefore compete against an increasingly large and capable cadre of research institutions.

Box 1-6
Aspiring to Excellence

New competition for research funds

In 2013, North Dakota's 11-campus university system is projected to receive a 14 percent increase in its operating budget and a one-time $177 million allocation for capital improvements. The chancellor of the state's higher education system has set a goal of having the state's research institutions "to be thought of in the same tier as the Big 10 institutions." In a similar vein, administrators "have made no secret of the fact that they aspire for one or both of the research universities to become a member of the Association of American Universities."

The Global Competitive Landscape

The global research landscape also is in transition. When EPSCoR was launched in the late 1970s, the U.S. scientific community was first in the world in virtually every category of assessment and faced no significant risks to its top ranking. While the nation retains many advantages, its preeminent status is no longer unchallenged. Emerging economies have adopted policies that have led to dramatic changes in the global scientific landscape—and the pace of change seems to be accelerating. China, which has increased its investment in science and technology by more than 20 percent a year over the past two decades, now has a scientific workforce comparable in size to that of the United States. Other countries, including Brazil and India, are also rapidly strengthening their research capabilities.

In light of these developments, EPSCoR may face a greater need to defend its budget. Whether the nation is best served by diversifying scientific capacity or by concentrating on a few centers of excellence in selected thematic areas may prove central to the size and shape of future EPSCoR appropriations.

Declining Research Budgets

Budget concerns—both at the federal and state levels—also pose difficulties for EPSCoR managers and beneficiaries. Sustaining the gains in research capacity that have been made to date may prove problematic as federal, state, and private R&D funding declines.[17] As a result, if EPSCoR is to fulfill its promise as a catalyst, at some point eligible states must sustain and expand their research capacity with funds from sources other than EPSCoR. This goal may become more difficult to achieve in an environment marked by sharp cutbacks in state funding for universities in general and research more specifically. In these austere times, it will become increasingly important to coordinate investments between the state and federal governments, and across all sectors of society, to attain a greater efficiency in efforts to improve state and regional scientific competitiveness.

[17] Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future (Washington, DC: The National Academies Press, 2006).

2
Program Structure and Operation

"The [EPSCoR] program has been a huge success—investments have generated growth in state economies, attracted students into STEM fields, and created a broader base of research expertise available to the agencies to meet their missions."

Testimony, Christopher M. Lawson, Executive Director, Alabama EPSCoR, Director of Graduate Research Scholars Program and Professor of Physics, University of Alabama at Birmingham, submitted to the House Committee on Appropriations Subcommittee on Commerce, Justice, Science and Related Agencies, March 22, 2012.

"Our nation's primary source of both new knowledge and graduates with advanced skills is our research universities."

Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security *(Washington, DC: The National Academies Press, 2012), p. 1.*

Despite largely shared goals, the federal agencies that operate the programs of the Experimental Program to Stimulate Competitive Research (EPSCoR) have established diverse administrative frameworks for achieving their directives.[18] Agencies differ not only in terms of EPSCoR budgets (ranging from $9 million at the Department of Energy [DOE] to $276 million at the National Institutes of Health [NIH] in fiscal year [FY] 2012) but also in terms of eligibility criteria, proposal review processes, award duration, and the level and intensity of state engagement. The National Science Foundation (NSF), EPSCoR's originating

[18] Details for each agency can be found in Appendix A.

agency, continues to drive eligibility requirements for most EPSCoR programs and has legislative authority over the EPSCoR Interagency Coordinating Committee.[19] NIH, which operates the EPSCoR-like Institutional Development Awards (IDeA) program, currently oversees the largest budget of any EPSCoR program. The Department of Agriculture (USDA) Agriculture and Food Research Initiative conducts an EPSCoR-like program, the Food and Agricultural Science Enhancement program, which functions much differently than other EPSCoR programs. The remaining EPSCoR initiatives—National Aeronautics and Space Administration (NASA) EPSCoR and DOE EPSCoR—operate at mission-driven agencies and control relatively small budgets (see Table 2-1).[20] The committee decided to focus most of its attention on the NSF and NIH programs because they have the broadest roles in supporting the U.S. research enterprise and account for more than 85 percent of the current EPSCoR spending

AGENCY CONTRASTS

Program Goals

NSF's funding mandate stretches across the spectrum of the scientific community's research interests—from anthropology to mathematics to zoology—as well as scientific policy concerns—from building scientific capacity to improving science education to fostering science-based economic development and innovation. NSF's mandate, in its broadest sense, *is* national scientific capacity building to directly advance innovation and discovery. This is reflected in the structure of its EPSCoR program (see Box 2-1).

In contrast, the EPSCoR strategy developed at NIH in part reflects the agency's concentration on biomedical research. In a sense, NIH is a mission-oriented agency that tailors its IDeA program to its overall research agenda. The NIH IDeA program, therefore, tends to emphasize basic and translational research and focuses less on the broader activities that have come to characterize NSF EPSCoR in more recent years.

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[19] Under the direction of Congress, in FY 1993 the federal agencies participating in EPSCoR agreed to form the EPSCoR Interagency Coordinating Committee (EICC). The purpose of the committee was "to produce…a plan to integrate all EPSCoR programs into a single unified effort to maximize the taxpayers' investment in this effort." See www.nsf.gov/od/oia/program/espscor/ehr_espscor_eicc.jsp. The committee did not find any evidence that the EICC was playing a strong role in coordinating activities. The agencies used it primarily to inform one another of their activities.

[20] DOD's DEPSCoR program ended in 2009. A summary of the program may be found in Appendix A. EPA's EPSCoR program was discontinued in 2006. The committee made an exhaustive effort to learn more about the rationale for the DOD and EPA decisions to cancel their EPSCoR programs, but neither agency was able to provide the information.

Table 2-1. Overview of EPSCoR and EPSCoR-like Program Properties and Policies FY 2012

Agency	Program Name	2012 Budget	Eligibility Threshold	State Committee	Matching Funds	Funding Pool	Award Period
NSF	EPSCoR	$150.9M	<0.75% of NSF funds, rolling 3-yr average	Required	Required	Independent; congressionally legislated	Up to 5 years
NIH	IDeA	$276.5M	Fixed in 2006, proposal success rate below 20%	Not used	Not required	Independent; congressionally legislated	Up to 15 years
DOE	EPSCoR	$8.5M	NSF requirement	Endorsement letters required	Not required	Independent; congressionally legislated	Up to 4 years
NASA	EPSCoR	$18.3M	NSF requirement	Not required	Required	Independent; congressionally legislated	Up to 3 years (2-year renewal)
USDA	FASE	$26.4M	<38th percentile of USDA funding recipients	Not used	Not required	10% of AFRI budget	Up to 2 years
DOD	DEPSCoR	$0M	NSF requirement and < 1.2% DOD funding	Not required after FY 2009	Required	Program discontinued in FY 2010	

[SOURCES: NSF Survey of Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions (WebCASPAR); Direct communications with program managers at agency EPSCoR offices ; DEPSCoR – Assessment of the Defense Experimental Program To Stimulate Competitive Research (DEPSCoR): Final Report Volume II—Supporting Material, Institute for Defense Analyses, October 2008 (FY 1995–FY 2008), Robin Staffin's presentation at third meeting.]

Box 2-1
NSF EPSCoR's Current Major Objectives

The major objectives of NSF EPSCoR, as articulated by NSF, are to:

- Catalyze key research themes and related activities within and among EPSCoR states and jurisdictions for the purposes of empowering knowledge generation, dissemination, and application.
- Activate effective state, jurisdictional, and regional collaboration among academic, government, and private -sector stakeholders to advance scientific research, promote innovation, and provide multiple benefits.
- Broaden participation in science and engineering by institutions, organizations, and people within and among EPSCoR jurisdictions.
- Use EPSCoR for development, implementation, and evaluation of future programmatic experiments to motivate positive change and progress.

SOURCE*: www.nsf.gov/od/oia/programs/epscor/about.jsp*.

NIH defines its IDeA program largely as an effort to strengthen research capabilities by building physical infrastructure, hiring faculty, and providing fellowships and research grants to postdoctoral students and junior faculty. In effect, the NIH IDeA casts its program's goals onto a much more narrowly confined template than NSF EPSCoR (see Box 2-2).[21]

NIH's administrative framework, however, does not mean that either federal or state program officials ignore the broader social and economic benefits that could potentially be derived from advances and applications of the biomedical research conducted by IDeA-supported researchers and research institutions. The direct ties between biomedical research and public health inherent in the research pursued by NIH IDeA grant recipients often provide an advantage in efforts to solicit public and political support. Due to the diverse subject matter of the research it funds, similar public support is sometimes more

[21] NIH IDeA laboratory funding includes investments in faculty development and recruitment, equipment, facilities renovation, postdoctoral studies and development, bioinformation training, release time, and training for grant management. See presentation by W. Frederick Taylor, Program Director for the Division of Training, Workforce Development, and Diversity, National Institute of General Medical Sciences, 1st NAS EPSCoR Evaluation Committee Meeting, Washington, DC, May 24–25, 2012.

difficult for NSF EPSCoR grant recipients to generate and sustain—although state governing committees seek to tie these research efforts to societal needs.[22]

Box 2-2
NIH IDeA Major Objectives (2013)

Broad descriptions of the NIH IDeA program are more difficult to find than for NSF EPSCoR. More often than not, NIH IDeA notes that its objectives are to build capacity and competitiveness among institutions in eligible states and jurisdictions for the purpose of acquiring NIH funds. However, in announcing its 5-year Institutional Networks of Biological Research Excellence (INBRE) awards, NIH outlined the following IDeA broad objectives:

- Build and strengthen local and partner institutions' biomedical research expertise and infrastructure.
- Support faculty, postdoctoral fellows, and graduate students through career development and training in research in partnering institutions.
- Increase research opportunities for undergraduate students and create a pipeline for undergraduate students to continue in health research careers within IDeA states.
- Provide outreach activities to students at undergraduate institutions, community colleges, and tribal colleges participating in the state's network.
- Enhance science and technology of the state's workforce.

SOURCE: *www.nih.gov/news/health/oct2009/ncrr*.

Eligibility and Funding

Each participating federal agency has instituted EPSCoR eligibility criteria based on previous state success in acquiring federal funding. At NSF, eligible states can receive no more than 0.75 percent of total NSF research funds, based on a rolling 3-year average, as defined and revised in the 2010 America COMPETES Act. NASA, DOE, and the DOD have each adopted NSF's criterion.[23]

[22] Issues that serve as the focal points of the NSF EPSCoR research program have evolved over time and varied from state to state. However, the current roster of key issues includes biodiversity, cyberinfrastructure, climate change, computational science, energy, rural health, defense, ecology, homeland security, and water.
[23] Details for each agency can be found in Appendix A.

Until FY 2008, NIH eligibility was based on a 3-year rolling average of proposal success rates. Under this system, all states with success rates of less than 20 percent were eligible to participate in the program. However, NIH has suspended all updates on possible changes in eligibility due to a nationwide decline in proposal success rates. In 2012, 46 states and territories—including California, Texas, and New York—were unable to convert more than 20 percent of their proposals into NIH awards.[24] NIH has proposed a new eligibility requirement allowing states that fall below the median in NIH research funding to participate in the program. The proposal is currently awaiting congressional approval.

USDA combines NSF's and its own unique eligibility criteria when considering grant proposals. Under this arrangement, all researchers (regardless of the state in which they reside) compete directly for funds. Meritorious but unsuccessful proposals (due to budget constraints) from states below the 38th percentile in total USDA research funding have access to a (protected) secondary funding pool based on the ranking of their proposal and the availability of funds.

Once eligibility has been determined, institutions in eligible states compete against one another in an open and meritorious review process. The funds for which they compete, however, are "sheltered" and thus not available to non-EPSCoR states.

Proposal Submission

The NSF EPSCoR and NIH IDeA proposal submission and review processes reflect each agency's effort to achieve both program and agency goals.[25] For example, NSF's requirements that participating states create EPSCoR governing committees, prepare strategic plans for science and technology, and identify nonfederal matching funds are designed to build scientific capacity and foster collaboration among universities, state and local governments, and the private sector.

Through NSF EPSCoR, competing institutions are encouraged to cooperate in preparing and implementing project proposals. Because each governing committee may submit just a single application for NSF's Research Infrastructure Improvement Track 1 grants, the proposal process encourages strong collaboration among its participants and a sense of shared ownership as the project moves ahead. These factors can have a lasting impact on scientific capacity in the state.[26] As Michael Khonsari, NSF EPSCoR Project Director and Associate Commissioner for Sponsored Programs Research and Development in Louisiana, observes: "What started out as a requirement in EPSCoR is now

[24] Communication with Fred Taylor, Program Director, Capacity Building Branch, National Institute of General Medical Sciences, National Institutes of Health.
[25] Details for all agencies can be found in Appendix A.
[26] Denise M. Barnes, Acting Head, NSF EPSCoR, presentation at the NAS EPSCoR Evaluation Committee, Washington, DC, May 24, 2012.

regarded as a normal course of operations. We collaborate because it increases our chances of securing research funding."[27]

EPSCoR governing committees also seek to foster opportunities for additional collaboration between federal agencies and state officials. NIH IDeA administrators sometimes work closely with NSF through state governing committees. Unlike NSF, however, IDeA accepts proposals only directly from researchers and not from state governing committees. Proposals are not vetted by the state governing committees before their submission to the NIH, although for the Institutional Network of Biological Research Excellence program, NIH ultimately chooses just one research proposal from each state.[28] Unlike NSF, moreover, NIH does not require matching funds from the state to cover a portion of the grant.[29]

Because NSF EPSCoR proposals address broader state strategies for capacity enhancement, NSF creates review committees with a diversity of expertise. In contrast, because NIH COBRE proposals focus more tightly on a specific research project, NIH chooses reviewers with directly related expertise as it would for any subject-specific research proposal.

Over time, NSF EPSCoR has expanded the scope of its funding activities from support for individual scientists to support for scientific institutions. Since the late 1990s, it has also pursued a co-funding strategy that combines NSF EPSCoR funds with funds from other NSF divisions to support worthy proposals that may otherwise not be awarded a grant due to insufficient funds.[30]

In theory, if institutions are able to compete successfully for funds from NSF's general research programs (even under the favorable conditions provided by the co-funding arrangement), then at some point the institutions should be able to compete on their own without any of the shelter provided by EPSCoR for general research funds. Yet, as a practical matter, the effort has yet to fulfill its promise as a "half-way house" between EPSCoR and non-EPSCoR status. No state has yet to permanently graduate from EPSCoR, which means that all institutions within EPSCoR states remain eligible for the program.[31]

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[27] Michael Khonsari NSF EPSCoR Project Director and Associate Commissioner for Sponsored Programs Research and Development in Louisiana, correspondence sent to the NAS Evaluation Committee, October 2012.

[28] The NIH Institutional Network of Biological Research Excellence (INBRE) program, like the NSF EPSCoR Research Infrastructure Improvement Development (RII Track I and II) program, has only one grant project operating in each state at a time. With the NIH Centers of Biomedical Research Excellence (COBRE) program, however, there can be more than one grant recipient operating at the same time.

[29] Institutional Development Award Program (IDeA), *NIH Guide*, vol. 22, no. 44, Dec. 10, 1993.

[30] Ibid. Also W. Henry Lambright, "Building State Science: The EPSCoR Experience," in J. Scott Hauger and Celia McEnaney, eds., *Strategies for Competitiveness in Academic Research* (Washington, DC: AAAS, (Washington, DC: AAAS, *http://www.aaas.org/spp/rcp/policy/strategies_book.shtml, 2000*).

[31] In April 2006, Tennessee announced that it would "begin the process of successfully transitioning out of the NSF EPSCoR program." State officials anticipated that the "exit" process would take 3

Most NSF EPSCoR research projects are funded for 5 years or less.[32] In general, no additional funds are made available after this period, but states can seek support for new projects. Conversely, NIH IDeA in its Centers of Biomedical Research Excellence program relies on a long-term, step-funding strategy for building sustainable research capacity. Successful applicants receive funding for up to 15 years, with continued funding eligibility over this period subject to the outcome of periodic program reviews. Conducted by experts in the field of study, these reviews take place once every 5 years. At the conclusion of a 15-year period, participating institutions are expected to have sufficient research capacity (and a reputation for scientific excellence) that will enable them to successfully compete for research funds from NIH's institutes and centers as well as from other federal, state, and private funding sources.

Both the NSF and NIH programs contain several successful elements. In particular, NSF's use of state committees to encourage both state- and region-wide coordination of education and infrastructure efforts and NIH's commitment to develop specific areas of research capacity via a stepped program lasting 15 years deserve recognition. In developing its recommendations, the committee built its proposal on agency initiatives that had demonstrated their effectiveness.

STATE BY STATE

EPSCoR states vary widely in demographic, economic, and scientific characteristics. Such diversity plays an important role in determining capacities and shaping strategies for science-based economic growth.[33] In Wyoming, for example, there is just 1 university that grants graduate degrees; in Tennessee, there are 31. Rhode Island is home to Brown University, one of the nation's elite private universities; in contrast, 11 EPSCoR states do not have a single research university ranked in the top 100 in the United States.[34] Four EPSCoR states—Idaho, New Mexico, South Carolina, and Tennessee—are home to DOE's national laboratories, which are the nation's largest supporters of research in the

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years. However, Tennessee still remains in the program. More recent data indicate that Tennessee is poised to graduate from the program in 2013, as are Iowa and Utah. See *U.S. National Science Foundation Experimental Program to Stimulate Competitive Research (EPSCoR)* (Washington, DC: Congressional Research Service, prepared by Christine Mathews, February 28, 2012). Also see data presented at the 4th EPSCoR Evaluation Committee, Washington, DC, March 27–28, 2013.

[32] There are occasions, when NSF RII Track 1 projects have been funded in a series of phases, each 5 years in length. But it is not clear how closely one phase is connected to the next, especially in terms of the research agenda and the program's goal of building sustainable capacity in particular fields of research. See profile in Appendix B, "Science in Place: Alaska's EPSCoR and IDeA Program."

[33] For selected in-depth state profile, see Appendix B.

[34] Richard-Duane Chambers, presentation, NAS 3rd EPSCoR Evaluation Committee, Washington, DC, December 10, 2012.

physical sciences .[35] States with national laboratories often have large nonprofit organizations, such as Oak Ridge Associated Universities and the New Mexico Consortium, that are designed to advance university research through close coordination with their national laboratories. Alabama is home to the NASA Marshall Space Center.

The committee recognized from the outset that it would have neither the time nor the resources to evaluate the states individually.[36] Instead, it decided to identify a few critical factors that are relevant to all state-level operations.

The state-to-state disparities make it difficult to devise a single national strategy or program that is capable of addressing each EPSCoR-eligible state's distinctive needs and aspirations. NSF EPSCoR required the creation of state governing committees, in part, to help address this challenge. Each state governing committee seeks to meld EPSCoR research grant proposals to the state's strategic science and technology and higher education plans.

To directly probe the working structure of the various state governing committees, the committee gathered information directly from the state governing committees of the NSF EPSCoR–eligible states. The committee contacted 29 states eligible for NSF EPSCoR in FY 2012 and received responses from 23. The committee asked for only publicly available, factual information. The questions can be found in Box 2-3. Due to the diversity in the states and the mechanisms that have been set up, general statements concerning the structure and responsibilities of the state governing committees are difficult to make. However, some common themes arose.

Committee Membership

Governing committee membership ranges from 8 individuals in North Dakota to 23 individuals in South Dakota. Almost all committees have state government representation, usually from the governor's office but also from both houses and/or both parties in the state legislature. High-level officials, such as provosts or vice presidents for research, often serve as representatives from the universities. Some states also encourage faculty representation. Many reserve a certain number of seats for representatives from industry.

Almost all committees have fixed terms—normally 3–4 years—with staggered start dates to ensure some continuity. A few states have term limits or limit the amount of time that an individual can serve.

Training for members is mostly informal. Many states now give new member copies of the state's science and technology (S&T) plan as well as relevant EPSCoR program information.

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[35] See *http://science.energy.gov*.

[36] For selected in-depth state profile, see Appendix B.

Box 2-3
State Governing Committee Questionnaire

- How are committee-members selected, introduced, and trained? What kinds of expertise does the membership have? How frequently does the committee membership and leadership change?
- What are the committee's primary EPSCoR-related responsibilities and goals and how have these responsibilities and goals evolved over time?
- Does the state committee have other responsibilities beyond EPSCoR? For instance, does the committee give input to statewide strategies for science and technology or educational planning?
- What metrics are used to determine program success? For example, do these metrics focus on the number of STEM graduates, faculty hires, migration of knowledge-based workers into and out of the state, release time policies, the creation or enhancement of sponsored research offices, and/or increased collaboration?

EPSCoR-related Goals and Functions

The committee's primary function and goal are oversight and maintenance of the state's EPSCoR program. Other key responsibilities include acting as a liaison between NSF and the state, selection of proposals for submission to EPSCoR, coordination between the EPSCoR programs, and promotion of science competitiveness. Overall, respondents did not discuss the evolution of these roles over time.

External Role of the Committee

Virtually all members of state EPSCoR committees have additional responsibilities independent of their positions on EPSCoR committees. Most are related to science, engineering, competitiveness, and/or enhancing the state's workforce. Many committee members mentioned contributing to the state's S&T plan—either individually or collectively. Some state committees double as the board for higher education or as subcommittees on these boards.

Metrics

While a few state committees outlined concrete goals with due dates and quantifiable metrics for measuring success, most provided a standard list of general output measures. For example (derived from Delaware's list):

- Acquiring additional extramural funding.

- Expanding the state's contributions to the scientific community (through a greater number of publications, presentations, honors, awards, and so on).
- Increasing the number of science, technology, engineering, and mathematics graduates.
- Enhancing the diversity of students and faculty.
- Raising the number and quality of faculty hires.
- Stimulating economic development (jobs, patents, new technology, and so on).
- Creating new research institutes.
- Strengthening collaboration and launching new interdisciplinary research and education programs.
- Developing state-of-the-art infrastructure (for example, by improving laboratory equipment and classroom facilities).

Nearly every respondent supplied a detailed list of the committee's activities and accomplishments. Only a small number of respondents, however, provided information about how these measures had been collected, where that information was being stored, or how it was being used. One state even mentioned that information was gathered "by word of mouth."

The committee was convinced that the states had made a conscientious effort to enhance research activities, and received anecdotal evidence pointing to their success. However, it questioned whether there were comparable data to determine which actions are most effective or which programs most successful.

3
Assessments and Outcomes

"It is easy to be complacent about U.S. competitiveness and preeminence in science and technology. We have led the world for decades, and we continue to do so in many research fields today. But the world is changing rapidly, and our advantages are no longer unique."

Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future *(Washington, DC: The National Academies Press, 2006), pp. 12–13.*

"The polity requires greater equality, the economy greater merit. The two, which are not absolute opposites, are however, to a degree in conflict. The task is to make them as compatible and as reinforcing as possible."

Clark Kerr, Troubled Times in American Higher Education (Albany, NY: State University of New York Press, 1994), p. 28.

Measuring the effect of the programs in the Experimental Program to Stimulate Competitive Research (EPSCoR) is no easy task. Congressional legislation describes different objectives for each program. Federal agencies—each harboring different legislative mandates—often pursue different programmatic strategies and seek different outcomes (see Figure 3-1). States, institutions, and researchers each bring their own aspirations, skill sets, and levels of commitment to the effort. Eligible states exhibit broad diversity in demographics, geography, economic standing, and scientific and technical capacity.

Perceived Objective	Example Legislation	DoD	DOE	EICC	NASA	USDA	NIH	NSF
Align Stakeholders	"Integrate [EPSCoR jurisdictions] in major activities and initiatives of the Foundation" (NSF)	● (yellow)		● (green)	● (green)	● (green)	● (green)	● (green)
Drive Competitive Research and Funding	Develop "the research infrastructure …[required to become] more competitive for … Federal research funding" (NSF)	● (green)	● (green)		● (green)	● (green)	● (green)	● (green)
Develop Education, Outreach, and Workforce	"Improve the environment for science, mathematics, and engineering education" (NASA)	● (yellow)	● (yellow)		● (green)	● (green)	● (yellow)	● (yellow)
Build Physical Infrastructure	Support "acquisition of special research equipment and the improvement of … education and teaching" (USDA)	● (yellow)	● (yellow)	● (green)	● (green)	● (green)	● (yellow)	● (green)
Encourage Scientific Collaboration	Help "facilitate collaborations, partnerships, and mentoring activities" (NSF EICC)		● (yellow)	● (green)	● (yellow)	● (green)	● (yellow)	● (yellow)
Promote Social and Economic Benefits	Create "new approaches to rural development, including rural entrepreneurship." (USDA)				● (yellow)	● (green)		● (yellow)
Conduct EPSCoR Program Evaluations	Coordinate and evaluate EPSCoR and EPSCoR like programs (NSF EICC)			● (green)				● (yellow)

Legend: ● (green) Clear Legislative & Agency Goal; ● (yellow) Clear Agency Goal

Figure 3-1. The governing legislation for various EPSCoR and IDeA programs reveal program objectives that differ by agency. [SOURCE: Legislative Objectives: PL 96-44; PL 111-358; PL 103-43; PL 107-293; PL 103-337; PL 102-588; PL 102-486; 7 USC Sec. 450i (AFRI); 42 USC 16.1862 p.9 (EICC). Agency Objectives: Agency program websites such *as http://grants.nih.gov/grants/guide/pa-files/PAR-12-205.html.* Accessed on August 13, 2013]

In short, significant differences among players, objectives, and capabilities present formidable obstacles to analysts and scholars seeking to design comprehensive assessments of the programs' accomplishments.

These obstacles, however, have not precluded assessments of EPSCoR programs. To the contrary, agency and participant reports often present a range of performance metrics that allow proponents to lay claim to EPSCoR's transformative impact on statewide research capacity and competitiveness. While these documents are useful for oversight and advocacy, they often lack the methodological controls required to isolate EPSCoR's impacts from other determinants or larger national trends. For example, countless government reports, academic studies and media stories have highlighted the role of science and technology in stimulating economic growth. The fact that state leaders have become more aware of the value of research cannot be credited to EPSCoR alone and is consistent with a national shift in attitude. Furthermore, commonly used metrics linking university research, technology transfer, and economic development have unproven ties to EPSCoR activities. Although there is broad agreement that research can be an important factor in stimulating economic growth, there is also consensus that it is not sufficient by itself.[37] Numerous

[37] *Measuring the Impacts of Federal Investments in Research: A Workshop Summary*. (Washington, DC: The National Academies Press, 2011); *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security*. (Washington, DC: The National Academies Press, 2012).

other public policy and economic factors play essential roles, and experts do not agree on how to measure the relative contribution of all these factors.

Few independent comprehensive evaluations of federal agency program design or state implementation of EPSCoR programs have been conducted. Existing assessments, moreover, have tended to focus on selected program aspects, have been largely confined to National Science Foundation (NSF) EPSCoR, or were conducted a decade or more ago.[38] As a result, they have not been able to take account of such critical factors as the increase in the number of eligible states, the expanding of programmatic objectives, and the cumulative effects of state and university participation in EPSCoR. In addition, few independent studies have evaluated eligibility criteria or presented comparisons of the effectiveness of the programs across agencies.[39] Nor have they considered the impact of a growing set of program objectives or assessed whether national demand can support an increasing number of research universities.

While such shortcomings warrant independent evaluations, a lack of data present significant additional obstacles. This problem is not unique to EPSCoR. The White House Office of Management and Budget (OMB) has been promotiing a government-wide effort to collect the data necessary for rigorous program evaluation.[40] Furthermore, publicly accessible data are collected and published in a highly aggregated form, making it difficult to draw clear conclusions about national impacts.

As a result of all these factors, EPSCoR's reputation (as recorded in the studies done to date) has been largely based on anecdotal and institutional evidence rather than on detailed analyses of statewide or national results.

EPSCOR IN THE NATIONAL CONTEXT

Given that EPSCoR's mandate calls for fostering greater research competitiveness nationwide, the programs must be assessed in a national context. States and their research institutions compete within a nationwide framework, seeking advantage in both research inputs (faculty, students, facilities, and funds) and research outputs (publications, degrees completed, economic development, and recognition). Furthermore, because EPSCoR's mandate also calls for reducing "undue concentration" of research, it must also be measured within a state, and not institutional, context.

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[38] For an exception, see *Assessment of the Defense Experimental Program To Stimulate Competitive Research (DEPSCoR): Final Report Volumes I and II,* Oct. 2008 (Alexandria, VA: Institute for Defense Analyses, 2008), which evaluates the Department of Defense DEPSCoR.

[39] These goals include improving science education, nurturing greater workforce diversity, serving as a catalyst for economic growth and innovation, and promoting public understanding and appreciation for science.

[40] Office of Management and Budget (OMB), "Memorandum for the Heads of Departments and Agencies," M-10-01, Executive Office of the President, OMB, October 7, 2009.

Share of Federal Academic R&D Expenditures

Evidence to date suggests that EPSCoR programs have had little impact on the national distribution of academic research and development (R&D) expenditures. Such expenditures have historically been concentrated in relatively few institutions located in a relatively few states. As of 2009, aggregating across all currently eligible states, EPSCoR states received approximately the same share of federal academic science and engineering funds as they did at the inception of EPSCoR in 1979 (see Figure 3-2).

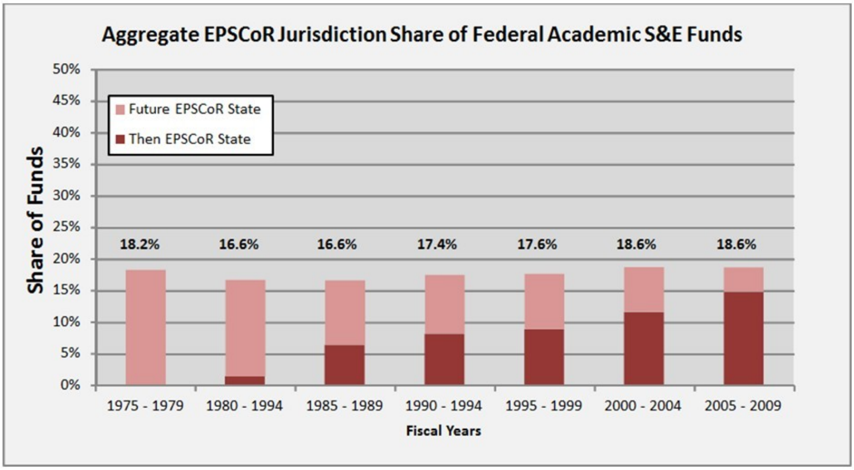

Figure 3-2. The share of federal academic science and engineering funds received by EPSCoR states has remained largely the same since the inception of the EPSCoR program. [SOURCE: NSF Survey of Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions via WebCASPAR]

This outcome should not be surprising. As Yonghong Wu, one of the most authoritative researchers of EPSCoR programs and Associate Professor of Public Administration at the University of Illinois at Chicago, observes:

> "Non-EPSCoR states, which have higher quality universities and researchers, can secure most of the increments of federal S&E [science and engineering] support. As a result, the growth of the aggregate federal S&E support could outpace the addition of EPSCoR funding to EPSCoR states, leaving the share of EPSCoR states' federal S&E funding stagnant."[41]

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[41] Yonghong Wu, "Tackling Undue Concentration of Federal Research Funding: An Empirical Assessment of NSF's Experimental Program to Stimulate Competitive Research (EPSCoR)," *Research Policy* 39 (July 2010).

However, this result does not imply that EPSCoR-like programs have had no impact. As Wu also notes:

> "A small positive effect is better than no effect… Given that non-EPSCoR states are advantaged in obtaining federal S&E support, the distribution of federal funds would have been even more uneven in the absence of the EPSCoR efforts."[42]

Yet noting that the program has produced some favorable results is not saying that it has met expectations. The committee noted that the goal of all federal programs is not just to do some good but to spend taxpayer funds as effectively as possible.

Proposal Success Rates

Changes in the submission and success rates of research grant proposals serve as key indicators of research participation and competitiveness. Available data do not suggest that EPSCoR programs have appreciably improved overall competitiveness of the EPSCoR states by these measures. At NSF, the success rate of proposals for all grants from EPSCoR states has consistently remained 3 to 5 percent lower than those from non-EPSCoR states since 1990 (see Figure 3-3).

However, broad trends in grant success rates mask significant differences among states. In recent years, some EPSCoR states have held their own when competing for federal R&D funds, despite a national decline in proposal success rates due to tightening federal R&D budgets. An increase in the number of proposals is an indication that a state is trying to raise its research profile by hiring additional researchers or giving current faculty more time to devote to proposal writing. The challenge is to maintain quality, which is reflected in the success rate, while increasing quantity. This is particularly difficult during periods when overall success rates are falling. All states have increased their number of submissions during the past two decades, and many have managed to do so without an excessive drop in success rate (see Figure 3-4). Idaho, for example, has doubled its number of proposals with no decline in success rate. Conversely, other EPSCoR states have failed to keep pace and have actually experienced a decline in their rankings for R&D expenditures.

[42] Ibid.

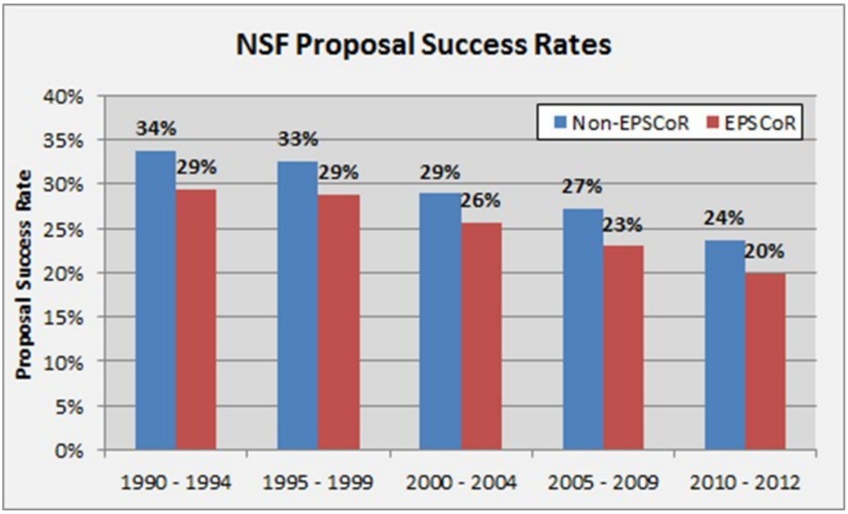

Figure 3-3. Declining proposal success rates have taken place in both EPSCoR and non-EPSCoR states (according to FY 2012 eligibility) although EPSCoR states are consistently lower. [SOURCE: NSF Competitive Proposal and Award Counts by State/Territory and Fiscal Year of Decision; NSF.gov/awardsearch]

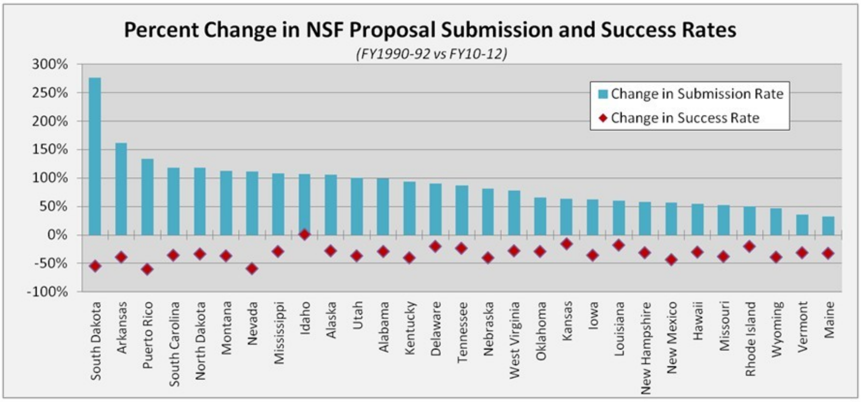

Figure 3-4. Some FY 2012 eligible EPSCoR states have done better than others in increasing their submission rates while minimizing a reduction in success rates. Here a positive "Change in Submission Rate" means an increase in the number of proposals submitted, and a negative "Change in Success Rate" means a decrease in the number of proposals approved. [SOURCE: NSF Competitive Proposal and Award Counts by State/Territory and Fiscal Year of Decision; NSF.gov/awardsearch]

The reasons for these disparities are difficult to determine and would require extensive institutional-level analysis beyond the scope of the committee's charge or resources. In fact, negative short-term trends could actually mark an expansion in the research community. As proposal-writing experience among young researchers grows, their success may increase.

Centers of Excellence

Opportunities for multiyear, multipurpose, and multiobjective centers—such as Engineering Research Centers, Science and Technology Centers, and Materials Research Science and Engineering Centers —represent an important element in NSF's R&D grant portfolio. These large-scale projects not only yield financial rewards but also raise the host institution's image and standing in the research community. Not surprisingly, competition is fierce.

Although universities in some EPSCoR states have successfully competed for these centers,[43] both the number and percentage of awards received by universities in EPSCoR states remains low. Whether this is because EPSCoR universities have submitted fewer proposals or because the proposals have not fared well during the review process cannot be determined. NSF policies do not permit the list of rejected proposals to be made public.

EPSCOR IN THE INSTITUTIONAL AND STATE CONTEXT

As the previous section highlights, EPSCoR programs face formidable challenges in their efforts to alter the national research landscape. EPSCoR proponents, however, often cite the programs' positive impact on individuals and institutions as evidence of programmatic success. Indeed, success on the individual and institutional level could take place—in fact, likely does take place—even as the overall competitiveness of the state does not improve.

Academic Rankings

Measuring the quality of a state's universities is a difficult, if not impossible, task. Recognizing how difficult the task is, the National Academies' assessment of the nation's graduate programs opted not to include a simple quality ranking of university departments.[44] A number of organizations, including *U.S. News and World Report*, publish widely cited rankings of university quality, but the committee does not consider these to be reliable measures of university quality. Universities in EPSCoR states have been submitting more research proposals, which is an indicator of increased research activity, and some universities have won competitions for major research

[43] Examples of research centers include: Montana State University, Mississippi State University, and Clemson University, which have been chosen to host Engineering Research Centers; the University of Alabama, University of Southern Mississippi, University of Nebraska, University of Oklahoma, and University of Arkansas, which have been chosen to host Materials Research Science and Engineering Centers. These and other centers types have also been awarded to other EPSCoR states; this list is not exhaustive.

[44]See *A Data Based Assessment of Research-Doctorate Programs in the United States* (Washington, DC: NAP, 2011).

projects such as the NSF Science and Technology Centers or Engineering Research Centers, which is an indicator of high quality.

Research Culture

Advocates often observe that the EPSCoR programs encourage state governments and institutions to support both higher education and research capacity building. They praise the EPSCoR program for helping to foster significant changes in the priorities, policies, aspirations, and the administrative structure of participating universities. Improvements include establishing chief research officers, creating positions for grant-writing experts, forging stronger private-sector relationships, and highlighting the role that research universities play in state economic growth.

In addition, EPSCoR's state committees are credited with having helped strengthen political support for higher education and facilitating research planning in a number of states. Although these effects are difficult to measure, EPSCoR has nevertheless been cited by administrators and faculty at participating institutions—and by outside observers as well—as having done an admirable job in helping to change the "culture" for the support of research in many of participating states. For example, funding per student at research universities in EPSCoR states has, in the aggregate, equalized to that in non-EPSCoR states (see Figure 3-5). It must be noted that state accounting practices vary and that other factors, such as demographic changes, affects these numbers. Also, total state spending on universities is not a perfect indicator of investment in research activity. In general, and as noted above, the broad cultural changes, which are commonly cited in state reports as due to EPSCoR effects, are impossible to quantify or attribute to EPSCoR alone.

While it is difficult to disaggregate the discrete impacts of EPSCoR, this much is clear: Public universities in EPSCoR-eligible states, many of which once focused largely on undergraduate teaching, have become increasingly invested in research. This trend has been stimulated by many factors, ranging from the growing interest of state governments to promote R&D as a key element of economic development and job creation strategies, to an ever-increasing pool of science, technology, engineering, and mathematics doctoral graduates and postdoctoral students in search of university employment, to the growth in federal funding for academic R&D (at least until recently), and to the pride and recognition that is engendered by having a "home state" university that is gaining a reputation for its research prowess. [45]

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[45]Not all assessments of EPSCoR's impact on state involvement in building research capacity have been positive. Of special concern, as suggested by empirical findings, is that EPSCoR funds may prompt a decline (or crowding out) of state government support of academic research, especially when considering the recent decline in funding for public research universities. As Yonghong Wu notes: "This negative trend of state governments' contribution to academic research contradicts the NSF's expectation of a high level of engagement and commitment by state governments, industries, and other major partners." See "NSF's Experimental Program to Stimulate Competitive Research

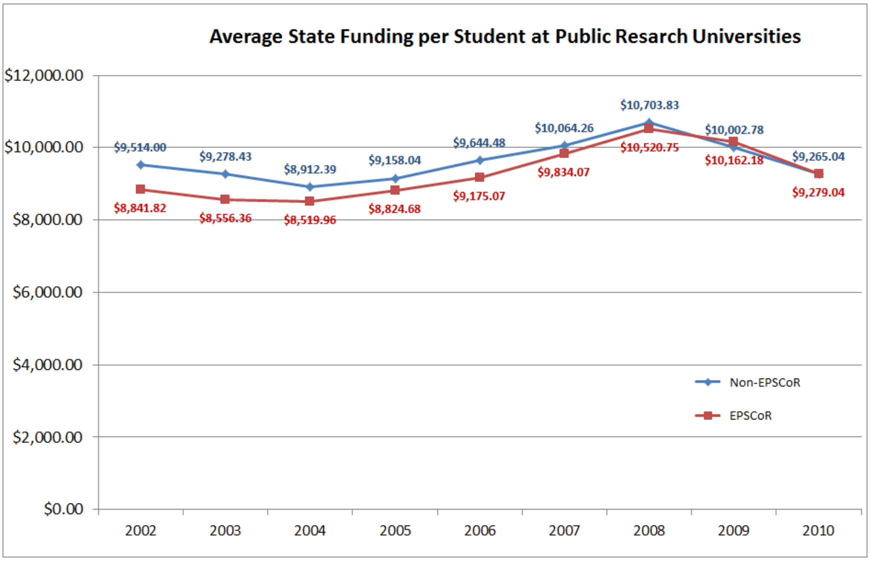

Figure 3-5. The FY 2012 eligible EPSCoR states have—on average—closed the gap in state funding per student. NOTE: Data are unclear as to the cause of this result and cannot be attributed solely to EPSCoR; other factors, such as population shifts or changes in state policies, could have a significant influence. [SOURCE: Table 8-29 "State funding for major public research universities per enrolled student, by state: 2002–2010";*http://www.nsf.gov/statistics/seind12/c8/interactive/table.cfm?table=29*]

BROADER ISSUES

Are Effects Sustainable?

EPSCoR programs face formidable challenges in helping eligible institutions compete for an increased share of federal R&D funds. Although universities pursuing federal R&D dollars are increasingly investing their own resources to build research infrastructure to enhance their competitiveness, public universities are generally facing shrinking appropriations from their states.[46] These reductions are exerting downward pressures on faculty and staff salaries and increasingly impeding the ability of universities to attract top faculty and/or research staff. State budget reductions often constrain funding for

(EPSCoR): Subsidizing Academic Research or State Budgets?" *Journal of Policy Analysis and Management* 28 (2009).

[46] Public universities currently contribute an average 24 percent of their own funds to research infrastructure and initiatives. See *Science and Engineering Indicators* 2012 (Arlington, VA: NSF National Science Board, 2012).

graduate and postgraduate student fellowships, decrease seed money for precompetitive and start-up activities, and delay laboratory maintenance and construction projects designed to enhance institutional research competitiveness. Long periods of fiscal retrenchment can also adversely affect faculty morale. While scant data exist on faculty mobility patterns associated with state budget cutbacks, anecdotal evidence suggests that public research universities have been losing some outstanding faculty to private research universities (see Box 3-1).

Box 3-1
Public University Budget Cuts

Potential Effects on EPSCoR States

In a survey on faculty satisfaction, Julia Melkers and Yonghong Wu found that faculties at EPSCoR state institutions were "generally less satisfied with their relatively low salaries…, were significantly less satisfied…with…the reputation of their institution and academic department," and expressed concerns about "the quality of research assistants and the availability of research equipment and instrumentation."

Following a 30 percent reduction in state support between 2009 and 2011, a junior faculty member commented that every other faculty member under the age of 50 was "looking for a job outside the state." Having joined the University of Nevada, Las Vegas (UNLV) in 2007 "at time when UNLV seemed to be on the rise," the faculty member recently concluded "that the state's antipathy toward academe [has] undermined the university's future."

SOURCE: Melkers and Wu, "Evaluating the Improved Research Capacity of EPSCoR States: R&D Funding and Collaborative Networks in the NSF EPSCoR Program." Review of Policy Research, Volume 26, Number 6 (2009).

It should be noted that public research universities in EPSCoR states do not appear to have suffered greater reductions in state support than their non-EPSCoR counterparts. However, there is no guarantee that state support will continue to be maintained, an important consideration for public universities in EPSCoR states given their more fragile research base (see Table 3-1).

Table 3-1. EPSCoR States Are Among the Most Dependent on State and Local Government Funding for Academic R&D Expenditures

Share of Academic R&D Expenditures from State or Local Government			
All Colleges and Universities		Public Colleges and Universities	
State	%	State	%
North Dakota*	23	District of Columbia	33
Arkansas*	23	North Dakota*	23
Idaho*	21	Arkansas*	23
Louisiana*	17	Louisiana*	21
South Dakota*	17	Idaho*	21
Oklahoma*	15	South Dakota*	17
Montana*	15	North Carolina	16
Kansas*	13	Oklahoma*	16
Virgin Islands*	13	Tennessee*	15
Texas	13	Montana*	15

NOTE: * indicates EPSCoR state
SOURCE: The Survey of Research and Development Expenditures at Universities and Colleges data 2009; *http://www.nsf.gov/statistics/rdexpenditures/*. Accessed on August 13 2013.

THE SUM OF ITS PARTS

Conceived as a time-limited, well-defined, and innovative program, EPSCoR has grown into a large and diffuse initiative. The failure to articulate a coherent and enduring rationale for EPSCoR programs has led both federal agencies and states to expand EPSCoR's strategic framework and range of activities. The absence of a clear and lucid rationale, in turn, has also stymied discussions on alternative eligibility and graduation. As a result, EPSCoR currently embraces definitions of responsibilities and success that not only diverge from the original mandate but are also difficult to examine or assess.

Nonetheless EPSCoR has contributed to increased research competitiveness at a select number of research-intensive and doctoral universities in a number of states. Data, however, show that EPSCoR has not had a significant impact on the aggregate share of federal academic R&D funds received by eligible states or the aggregate award rate of research proposals from EPSCoR states. Additional progress on competitiveness measures would require EPSCoR to overcome structural factors such as the size or population of the states that play such large roles in determining university research competitiveness. EPSCoR funding is a small percentage of the total research funding going to the EPSCoR states, and the committee could not find evidence that the EPSCoR did or did not have a significant impact on the states' ability to attract non-EPSCoR funds. This task is well beyond the mission and means of the EPSCoR program and would be difficult for any initiative to achieve under any circumstances.

Recent reductions in state funding for public universities in most states raise serious questions as to whether the modest gains in research capacity in EPSCoR states can be sustained. If state financial support for higher education falters, the core responsibility of EPSCoR—to serve as catalysts for building research capacity—will falter as well. States that are committed to strengthening research capacity can demonstrate their desire by maintaining support over the long term and taking other actions to encourage research.

4
Findings and Recommendations

"...EPSCoR is critically important and it is important not just because of its basic function of bolstering research and supporting graduate education across the nation but also because of the values it represents."

John Holdren, Assistant to the President for Science and Technology, Director of White House Office of Science and Technology Policy, and Co-Chair of the President's Council of Advisors on Science and Technology (PCAST), in EPSCoR 2030: A Report to the National Science Foundation (Arlington, VA: NSF, *www.nsf.gov/od/oia/programs/epscor/2030%20Report.pdf, 2012*).

"Smart people are everywhere."

Ann Zulkosky, member of the professional staff at the U.S. Senate Subcommittee on Science and Space, First Meeting of the NAS EPSCoR Evolution Meeting, May 24–25, 2012.

Congressional demands for more equitable geographic distribution of federal research spending led to the creation of the first Experimental Program to Stimulate Competitive Research (EPSCoR) program. Aiming to expand opportunities for less advantaged researchers without compromising meritocratic principles, EPSCoR's designers envisioned a short-term initiative that would improve the research competence of eligible states and enable them to successfully compete for federal dollars.

Today's EPSCoR is much different than the EPSCoR of 30, 20, or even 10 years ago. Changes in the program's membership and focus reflect changes both in stakeholder needs and in the broader research environment. The definition of success has shifted to focus largely on institutional rather than statewide research capabilities. All of this has caused EPSCoR to drift from its original mandate while pursuing goals that are in line with its core responsibilities. This assessment of EPSCoR has sought to evaluate the program in terms of its original mandate as well as in its accomplishments that lie both within and beyond what it was initially designed to achieve.

FINDINGS AND RECOMMENDATIONS

The committee supports the continuation of programs that support the proposition stated in the America COMPETES Act:

"The Nation requires the talent, expertise, and research capabilities of all States in order to prepare sufficient numbers of scientists and engineers, remain globally competitive and support economic development."

America COMPETES Reauthorization Act of 2010 *(111th Congress, 2009–2010, April 22, 2010), http://www.govtrack.us/congress/bills/111/hr5116.*

Findings

- **The talent necessary to succeed in science and engineering resides in all states.** Thus, it is in the national interest for the federal government to support efforts to develop and utilize this talent to enhance national research capacity.
- **EPSCoR programs are a part of a broader national and global research enterprise.**
- **Congressional changes in state eligibility requirements and congressional mandates to agencies to create EPSCoR-like programs have resulted in multiple and often competing objectives and policy directives by participating agencies**.
    - Current eligibility criteria have led to more than half the states being included, blurring the programs' objectives and reducing the likelihood of their success.
    - Patterns of eligibility do not align well with other indicators of capacity, such as state population or number of research-intensive universities. As a result, outcomes are difficult to assess, especially on a comparative basis.
- **EPSCoR programs have enhanced the nation's human capital** by strengthening research infrastructure and by training many future scientists and engineers in states where, in some cases, training opportunities had been scarce and largely inadequate prior to the program's arrival.
- **There is some evidence that the EPSCoR programs have not been a good fit for the mission agencies**. For example, EPA and DOD terminated their EPSCoR programs. However, the mission agencies are the major

source of engineering research funding and therefore critical to engineering education.

- **State-level commitments to enhancing research capacity are uneven** across the participating states. The effectiveness of state committees in NSF EPSCoR states is also uneven.
- **There is considerable variation** in agency programs, review processes, and the role and composition of state committees. Further, the NIH IDeA program does not formally involve the state committee in its implementation, although informal interactions do occur.
- **The aggregate share of federal R&D to eligible states has not changed significantly** over the course of the program. There is also considerable variation among states in their progress toward a more competitive posture. In the aggregate, eligible states continue to be less successful in garnering NSF funding than are other states.
- **Nearly all participating states report positive cultural change** in attitudes toward science and engineering as a consequence, at least in part, of EPSCoR programs. Similarly, they also report positive organizational, policy, and program changes that have enhanced their research environment. Further, there is evidence that research capacity in eligible states has increased (although not enough in most cases to change their relative standings). There is anecdotal evidence that EPSCoR programs have contributed to this result, but the magnitude of their contribution is difficult to determine.
- **The evaluation efforts of the EPSCoR-type programs leave much to be desired**. To date, such efforts have relied on incomplete and inconsistent assessment of program designs and on metrics that do not allow for comparisons of effectiveness.

Recommendations

The committee recommends that the federal government continue to promote the development of research capacity in every state so that all citizens across the nation have the opportunity to acquire the postsecondary education, skills, and experience they need to pursue productive and successful careers in science, technology, engineering, and mathematics (STEM) fields and to contribute fully to the nation's research enterprise.

With that in mind, the committee recommends the following actions to create a more focused program with greater impact.

- **EPSCoR programs should concentrate on the programs' core elements**:
    - To enhance research excellence through competitive processes.
    - To enhance capacity for postsecondary training in STEM fields.

- **EPSCoR programs should be restructured to combine beneficial aspects of current programs**:
  - The NIH and NSF EPSCoR programs should pursue a "blended" funding strategy with two tracks:
    - A competitive-grant track that provides fewer and larger grants that are evaluated first for scientific merit and that are intended to produce focal points of research excellence and research opportunities for junior as well as senior faculty.
    - A smaller-scale, infrastructure investment or statewide investment track that works with state committees to ensure that every state has the capacity to provide advanced education and research experience.
  - DOE, NASA, and USDA should develop strategies to help meet the mandate laid out in the America COMPETES Act that all mission agencies support postsecondary education in STEM disciplines.

- **The EPSCoR programs, working through the EPSCoR Interagency Coordinating Committee (EICC), should develop and enforce a realistic framework for state eligibility and graduation from the program**:
  - The 0.75 percent criterion fails to account for population and other critical aspects of research capacity and competitiveness. New graduation and eligibility criteria should be developed and implemented that could consider:
    - Population.
    - State commitment.
    - Proposal success rates per research-university faculty member.
    - Total research funding.
    - Progress to date and future opportunities for progress.
    - Financial need.

- **The committee recommends that the agencies, cooperating through the EICC, reset the guidelines and that all states must reapply for eligibility after the expiration of their current EPSCoR grants.**

- **The proposal review for prospective EPSCoR projects should be made more rigorous to:**
  - Ensure that reviews of the scientific merit of the proposals are conducted by the most highly qualified panels of experts in the field of study. Scientific merit should be the first consideration in any assessment of a proposal's strength and value. Specifically, all proposals should be reviewed in a two-step, sequential process.

        - First, a review of the proposal's scientific merit—a "science score."
        - Second, a review of the proposal's potential (state, agency, societal) impacts—a "program score."
    - Require some level of matching contribution for all research awards to ensure that the state is involved and committed to the project.
        - Sources dedicated as matching funds can be from the state, the university, the private sector, or other sources.

- **The evaluation process conducted during and after an EPSCoR project's implementation should be made more rigorous by:**
    - Developing and implementing an effective third-party evaluation design that is reliable and valid and that is consistent with other federal evaluation approaches, such as those developed by the Office of Management and Budget.

In conclusion, the committee recommends that the newly refocused federal programs be renamed to better reflect their mission and to remove "experimental," which is now a misnomer.

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- 51 USC §40903

Submitted to The Committee to Evaluate EPSCoR…

- Denise M. Barnes, Acting Head, NSF EPSCoR, presentation at the NAS EPSCoR Evaluation Committee, Washington, DC, May 24, 2012.
- Richard-Duane Chambers, presentation, NAS 3rd EPSCoR Evaluation Committee, Washington, DC, Dec. 10, 2012.
- Michael Khonsari NSF EPSCoR Project Director and Associate Commissioner for Sponsored Programs Research and Development in Louisiana, correspondence sent to the NAS Evaluation Committee, October 2012.

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- W. Frederick Taylor, Program Director for the Division of Training, Workforce Development, and Diversity, National Institute of General Medical Sciences, presentation, 1st NAS EPSCoR Evaluation Committee Meeting, Washington, DC, May 24–25, 2012.
- Presentations at 2nd NAS EPSCoR Evaluation Committee Meeting, Washington, DC, September 12-13, 2012.

Appendixes

A
Agency Profiles

This appendix contains brief descriptions of the Experimental Program to Stimulate Competitive Research (EPSCoR) activities in all federal agencies that are currently engaged in the program: The National Science Foundation (NSF), The National Institutes of Health (NIH), The Department of Energy (DOE), and the National Aeronautical and Space Administration (NASA). There is also a description of the Department of Defense's (DOD) DEPSCoR program, which operated from 1995 to 2010. The information in this appendix is drawn directly from material provided by the relevant agencies and from the presentations they made at the committee's first meeting. The format and organization of the information has been standardized to facilitate comparisons. The information includes eligibility criteria, goals, structures, budgets, and current activities. Although all the agency programs emerge from the same underlying motivation to expand and enhance research capacity, they differ in significant ways as a result of each agency's size, mission, management structure, related programs, and research priorities.

NSF EPSCOR

Mission and Evolution

NSF EPSCoR was launched in 1979 in response to Congressional concerns that federal research and development (R&D) funding was concentrated in just a few states and among a few elite research institutions. The program is designed to assist NSF in achieving its statutory function "to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education."[47] An overview of the program is given in Box A-1.

Specifically, NSF EPSCoR promotes sustainable improvements in R&D capacity and competitiveness among eligible states and territories. Further, it seeks to advance research activities for knowledge generation, dissemination and application; nurture collaboration among universities, government and the private sector; expand the participation of individuals and institutions in the science and technology community; and serve as a test-bed for developing other programs designed to advance NSF's major goals.

Key aspects of NSF EPSCoR program have evolved over time. The first grants were designed to investigate the state of research in potentially eligible states and establish state committees to oversee the grant-review process in partnership with the NSF. The initial budget was $1 million (1979 dollars), shared among 5 states. Since NSF EPSCoR's inception, Congress has appropriated more than $900 million to the initiative. In 2012, Congress allocated $151 million to NSF EPSCoR, which accounted for 2 percent of Foundation's $7.1 billion annual budget.

Eligibility requirements have also evolved. At the program's inception, only states receiving less than $1 million in total federal research funding and meeting multiple science and engineering indicators were considered eligible. During the 1990s, Congress adjusted the funding maximum to 0.5 percent of total NSF research funding (based on a 3-year rolling average). Science and engineering indicators were removed as eligibility requirements in the 2000s. At present, Congress requires that eligible states receive less than 0.75 percent of NSF research funds. NSF also mandates that participants create a science and technology development plan. Less stringent eligibility criteria have enabled additional states to join EPSCoR over the past decade. In FY 2012, 28 states and Puerto Rico, the Virgin Islands and Guam participate in the program (see Figure A-1).

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[47] National Science Foundation (NSF) Act of 1950 *(Pub. L. 507-81st Congress, as amended)*

Box A-1
Overview of NSF EPSCoR

Basic Information

- Established: 1979
- Governing Legislation: 42 USC §1862
- *Eligible Jurisdictions:* 31 (2012), based on <0.75% of NSF funding
- *Budget:* $150.9 million (2012)

Program Components

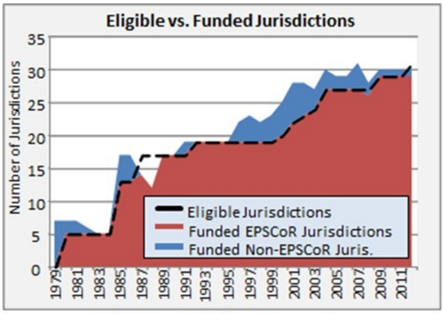
- **The Research Infrastructure Improvement (RII)** awards provides funding for infrastructure and faculty hiring (Track 1); enhances collaboration for discovery, learning and economic development (Track 2); and expands broadband access (C-2 awards).
- **Co-funding** supports applications that require both EPSCoR and non-EPSCoR funding.
- **Workshops & Outreach** activities develop and promote best practices for promoting capacity building, workforce diversity, and science education.

Legislative Goals

- Help develop "the research infrastructure that will make [eligible states] more competitive for Foundation and other Federal research funding"
- "Integrate … EPSCoR jurisdictions in major activities and initiatives of the Foundation."

Additional Agency Goals

- Strengthen US research and education in science and engineering
- Catalyze research themes within EPSCoR Jurisdictions
- Promote regional collaboration
- Broaden participation in Science and Engineering
- Develop, implement, and evaluate programmatic experiments



NSF EPSCoR Eligible Jurisdictions FY2012			
Alabama	Kentucky	New Mexico	Vermont
Alaska	Louisiana	North Dakota	Virgin Islands
Arkansas	Maine	Oklahoma	West Virginia
Delaware	Mississippi	Puerto Rico	Wyoming
Guam	Missouri	Rhode Island	New Jersey
Hawaii	Montana	South Carolina	Utah
Idaho	Nebraska	South Dakota	
Iowa	Nevada	Tennessee	
Kansas	New Hampshire	Utah	

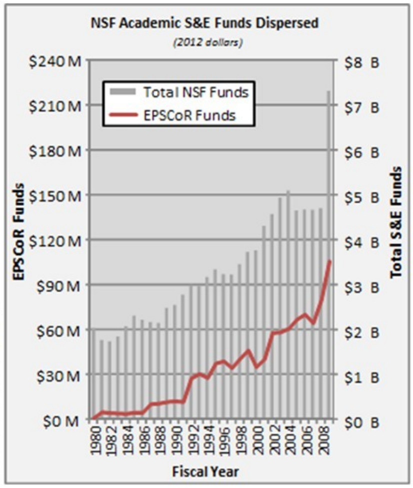


Figure A-1. Changing in NSF EPSCoR over time (Clockwise from upper left): The number of jurisdictions that have received funding has almost always tracked with the number of jurisdictions that are eligible; total funding for NSF EPSCoR has increased steadily with the totally NSF budget; the list of eligible jurisdictions for FY 2012.

The focus of NSF EPSCoR grants has changed over time. The earliest research grants were given to individual investigators. In the 1990s, NSF EPSCoR began to support multi-institutional activities. In 2005, funds for investigators were discontinued in favor of supporting research institutions and consortia. More recently, NSF EPSCoR has supported diverse areas of scientific capacity building that include science education, workforce diversification, economic development, and public appreciation for science.

Operation and Context

In contrast to NSF's general grant program, where individual researchers submit applications directly to the Foundation, the EPSCoR application process relies on state committees to review grant proposals and recommend submissions for NSF's consideration. EPSCoR-eligible researchers may apply for the following funding:

- The *Research Infrastructure Improvement Program (RII)*, accounting for more than 80 percent of the NSF EPSCoR budget, is divided into three tracks:
    - *Track 1 awards* provide up to $4 million a year for up to 5 years to improve the capacity and competitiveness of research institutions in EPSCoR states and territories. Funds are used to build infrastructure, hire new faculty, and support graduate students in fields of research supported both by NSF and the state's science and technology plan.

  - *Track 2 awards*, established in FY 2009, provide up to $2 million a year for up to 3 years to promote collaboration among EPSCoR states in science, engineering, and education. Awards are intended to enhance discovery, learning, and economic development.
  - *C 2 awards*, established in FY 2010, provide up to $1 million for up to 2 years to promote inter- and intra-campus cyberconnectivity in EPSCoR states. The awards seek to expand broadband access for research activities that address issues conforming to the state's science and technology plan.
- *Co-Funding* enables individual investigator grant applications that have been recommended for an award by another NSF office, yet denied funding due to budget constraints, to receive 80 percent of funding from the EPSCoR office and 20 percent from other NSF directorates.
- *Workshops and outreach* awards support conferences, community activities, and travel to explore opportunities in emerging areas of science and engineering, to exchange information concerning NSF policies and programs, and to promote “best practices” for capacity building, workforce diversity, science education and other strategic areas.

Process Assessment

NSF EPSCoR’s proposal process attempts to ensure local commitment to science and technology. EPSCoR state committees—comprised of university administrators, researchers, and representatives from the private sector, among others—seek to integrate the program into state strategies for scientific capacity and economic development. NSF mandates that states develop strategic plans for building scientific capacity and requires 20 percent cost-sharing for all RII awards. This approach has been credited with encouraging the development of niche research capabilities. For example, in West Virginia, EPSCoR funding has helped to advance bionanotechnology and molecular science; in Oklahoma, genomics and research on biofuels; in Wyoming, research on water quality and systems; and in Hawaii, research on biodiversity.[48]

Once research proposals are submitted to NSF, the Foundation’s internal review is intended to ensure that all activities have both scientific merit and the potential to exert a broad impact on society and the economy.

Program Assessment

Assessments of EPSCoR, while generally positive, have elicited several criticisms. These criticisms, often produced as official agency reports, are offered as helpful suggestions designed to improve what is viewed as a

[48] Presentations at 2nd NAS EPSCoR Evaluation Committee Meeting, Washington, DC, September 12-13, 2012.

worthwhile initiative. The *EPSCoR 2030* report, for instance, notes that the program increasingly addresses challenges—including improving primary school science education, diversifying the science and technology workforce, and linking scientific capacity to economic development—that are only peripherally related to competitiveness.[49] While these are worthy efforts, there is growing concern that NSF EPSCoR may not have sufficient resources to address such complex national issues. Observers also note that NSF has collected scant evidence supporting the program's long-term impact in these areas.

Regarding NSF EPSCoR's legislative objectives, NSF strongly emphasizes its effort to integrate EPSCoR states into its general research grants programs and administrative frameworks. While observers acknowledge that these efforts have not uniformly increased competitiveness, EPSCoR participants have increased their share of NSF funding, even if only in small amounts (see Figure A-2). However, no state has merited graduation by increasing its share of the NSF budget beyond 0.75 percent although Tennessee, Utah and Iowa appear on track to do so in 2013.

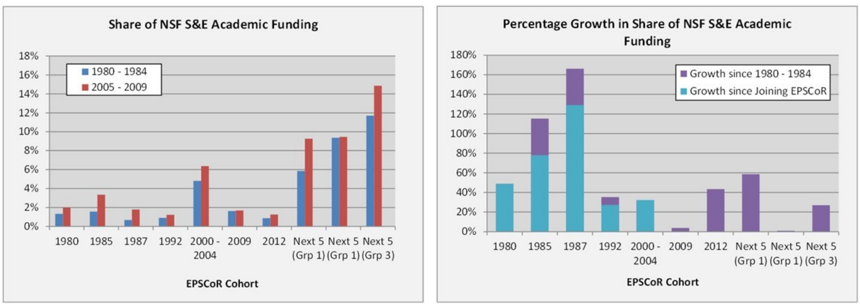


Figure A-2. Each cohort has benefitted from increases in its share of NSF funding, much of which occurred after joining EPSCoR. Many non-EPSCoR states, while increasing their share, have not grown as rapidly.

Moreover, the share of NSF research funding held by the 2012 EPSCoR states has remained remarkably consistent. Changes to the distribution of NSF funds do not suggest a reduction in "undue concentration." (See Figure A-3).

[49] *EPSCoR 2030: A Report to the National Science* Foundation (prepared by Paul Hill, Principal Investigator: Arlington, VA: NSF, 2012).

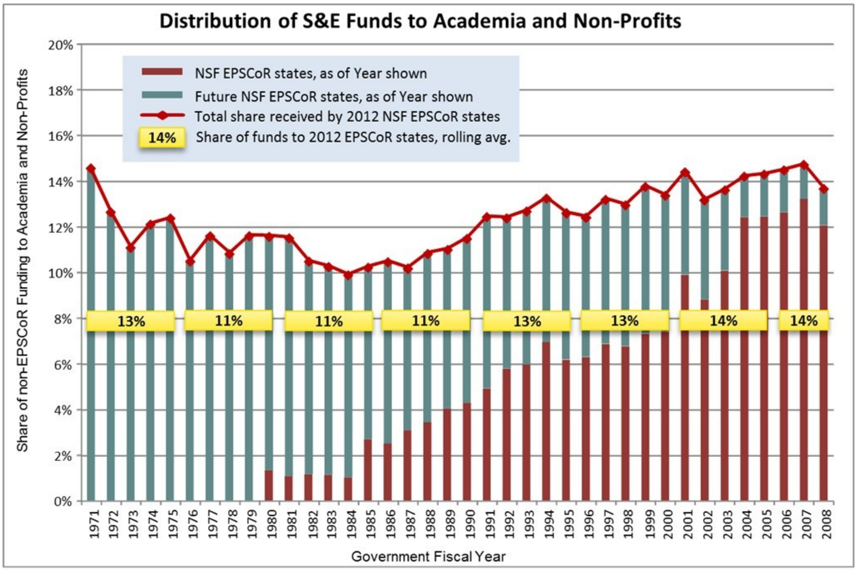


Figure A-3. EPSCoR states have not been the main beneficiaries of changes in the distribution of NSF funding. The share of non-EPSCoR funding to academic and non-profit organizations in EPSCoR states has not changed dramatically since the program's inception.

Despite the program's limited or negligible impacts, officials and administrators involved in EPSCoR express high regard for the program, claiming that it has not only strengthened scientific capabilities but has also changed cultural attitudes towards science by raising the profile and importance of science in economic development strategies.

NIH IDEA

Mission and Evolution

The Institutional Development Award (IDeA) program aims to increase the competitiveness of research institutions in states that historically have experienced low NIH grant proposal success rates. IDeA provides opportunities for underserved populations, augments national biomedical research capacity, and promotes economic and workforce development. An overview of the program is given in Box A-2.

Launched in 1993 with a budget of $2 million, IDeA has benefitted from broad federal interest in biomedical research. Although IDeA receives only a small portion of total NIH funding, its budget (totaling $230 million in FY 2012) makes it the largest EPSCoR-like program, accounting for half of the national EPSCoR budget allocation.

Operation and Context

IDeA is comprised of three components:

- The *Centers of Biomedical Research Excellence (COBRE)* program supports multi-disciplinary, collaborative facilities under the leadership of an established senior researcher. Junior investigators involved in the program supervise independent projects with a shared theme. Intended to develop biomedical faculty research capabilities and enhance research infrastructure within a specific institution, COBRE currently supports 84 thematic centers and receives 80 percent of the IDeA budget.
- The *IDeA Networks of Biomedical Research Excellence (INBRE)* program promotes collaboration among institutions within a state. Funding is intended to improve the research capacity of partnering institutions and increase the state's scientific capabilities by providing research support to faculty and funding research and outreach opportunities for undergraduates. INBRE currently supports 270 undergraduate institutions and funds IDeA-Net, an internet-based network designed to promote collaboration.
- The *Infrastructure for Clinical and Translational Research* (IDeA-CTR) program, a COBRE-related activity launched in September 2012, funds clinical and translational research on diseases that either affect medically underserved populations or are prevalent in IDeA states.

Box A-2
Overview of NIH IDeA

Basic Information

- Established: 1993
- Governing Legislation: 42 USC 282
- *Eligible Jurisdictions:* 24, based on proposal success rate of under 20% or average total award of under $120 million/year, from 2001 - 2005
- *Budget*: $230M (2012)

Program Components

- **IDeA Centers of Biomedical Research Excellence (COBRE)** promotes – in three five-year phases – multi-disciplinary centers, led by an NIH-funded investigator.
- **IDeA Networks of Biomedical Research Excellence (INBRE)** support collaborations between research institutions.
- **Infrastructure for Clinical & Translational Research (IDeA-CTR)** grants develop regional capacity and fund collaboration across states.

Legislative Goals

- "Assist … in developing [and implementing] a plan for biomedical or behavioral research proposals"
- "Enhance the competitiveness of [IDeA institutions] in obtaining funds from the national research institutes"

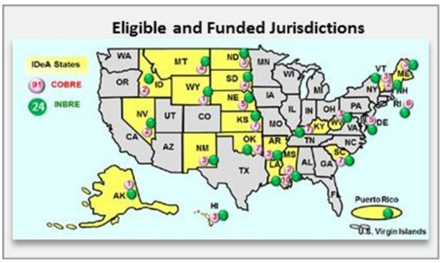
Additional Agency Goals

- "Augment and strengthen biomedical research capacity"
- "Build on the established multi-disciplinary research network"
- "Provide research opportunities for students from primarily undergraduate institutions, community colleges and minority serving institutions"
- "Include accomplishments in … workforce and economy"

Process Assessment

Programmatic evaluations underscore IDEA's effectiveness in sustainably strengthening institutional research infrastructure and training junior investigators. Unlike other EPSCoR agencies, NIH is based on long-term funding strategies, requires participants to create detailed mentoring plans, and expects beneficiaries to develop a plan for sustaining gains once IDeA funding ceases. COBRE grants are awarded in three five-year phases. Renewal depends on success in the previous phase. Phases I and II seek to develop research infrastructure and nurture a critical mass of investigators. Phase III supports pilot projects and additional training to ensure the center's sustainability. At the conclusion of Phase III, COBREs are expected to maintain their research excellence through institutional support and external funding, including from non-IDeA NIH programs.

IDeA eligibility requirements, however, raise concern about the program's trajectory. Under the official requirements—which admit all states with proposal success rates below 20 percent—40 are eligible. In response to the challenges posed by an increasing number of participants, NIH froze eligibility in FY 2008. While this action will help ease pressure on the budget, it is likely to preclude graduation. A longer-term solution is warranted (see Figure A-4).



NIH IDeA Eligible Jurisdictions

FY2012 NIH IDeA Eligible		Addt'l Success Rates < 20% (FY08-12)	
Alaska	Montana	South Dakota	Guam
Arkansas	Nebraska	Vermont	Illinois
Delaware	Nevada	West Virginia	Indiana
Hawaii	New Hampshire*	Wyoming	Iowa
Idaho	New Mexico	Alabama	Michigan
Kansas	North Dakota	Arizona	New Jersey
Kentucky	Oklahoma	Colorado	Ohio
Louisiana	Puerto Rico	D.C.	Texas
Maine*	Rhode Island	Florida	Virgin Islands
Mississippi	South Carolina	Georgia	Virginia

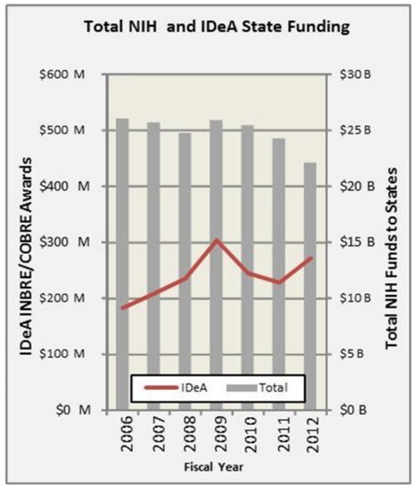


Figure A-4. While freezing eligibility prevents growth in the number of IDeA states and safeguards the budget, it may also prevent states with growing research capabilities from graduating from the program.

Program Assessment

IDeA concentrates on strengthening institutional research capacity and competiveness largely by helping institutions to build laboratories, purchase equipment, and support mentorship activities for faculty and students. A 2008 evaluation of the COBRE program yielded a positive program review, noting that "COBRE funds were often able to be leveraged to obtain matching funds from other sources to enhance the research infrastructure."[50]

Other success metrics highlight the availability of competitive funding and the number of IDeA-related articles published in peer-reviewed journals

[50] "Process Evaluation of the Centers of Biomedical Research Excellence (COBRE) Program." Carlyn Consulting. Submitted to the National Center for Research Resources, National Institutes of Health. September 2008.

(See Figure A-5). More than 80 percent of junior investigators who have received IDeA funding have subsequently attained non-IDeA research funds from NIH and other sources. In FY 2011, COBRE's 786 research projects—involving 1482 investigators, 21 historically black colleges and universities, 17 tribal and 21 Hispanic-serving colleges and universities—collectively published 1449 articles, with another 693 papers in press. In the same year, INBRE funded 658 research projects with 1808 investigators, supported more than 800 summer research students, and produced 610 peer-reviewed articles (with another 259 in press).

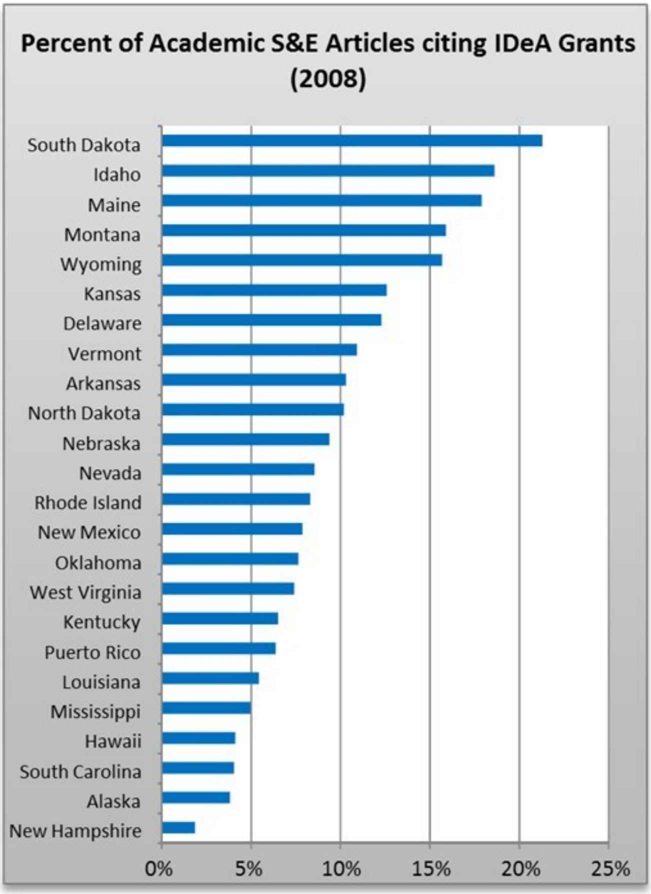


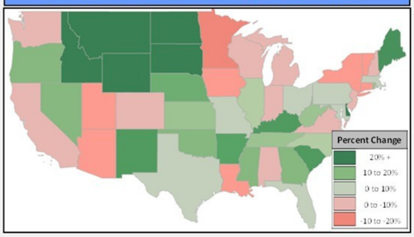
Figure A-5. Self-reported data collected by NIH indicate that IDeA supports significant shares of published articles in several IDeA states.

However, the ability of IDeA to increase the competitiveness of participating institutions for federal funding remains difficult to measure (see

Figure A-6). The Committee was unable to procure a comprehensive evaluation of non-EPSCoR federal funding by institution. Further, there is no clear way to assert that changes in institutional competitiveness result from IDeA or related programs. One potential proxy measure, the distribution of NIH science and engineering (S&E) funding by state, does not suggest a strong correlation between IDeA and competitiveness. While many IDeA states have increased their share of NIH funding over the lifetime of the program, the list of the most (and the least) competitive states remains virtually unchanged. Given that no COBRE institution has completed all three phases of the program, more time may be required before a full analysis is possible.

Distribution of NIH S&E Funds to Universities, Colleges, and Non-Profits

Change in Share of NIH Funding *(FY90-94 vs. FY05-09)*



Rank of Jurisdictions by Funding Received

Rank	1993	2009	Rank	1993	2009
1	California	California	43	West Virginia	Mississippi
2	New York	New York	44	Nevada	Delaware
3	Pennsylvania	Pennsylvania	45	Montana	West Virginia
4	Texas	Texas	46	Delaware	Nevada
5	Massachusetts	Massachusetts	47	North Dakota	South Dakota
6	Maryland	North Carolina	48	Alaska	Alaska
7	North Carolina	Maryland	49	Wyoming	Idaho
8	Illinois	Illinois	50	Idaho	North Dakota
9	Michigan	Michigan	51	South Dakota	Wyoming
10	Connecticut	Ohio	52	Maine	Maine

Figure A-6. (Left) While the percentage increase in funding share is dramatic in South Dakota (730%), North Dakota (273%), Montana (264%), and Alaska (164%), the total amount of money garnered by these states remains relatively small. (Right) The ranking of the most and least competitive states has not changed dramatically since the start of the IDeA program.

A lack of available data makes it difficult to measure IDeA's impact on developing physical infrastructure. Moreover, wide variations in the initial competitiveness of participating institutions may give an edge to more "research ready" institutions and therefore could mean that funds are being channeled to those least in need. IDeA-supported mentoring and recruitment efforts, moreover, have been uneven. For example, the program has been more successful in recruiting male researchers than it has been in recruiting female researchers.[51] More broadly, all of the indices and testimonials pointing to success beg the question of whether investments in IDeA represent the most effective way to spend NIH's resources, especially when the success rate for NIH general research grants continues to fall due to declining federal budgets for R&D.

[51] IDeA Program 2012 Report: Submitted to the National Academy of Sciences. Capacity Building Branch, Division of Training, Workforce Development, and Diversity, National Institute of General Medical Sciences, National Institutes of Health (2012).

USDA EPSCOR

Mission and Evolution

In line with other EPSCoR programs, USDA EPSCoR seeks to improve university research capabilities and to support faculty and young scientists in states that have historically received low levels of research funding. USDA EPSCoR also supports the agency's long-standing mission to improve agricultural practices. As a result, applicants are encouraged to submit grants that focus not only on research but also on education and extension services. Further, USDA officials work directly with agricultural scientists and not through state oversight committees. An overview of the program is given in Box A-3.

Box A-3
Overview of USDA EPSCoR

Basic Information

- Established: 1992
- *Governing Legislation:* 7 USC Sec. 450i (AFRI)
- Eligible Jurisdictions: 26 (2012)
- *Budget:* $18.3M (2012 Strengthening)

Program Components

The Agriculture and Food Research Initiative (AFRI) Food and Agricultural Science Enhancement (FASE) program gives EPSCoR states special consideration for fellowships, new investigator and strengthening awards. Strengthening awards, which devote 7.5% of the AFRI budget to EPSCoR and small/minority-serving institutions, include:

- Strengthening Standard Proposals.
- Strengthening Coordinated Agricultural Project Proposals.
- Seed Grants ($150,000 for two years). Sabbaticals (up to 1 year), and Equipment Grants (50% of cost or $50k).

Legislative Goals

- "Allocate grants…to high-priority research."
- "Improve research … capabilities in States … in which institutions have been less successful."
- Improve "research, development, technology transfer, and education capacity through the acquisition of special research equipment."
- "Make grants for research … by multi-disciplinary teams."
- Support "new approaches to rural development"

Operation and Context

Unlike other agencies, USDA does not operate a separate EPSCoR program as an independent program with a separate budget. Instead, USDA EPSCoR is embedded into the Agriculture and Food Research Initiative (AFRI), USDA's largest competitive grants program. AFRI—which funds studies in sustainable food production, bioenergy and the environment, food safety and nutrition, and youth, family and community—supports a range of research institutions through various grants, including:

- *Standard grants* devoted to research, education, and extension services.
- *Coordinated agricultural project (CAP) grants,* which foster collaboration among individuals, institutions, states, and regions.
- *New investigator awards* for researchers with fewer than 5 years of post-graduate experience and no competitive federal funding beyond postdoctoral grants.
- Pre- and post- doctoral fellowships.
- Conference grants.
- Food and Agricultural Science and Enhancement (FASE) grants.

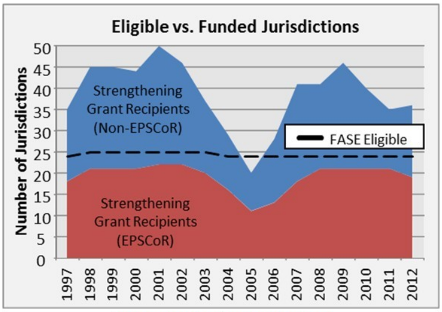
Like other EPSCoR programs, FASE restricts eligibility requirements. USDA only accepts FASE applications from states falling below the 38th percentile in terms of AFRI research funding.

If a meritorious FASE-state application does not procure funding (due to budget constraints), it is given another opportunity for consideration. FASE reserves 10 percent of the total AFRI budget for these applications. A quarter of this budget reserve, or 2.5 percent of the total, supports new investigator awards and the remaining 7.5 percent supports strengthening awards designed to build institutional capacity in eligible states or in small- and mid-sized institutions that have had limited success in securing federal funds. Strengthening awards provide for AFRI standard and CAP grants. The awards also provide funds for equipment, faculty salaries, student stipends, sabbaticals and seed money for preparing larger grant proposals.

Process Assessment

USDA EPSCoR has several positive attributes unique to this program. Because FASE is fully integrated into USDA's overall grants program, all applicants must first compete directly with their counterparts from across the nation. This process offers a clear and compelling gauge of competitiveness. In addition, the FASE budget framework provides greater financial protection from direct budget cuts than other EPSCoR programs since reductions in FASE funding require similar reductions in the AFRI budget. Finally, FASE's eligibility requirements allow for a changing roster of participants and permit graduation. States such as Connecticut, Mississippi, Rhode Island and New

Mexico, for example, have become ineligible for the program based on their comparative ranking in securing AFRI funding (see Figure A-7).



USDA EPSCoR Eligible Jurisdictions			
FY2012			Pre-FY2012
Alabama	New Hampshire	Wyoming	Arkansas
Alaska	New Mexico	American Samoa	Delaware
Connecticut	North Dakota	D.C.	Hawaii
Idaho	Oklahoma	Guam	Louisiana
Kentucky	Rhode Island	Micronesia	New Jersey
Maine	South Carolina	N. Mariana Islands	Utah
Mississippi	South Dakota	Puerto Rico	
Montana	Vermont	U.S. Virgin Islands	
Nevada	West Virginia		

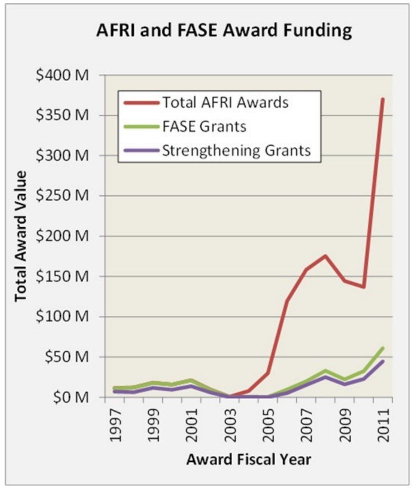


Figure A-7. While the number of FASE-eligible states has remained fairly stable, FASE funding has fluctuated with the AFRI budget.

Objectives Assessment

Limited information exists for assessing the ability of USDA EPSCoR to achieve its long-term goals. Unlike other agency competitive grant programs, USDA AFRI displays a relatively balanced geographical funding distribution. Between 2009 and 2012, for instance, no state received more than 10 percent of AFRI funding. However, this may not indicate that FASE-eligible states have become more competitive. Rather, the overall proposal success rate of FASE states has fallen over this period.

AFRI has clearly provided for significant research and training investments in FASE-eligible states. Of the 136,000 training months (undergraduate, graduate and post-doc) funded by AFRI since 1997, more than 16 percent were conducted through strengthening grants (see Table A-1). The long-term effects of this capacity building remain to be seen.

Table A-1 Composition of AFRI Strengthening Awards (1997 – 2012)

Strengthening Grants	**Award Count**	**Total Award (Millions)**	**Training Months**
Standard Grants	546	$158	17,628
Seed Grants	124	$15	1,926
Unmarked/Other	219	$14	2,456
Equipment	229	$10	36
CAP Grants	2	$7	54
Career Enhancement	50	$3	(no data)
Sabbatical	5	$0.3	7
Subtotal	**1.175**	**$206**	**22,107**
Total ARFI	**4.117**	**$1,413**	**136,001**
Strengthening %	**29%**	**15%**	**16%**

Finally, USDA data suggest that EPSCoR states actively participate in USDA activities. Of the 522 panelists serving USDA in 2012, 14 percent originated from EPSCoR states. Unfortunately, insufficient data exist to show trends over time. Similarly, the Committee was unable to obtain sufficient information regarding the effects of USDA EPSCoR on economic development or scientific collaboration.

DOE EPSCOR

Mission and Evolution

Launched in 1991 as part of the DOE's University and Science Education Programs, DOE EPSCoR seeks to enhance participant capabilities in fields relevant to the DOE research agenda. Housed in the Office of Basic Energy Sciences (BES), DOE EPSCoR helps BES and other DOE offices sponsor interdisciplinary research in such fields as computing, biological and environmental research, fusion energy, and waste management. An overview of the program is given in Box A-4.

Initially designed to help states develop competitive proposals through planning grants, the program has increasingly focused on developing research clusters, fostering collaborative relationships between EPSCoR states and national laboratories, and providing financial support to graduate students, post-doctorate students, and young faculty.

As of FY 2012, the program budget had declined to $8.5 million, a significant reduction from FY2 011's $22 million budget allocation. Yet, the number of eligible states increased over the same period. In 2012, twenty-eight states and three U.S. territories—including new entrants Missouri and Guam—were eligible to receive funding.

Operation and Context

DOE EPSCoR's stated goals include enhancing the capacity of states to conduct sustainable and nationally competitive research, promoting infrastructure development through improved human and technical resources, and fostering relationships between universities and the DOE national laboratories. DOE EPSCoR pursues these goals through three grant types:

- *Implementation grants* provide up to $2.5 million per year (with an optional 3 year renewal) to "clusters" of scientists conducting research on a theme relevant both to DOE research and the state's strategy for building scientific capacity. States may support concurrent proposals and grants. Other DOE offices are requested to co-fund 10 percent of the budget.
- *Laboratory partnership grants* allow individual principal investigators to receive up to $200,000 per year, over 3 years, to foster collaborative research with a DOE national laboratory. Grants are intended to promote student and faculty training as well as site visits.
- *Early career awards*, issued by the Office of Science Early Career Research Program, support the research programs of meritorious young scientists. When funds are available, EPSCoR-state applicants, who may not otherwise have received funding, are given 4 years of support through the EPSCoR program. A fifth year of support must be provided by a partner DOE program area or office.

Box A-4
Overview of DOE EPSCoR

Basic Information

- Established: 1991
- Governing Legislation: 42 USC §13503
- *Eligible Jurisdictions:* Based on NSF criterion
- *Budget*: $8.5 million (2012)

Program Components

- **Implementation grants** promote university capabilities by funding research "clusters" for three to six years.
- **Laboratory partnership grants** support student and faculty development by supporting collaboration with DOE laboratories.
- **Office of Science early career awards** provide five years of funding, through an Office of Science program, to promising EPSCoR-eligible researchers.

Legislative Goals

- "Enhance the competitiveness of the peer review process within academic institutions
- "Increase the probability of long-term growth of competitive funding to investigators"

Additional Agency Goals

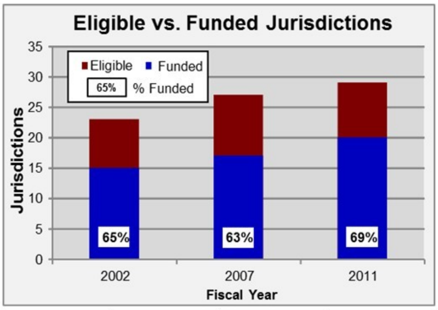
- "Jumpstart infrastructure development…through increased human and technical resources [and] training scientists and engineers
- "Build beneficial relationships between scientists and engineers in the designated states and territories with the 10 world-class laboratories managed by the Office of Science"

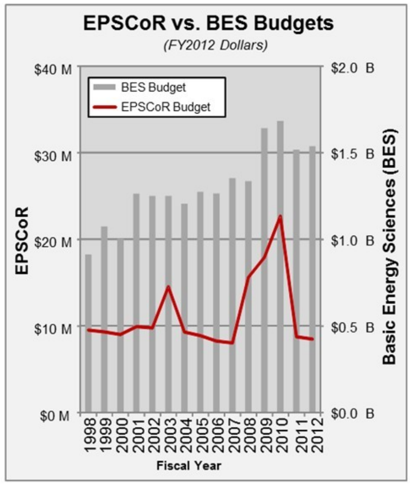
Process Assessment

The DOE EPSCoR proposal assessment process includes several measures to ensure that EPSCoR funding supports both the agency mission and the state's science and technology strategy. States, for instance, play a key role in identifying proposals for review. Laboratory partnership grants include endorsement letters. The states select a single candidate for implementation awards.

As is the case in other mission-oriented agencies, DOE's co-funding strategy strives to ensure that EPSCoR supports the broader agency mission. All grant applicants must identify the DOE program to which their proposal is most relevant. While states are not required to provide matching funds to receive EPSCoR awards, DOE program offices are requested to co-fund up to 10 percent of each implementation grant. Laboratory partnership grants are required to co-fund 20 percent of science early career awards. According to the DOE EPSCoR program, this measure is critical to transitioning its projects to other DOE offices.

As in other agencies, DOE EPSCoR proposals also undergo peer review based on scientific merit. To date, this process has permitted nearly two-thirds of eligible states to receive EPSCoR funding in each year for which data were readily available (see Figure A-8).





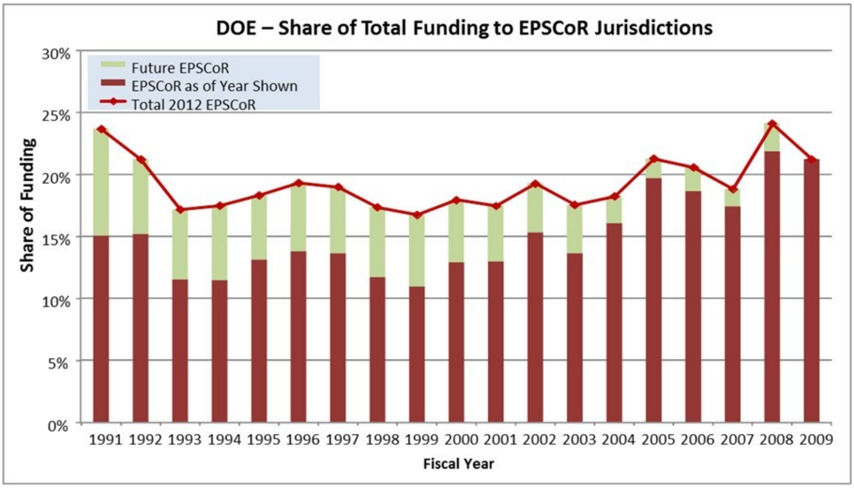
DOE EPSCoR Eligible Jurisdictions FY2012			
Alabama	Kentucky	New Mexico	Vermont
Alaska	Louisiana	North Dakota	Virgin Islands
Arkansas	Maine	Oklahoma	West Virginia
Delaware	Mississippi	Puerto Rico	Wyoming
Guam	Missouri	Rhode Island	New Jersey
Hawaii	Montana	South Carolina	Utah
Idaho	Nebraska	South Dakota	
Iowa	Nevada	Tennessee	
Kansas	New Hampshire	Utah	

Figure A-8. Despite operating with less than 1 percent of the BES budget on average, EPSCoR funded approximately two-thirds of eligible states in the years surveyed.

Program Assessment

Unlike other EPSCoR programs, DOE EPSCoR's legislative mandate focuses exclusively on institutions and individual researchers rather than on states as a whole. There does not appear to be a requirement for reducing "undue geographic concentration" as, for example, in the NSF program. However, the lack of historical data on institutions and researchers calls for investigating trends at the state level.

Neither DOE funding nor proposal success trends indicate changes in the competitiveness at the state level. A review of DOE funding for science and engineering at universities, colleges, and non-profit organizations, moreover, does not suggest a significant change in the share of funding received by EPSCoR states since 1991. Similarly, while proposal success rates for non-EPSCoR and EPSCoR states have been remarkable similar, EPSCoR states do not appear to have improved their competitiveness (see Figure A-9). Rather, the gap seems to be widening despite the addition of more successful states like Rhode Island (2004), Tennessee (2004) and Utah (2009).



	2012 Non-EPSCoR		2012 EPSCoR		Overall	
Year	Proposals	Success Rate	Proposals	Success Rate	Proposals	Success Rate
2002	2,197	48%	544	48%	2,741	48%
2007	2,527	46%	560	46%	3,087	46%
2011	2,720	44%	671	39%	3,391	43%

Figure A-9. Neither the success rate of proposals in the BES nor the EPSCoR-state share of total DOE funding suggest increases in competitiveness.

The data required to assess EPSCoR's impact on scientific collaboration and researcher development are similarly limited. Only data regarding the number of students supported in 2011 were available (see Figure A-10).

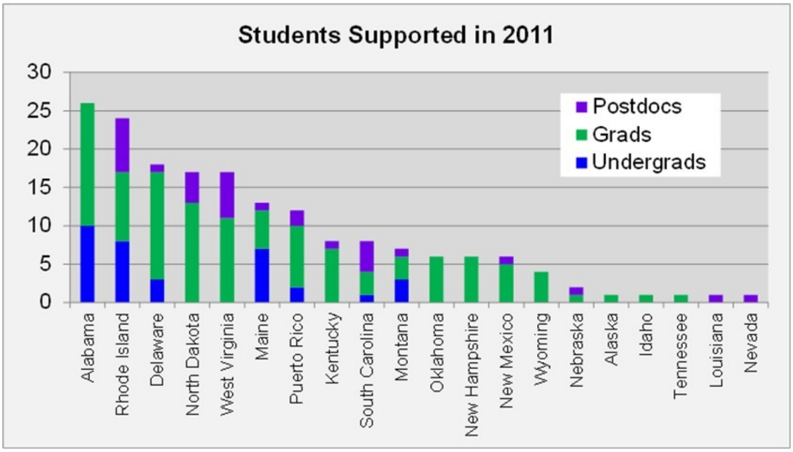


Figure A-10. The number and type of students supported varied greatly across the states. NOTE: Data only available for 2011.

NASA EPSCOR

Mission and Evolution

Established in 1993, NASA EPSCoR seeks to sustainably improve the competiveness of eligible institutions in aerospace research and other fields aligned to the agency's mission. NASA EPSCoR supports broad capacity-building goals, including greater workforce diversity, improved science education, and stronger ties between research and economic development activities. An overview of the program is given in Box A-5.

Box A-5
Overview of NASA EPSCoR

Basic Information

- Established: 1993
- Governing Legislation: 51 USC §40903
- Eligible Jurisdictions: Based on NSF criterion
- *Budget:* $18.3 million (2012)

Program Components

- **Research Infrastructure Development (RID) awards** build scientific capacity by strengthening the relationships between academic and NASA researchers.
- **Research awards** address high-priority NASA research and technology development needs.

Legislative Goals

- "Ensure the resilience of the national space and aeronautics infrastructure"
- "Foster competitive research capacity in all geographic areas of the Nation"
- "Enhance the ability of researchers in the State to become more competitive"
- "Improve the environment for science, mathematics, and engineering education"

As at NSF, NASA EPSCoR's governing legislation addresses equity issues, requiring the NASA Administrator to seek the "maximum distribution of grants among eligible states, consistent with merit."[52] The legislation further asserts that strengthening the research capacity of previously unsuccessful states strengthens the U.S. aviation enterprise as a whole.

[52] 51 USC §40903

NASA EPSCoR program objectives include developing research infrastructure in areas of strategic importance, forging partnerships between universities, industry and NASA centers, and strengthening scientific capabilities, science education, and economic development in eligible states. To ensure alignment with similar NASA programs, EPSCoR is required to work closely with NASA's National Space Grant College and Fellowship Program, which is designed to improve STEM education.

In FY 2012, NASA EPSCoR operated with a budget of $18.4 million, a decline from the $25 million FY 2010 budget. At the same time, the number of eligible states grew to 31 in 2012. Program eligibility conforms to the NSF requirement that participating states receive less than 0.75 percent of NSF funds (averaged over the past 3 years).

Operation and Context

The two main components of NSF EPSCoR are:

- *Research Infrastructure Development (RID)* awards, which provide $125,000 in annual funding for 3 years (with provisions for a 2-year renewal). Managed by a NASA EPSCoR Director, RID awards support seed grants, meetings, and the development of new funding proposals.
- Research Awards (RA), which provide up to $750,000 over 3 years to address high-priority NASA research and technology development needs.

Process Assessment

NASA uses a proposal review process intended to ensure that EPSCoR funding supports agency priorities while conforming to the goals of state science and technology and economic development strategies (see Figure A-11). NASA state directors provide a point of contact between NASA and the state's scientific partners. State directors are also required to work closely with a technical advisory committee and to coordinate their efforts with the state's EPSCoR director. NASA evaluates RID proposals solely on the basis of technical merit. Larger RA awards are evaluated first by online peer review and then by a NASA expert panel. Once a research award has been granted, NASA monitors the work to ensure that the research meets NASA standards.

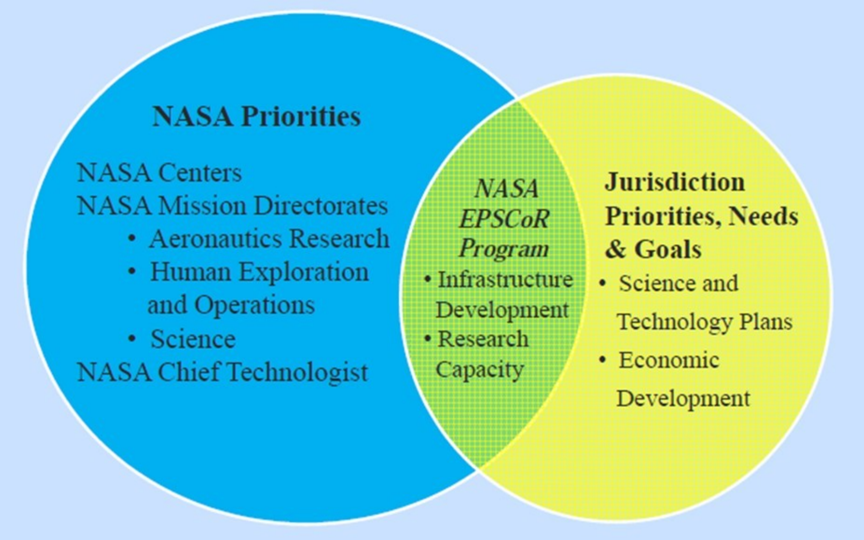


Figure A-11. NASA EPSCoR exists at the intersection of NASA priorities and the state's economic development strategy.

RID awards require a one-to-one match in in-kind contributions and/or nonfederal funds from participating institutions. Research awards require a 50 percent match. Whereas the number of RID awards is limited to one per state, RA awards are limited by proposal merit and the available budget.

Program Assessment

NASA collects extensive data on the benefits of its EPSCoR program. Metrics include funding per state, faculty and student participation rates and the number of publications and presentations, collaborations and patents. Data show that, in recent years, EPSCoR has supported an increasing number of research and collaborative activities as well as minority participation in science and engineering (see Figure A-12). Metrics on physical infrastructure and the "resilience of the national space and aeronautics infrastructure" are not available.

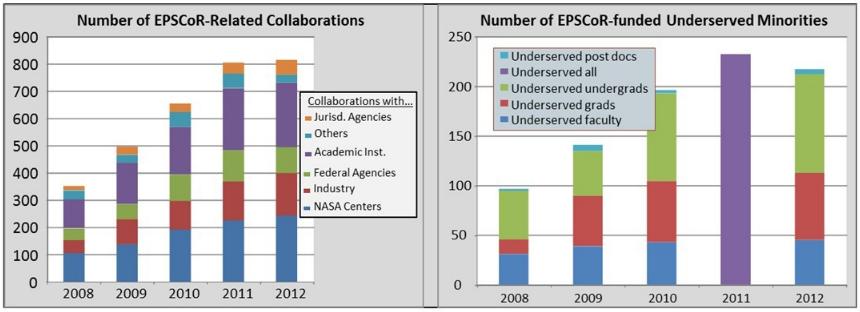


Figure A-12. There has been an increase in both the number of collaborations (left) and the number of underserved minorities (right) since 2008.

An assessment of existing funding data suggests that there have not been significant changes in the geographic distribution of funds or that NASA EPSCoR states have grown more competitive. Instead, the share of funds claimed by the 2012 EPSCoR states has fallen since the program's inception (see Figure A-13). Information on proposal success rates across the agency was not available.

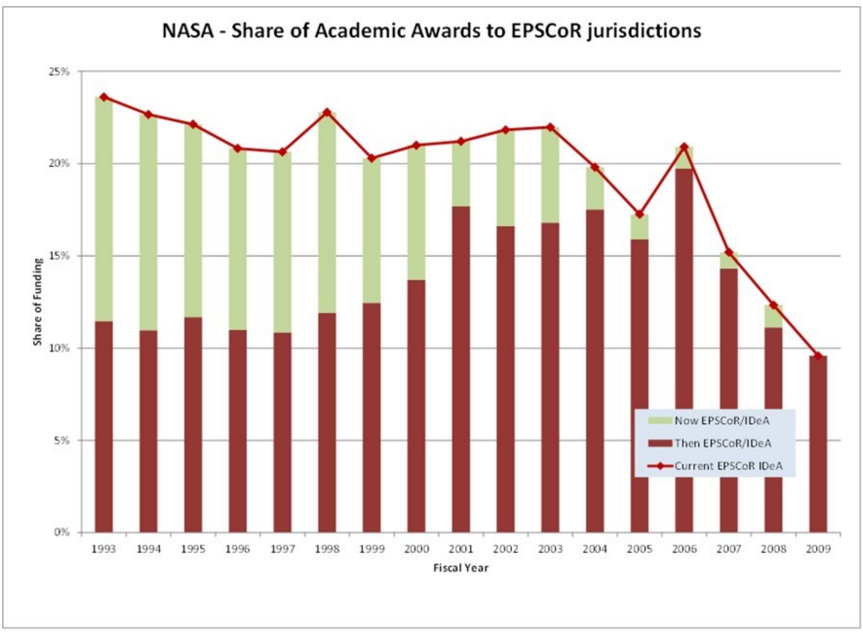


Figure A-13. Share of academic awards received by EPSCoR states. Red indicates eligible state during that year, tan indicates current (2012) eligible states.

DEPSCOR

Mission and Evolution

The Defense Experimental Program to Stimulate Competitive Research (DEPSCoR) was launched in 1995. DEPSCoR was one of several of EPSCoR-like programs created by federal agencies in the 1990s as a result of Congressional authorization. This period marked a second wave in EPSCoR that extended the program beyond its origins in the NSF. An overview of the program is given in Box A-6.

Box A-6
Overview of DEPSCoR

Basic Information

- Established: 1995
- *Governing Legislation:* PL 103-337 ("National Defense Authorization Act for Fiscal Year 1995")
- *Eligible Jurisdictions:* 27 over the program's history
- *Budget:* $14.1 million (2009)

Program Components

- Basic and Applied Research Grants.
- Graduate Traineeships.
- Research Instrumentation.

The typical DEPSCoR research award: about $100,000 a year for three years.

Legislative Goals

- "Enhance the capability of institutions of higher education"
- "To develop, plan, and execute competitive science and engineering research"
- "Increase probability of long-term growth in competitively awarded federal funds"

Agency Goals

- "Enhance existing or develop new research capabilities in support of DoD research goals"
- "Intent of the DEPSCoR program to build infrastructure (human or physical capital)"
- "Build infrastructure: education of scientists and engineers"

According to the National Defense Authorization Act for FY 1995, DEPSCoR was designed to pursue two interrelated objectives:

- Enhance the capabilities of institutions of higher education in eligible states to develop, plan, and execute science and engineering research that is competitive under the peer-review systems used for awarding federal research funds.
- Raise the percentage of financial assistance that eligible states receive from the federal government for scientific and engineering research based on their institutions' increased scientific capabilities and excellence.

Between FY1995 and FY2011, DEPSCoR awarded nearly 700 grants. Funding totaled $230 million over this 16-year period. The average yearly expenditure was $14.4 million. Individual grants averaged $340,000 (see Figure A-14).

Aggregate figures and averages for DEPSCoR, however, may be somewhat misleading. DEPSCoR experienced two distinct periods in funding. Between FY 1995 and FY 2004, the level of funding and the number of grants that DEPSCoR awarded declined. Between FY 2004 and FY 2009, the level of funding and the number of grant awards fluctuated, yet the average size of the awards rose substantially. From FY 1995 to FY 2002, individual awards ranged from $250,000 to $330,000. From FY 2002 to FY 2009, awards ranged from $420,000 to $500,000.

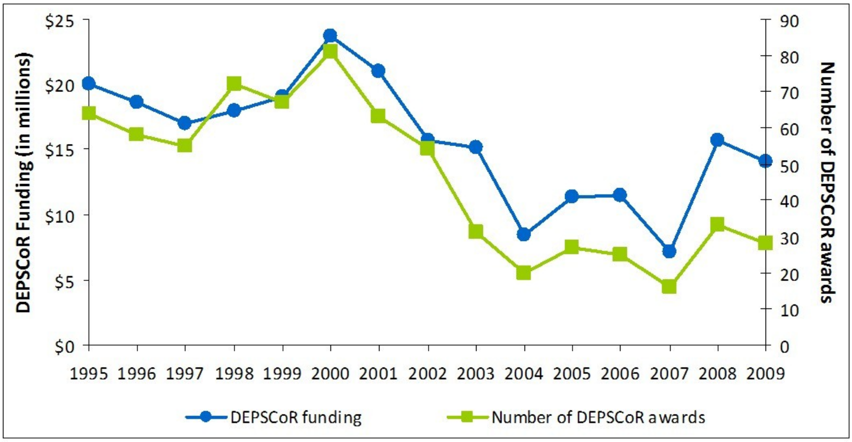


Figure A-14. DEPSCoR funding and number of awards: FY1995 – FY2009.

These figures shed light on several aspects of DEPSCoR. The declining and then fluctuating budget suggests that the program was never fully integrated into DOD strategic thinking for R&D. The trend towards larger individual grant awards indicate that DOD decided to support fewer institutions but to provide them with larger sums of money to strengthen the impact of their initiatives.

Between FY 2010 and FY 2011, DEPSCoR was discontinued. The Department has noted that "then deputy undersecretary of defense for laboratories and basic science decided to have all institutions in all states compete in all full and open funding opportunities in the DOD." The EPSCoR/IDeA Foundation reported that "DOD would ensure DEPSCoR states participate in DOD research activities by ensuring that 20% of [the University Research Initiative] funding occurs in DEPSCoR institutions."

Eligibility

Between FY 1995 and FY 1997, NSF was responsible for determining DEPSCoR's eligibility requirements. To be eligible, a state had to receive less than 60 percent of the national average of federal science and engineering R&D funding given to universities (based on figures for the previous fiscal year or the last fiscal year for which information was available). Beginning in FY 1997, additional criteria required eligible states to receive less than 1.2 percent of DoD's average annual science and engineering R&D funding to universities (based on calculations made over the 3 most-recent fiscal years for which information was available).

The appropriation for DEPSCoR in FY 1997 further altered eligibility requirements by no longer requiring DEPSCoR states to also be eligible for EPSCoR. However, as a practical matter, it required the proposals to be submitted through EPSCoR state committees. This made it virtually impossible for universities in non-EPSCoR states to apply for DEPSCoR grants.

Over the entire duration of the program, 27 states were eligible to participate in DEPSCoR. Of these, 15 were eligible throughout the period; 6 became eligible during the period; 2 were eligible in FY1995, lost their eligibility at some point but regained it by FY2009; and 4 that were once eligible became ineligible. Alabama, Hawaii, Mississippi, and New Mexico "graduated" from the program. New Mexico was eligible only in FY 2002. The channels for moving in and out of DEPSCoR seem to have been freer flowing than in other federal agencies with EPSCoR-like programs (see Table A-2).

Table A-2 DEPSCoR eligibility from FY 1995-2009

State	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09
AL	X	X	X	X	X	X	X	X	X	X					
AK						X	X	X	X	X	X	X	X	X	X
AR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DE										X	X	X	X	X	X
HI								X	X	X	X	X			
ID	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
KS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
KY	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LA	X	X	X	X	X								X	X	X
ME	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MS	X	X	X	X	X	X	X	X							
MT	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NE	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NV	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NH											X	X	X	X	X
NM								X							
ND	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OK	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
RI											X	X	X	X	X
SC	X	X	X	X	X	X			X	X	X	X	X	X	X
SD	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TN											X	X	X	X	X
VT	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WV	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WY	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
VI									X	X	X	X	X	X	X

NOTE: An X denotes a year in which a state was eligible for participation in DEPSCoR.
SOURCE: Adapted from *Assessment of the Defense Experimental Program To Stimulate Competitive Research (DEPSCoR): Final Report Volume I*, Institute for Defense Analyses, Oct. 2008; Broad Agency Announcement No. W911NF-09-R-0003, FY2009.

Assessment

The FY 2008 National Defense Authorization Act called for an assessment of the DEPSCoR program, resulting in the publication report in two volumes*: Assessment of the Defense Experimental Program To Stimulate Competitive Research (DEPSCoR): Final Report Volume I—Summary* and *Volume II—Supporting Material.*

On the positive side, the report found:

- The DEPSCoR states' share of non-DEPSCoR DOD funding to universities increased between FY 1995 and FY 2005 despite fluctuations in DEPSCoR funding levels.
- 15 percent of the states that were eligible for DEPSCoR achieved funding levels above the 1.2 percent threshold and were no longer eligible for the program.

In short, critical indices for determining the impact of DEPSCoR seemed to have improved during the period in which the program was in place.

On the negative side, the report found:

- DEPSCoR supported institutional activities that may have increased research capacity but the significance of these activities for the national research infrastructure had not been fully assessed.
- DOD's proposal review processes was not entirely consistent with the program's mandate to increase competitiveness for research funding.
- DOD had not established a formal DEPSCoR post-award management process to increase future competitiveness of the awardees.
- Available data on DEPSCoR activities and outcomes were insufficient for monitoring and evaluating the program.

The reports contained the following recommendations for improving DEPSCoR:

- DOD should reform the proposal review process to focus more on investigators' potential to conduct research in the future instead of their current research capabilities.
- DOD program managers should be formally encouraged to serve as mentors and facilitators for DEPSCoR investigators seeking to engage in additional defense-related research.
- DOD should develop more sophisticated data systems for tracking DEPSCoR activities and outcomes.
- DEPSCoR's equipment purchases and training activities should be more fully exploited to enhance institutional competitiveness (rather than focusing primarily on enhancing the competitiveness of individual investors and small teams).

- Ambiguous aspects of DEPSCoR's legislative mandate create the potential for misinterpreting the legislative intent. Congress should re-examine and consider clarifying DEPSCoR's legislative mandate.
- Once the DEPSCoR objectives have been clarified, the program should be redesigned with a clearer and more focused strategy for enhancing the competitiveness of individual researchers, research institutions and eligible states.

Due to the discontinuation of DEPSCoR, none of these reform measures were put into place. However, other federal agencies might find them useful to consider in their efforts to enhance the impact and effectiveness of their EPSCoR programs.

B
State Profiles

This appendix consists of brief profiles of the Experimental Program to Stimulate Competitive Research (EPSCoR) activities in six states: Alaska, Kansas, Montana, New Mexico, Rhode Island, and South Carolina. These states were selected to represent the diversity in state programs, and the selection does not reflect any judgment on the relative effectiveness of state programs. They were chosen because of the way they differ in population, geography, economic base, history of research activity, length of time in the program, and other factors (see boxes B-1 through B-6). All of the information included comes from reports by the states because the committee believes it is important to see how the states understand the program, use the funding, and assess the results.

SCIENCE IN PLACE:
ALASKA'S EPSCOR-IDEA PROGRAM

Box B-1
Alaska

SOURCE: USGS

Population (2011): 0.7 M

Size: 663,268 sq mi

Gross State Production (FY 2011):$51376 M

Four-year Universities: the University of Alaska System has three branches - Anchorage, Fairbanks, and Southeast

First year in the EPSCoR Program: 2000

Alaska became eligible for the National Science Foundation (NSF) EPSCoR and National Institutes of Health (NIH) Institutional Development Awards (IDeA) programs in 2000. Programmatic funding began arriving the following year. Since then, Alaska has invested these funds largely on efforts to strengthen state research capabilities in environmental science and biomedicine. The research has been driven by Alaska's unique environment—both natural and sociological. The funds have helped bolster Alaska's research capabilities, most notably in areas related to Arctic studies, climate change, community health, and participatory research.

Alaska, which is one-fifth the size of the continental United States, is the nation's only Arctic state. It is also the nation's largest and most sparsely populated state. Home to less than one million people, Alaska's population density is less than one person per square mile. Federal, state, and Native Alaska organizations own 99 percent of the land. While 40 percent of the population lives in Anchorage, the Native Alaskan population (representing 15 percent of the population) resides largely in small isolated villages, many with less than 500 people.

Vast open spaces and extreme weather make infrastructure difficult and expensive to develop, especially for transportation and energy. In this energy-rich state, electricity can nevertheless cost $1 per kilowatt hour and gasoline can cost $10 a gallon. Troves of natural resources provide a strong economic base but also create environmental challenges. The scientific consensus is that climate change will have greater impact on Alaska than any other state in the nation, rendering profound changes in sea ice levels, coastal zones, timberlands, permafrost, and ecology that will require policies that promote resilience and adaptability.

The state's university and research community is also unique. The University of Alaska system comprises 3 main campuses—at Fairbanks, Anchorage, and Juneau (the University of Alaska Southeast)—and 13 satellite campuses. Student population totals 33,000, which is less than the student population of many flagship state universities on the continental United States. Private universities are few in number. More than 80 percent of the research in Alaska is funded by the public sector. Only 20 percent of the funds come from the private sector. In the continental United States, the percentages are nearly reversed: 72 percent of research funding is derived from the private sector and 28 percent is from the public sector.

Before the arrival of EPSCoR, Alaska's university system had developed strengths in a number of research areas, including geophysics and Arctic research (the University of Alaska Fairbanks is a land-grant, sea-grant, and space-grant institution). However, the system did not have strong research capabilities in either health-related environmental science or biomedicine (Alaska does not have degree-granting medical, dental, or veterinarian schools). The state's long coastline and expansive wilderness make it an ideal place for monitoring and studying natural resources and climate change. Its isolated communities lend themselves to research—and applications of research—related to resilience and sustainability. EPSCoR has concentrated on building research capacity in these areas.

NSF EPSCoR's 5-year $20 million Research Infrastructure Improvement (RII) Track 1 grant initiative, Alaska Adapting to Changing Environments, which began in 2012, is phase four of an ongoing project to examine the rapid biophysical and societal changes now taking place in Alaska and explore how the people of Alaska, particularly Native Alaskans, can respond and adapt to these changes. Researchers are examining a broad range of forces driving change, including climate, urbanization, landscape transformations, social organizations, and mores and attitudes.

The project not only supports research conducted by scientists but also encourages residents and researchers to work together on challenges that span scientific and public concerns—for example, food security and public health, the impact of degraded permafrost on roadbeds and buildings, and public health and disease risks due to changing temperatures and precipitation patterns.

The project focuses on three test cases: (1) the southeast case study, where changes in ecosystem services as a result of glacial recession in the Juneau area are explored; (2) the south-central case study, where the impact on changes in land cover and precipitation on fisheries and tourism in the Kenai River watershed are examined; and (3) the northern case study, where the effects of permafrost degradation and land-cover alterations are analyzed to determine how these changes are impacting subsistence resources in Arctic and interior villages.

The research which is defined in terms of geography (and not discipline) represents a deliberate attempt to foster multidisciplinary investigations focusing on social-ecological systems. The ultimate objective is to develop and deliver decision-making tools and to create integrated modes and assessments across regions; as one researcher noted: "One goal [of the program] is to actually change the way we do science."

The NIH IDeA is also active in Alaska. Alaska's Institutional Networks of Biological Research Excellence (INBRE), which was launched in 2000, is a biomedical network that initially focused on infectious and toxic diseases. The research agenda has since been expanded to include microbial and computational biology, evolutionary biology, integrative physiology, neuroscience, wildlife toxicology, and the sociology of climate change. Environmental health issues, especially those related to Native Alaskans, receive special attention. The network currently examines a broad range of health issues related to diet, infectious and zoonotic diseases, ecology and climate change, health disparities, and cultural values that influence health and well-being. Specific projects have ranged from investigations into the toxicology of subsistence species that form the traditional food base of Native Americans to understanding and relieving stress in remote Arctic villages.

Like NSF EPSCoR, NIH IDeA engages local populations and community organizations and diligently pursues participatory research, seeking to draw on indigenous knowledge and local practices to enhance understanding of the issues and devise effective solutions to Alaska's wide-ranging health challenges. NIH's Centers of Biomedical Research Excellence (COBRE)—the

Center for Alaska Native Health Research at the University of Alaska Fairbanks—examines a similar set of health issues related to genetics, nutrition, diabetes, and substance abuse, especially among Native Alaskans. Research projects include, for example, an examination of Yup'ik perceptions of body weight and diabetes and assessments of the level of contaminants in subsistence food supplies.

Alaska has received funds from other EPSCoR programs. An NSF RII Track 2 has funded a joint Alaska-Hawaii project—the Pacific Area Climate Monitoring and Analysis Network—to improve the monitoring and modeling of climate change across the Pacific and to explore, for example, how climate change is affecting freshwater resources and how diminished Arctic ice packs may be impacting precipitation patterns across continents. An NSF EPSCoR RII Inter-Campus and Intra-Campus Cyber Connectivity (C 2) grant, given to the University of Alaska Fairbanks and the University of Alaska Anchorage, is strengthening cyberconnectivity, data storage, and visualization capabilities at both universities. Department of Energy (DOE) EPSCoR has awarded grants to Alaskan researchers at the University of Alaska Fairbanks for research on hybrid wind-diesel energy systems. National Aeronautics and Space Administration (NASA) EPSCoR has funded projects to study atmospheric aerosols and satellite mapping of land-surface changes with a particular focus on permafrost degradation. In the past, Department of Defense (DOD) EPSCoR—DEPSCoR—provided a grant to the University of Alaska Fairbanks to analyze the surface-atmospheric interface of weather systems in the region.

A distinguishing feature of Alaska's EPSCoR and IDeA programs has been an emphasis on multidisciplinary research and dedicated efforts to engage citizens and local communities in the research, not just as recipients of the findings but also as active participants in the research process. There also seems to be good coordination between the EPSCoR and IDeA programs, especially on issues related to ecological and sociological change.

The small number of education and research institutions—Alaska has fewer than 10 four-year degree-granting universities—lends itself to greater coordination. The unique conditions of the state's Native Alaskan population, moreover, create an environment where participatory research and results-oriented investigations have an opportunity to flourish. In no other EPSCoR state does place so clearly define the research agenda and determine how EPSCoR funds are invested.

FROM STRENGTH TO STRENGTH: KANSAS'S EPSCOR-IDEA PROGRAM

Box B-2
Kansas

SOURCE: USGS

Population (2011): 2.9 M

Size: 82,277 sq mi

Gross State Production (FY 2011):$ 130923 M

Four-year Universities: there are six public Universities - the University of Kansas (KU, includes KU Medical Center); Kansas State University (KSU); Wichita State University (WSU); Fort Hays State University (FHSU); Pittsburg State University (PSU); and Emporia State University (ESU).

First year in the EPSCoR Program: 1992

Kansas first joined NSF's EPSCoR program in 1991, when the state's share of federal research and development (R&D) funding stood at 0.2 percent.

The state has displayed strong, persistent, and enthusiastic support for EPSCoR programs ever since. In 1996, for example, the governor of Kansas set aside $500 million to provide a deep pool of state-matching funds for EPSCoR awards. Over the years, Kansas has established a number of state agencies, including Kansas, Inc. and the Kansas Bioscience Authority, to strengthen the state's science and technology capabilities and to work closely with federal funding agencies.

These efforts have helped to forge productive state-federal partnerships that have proven instrumental in advancing the state's science and technology goals. Even local governments have become involved. In 2008, Johnson County passed a 0.125 percent sales tax estimated to generate about $15 million a year. The tax provided financial support for the Johnson County Education Research Triangle. Proceeds have funded the construction and operation of the University of Kansas Edwards Campus Business, Engineering Science and Technology building, the Kansas State University International Animal Health and Food Safety Institute, and the University of Kansas Clinical Research Center.

A key to Kansas's success has been its ability to draw on its traditional strengths in a number of different research fields that predate the arrival of funds from EPSCoR. These fields include agricultural research, aviation and transportation research, pharmaceuticals and medicinal chemistry, and human and animal health. The goal is to make Kansas a national leader in a number of research fields.

Kansas has tapped into EPSCoR funds from all federal agencies, including the Department of Agriculture (USDA) (for research on crop improvement), DOD (for research on electronics and new materials), the Environmental Protection Agency (EPA) (for research on soils and pesticides), DOE (for research on semiconductors), and NASA (for research on carbon-fiber composites).

Not surprisingly, the state's two most important federal R&D partnerships have been with NSF and NIH.

NSF EPSCoR grants currently consist of:

- A Research Infrastructure Improvement Track 1 award, "Climate Change and Renewable Energy: Basic Science, Impacts and Mitigation." Launched in 2009, the $20 million, 4-year project is a multi-institutional, multisectorial initiative involving four universities—Kansas State University, the University of Kansas, Wichita State University, and Haskell Indian Nation University—as well as a host of primary and secondary educational institutions and private companies. Researchers skilled in a broad cross-section of disciplines, ranging from agronomy to sociology to physics, have examined the potential environmental, social, and economic impacts of climate change on Kansas, especially on the state's agricultural sector. The project also proposes mitigation strategies in the face of climate change to help the state make informed decisions about biofuel and food crop cultivation, energy production and consumption, and land conservation and water use. In addition, it has created an e-curriculum and a teacher-training program to improve instruction for students in grades K–12. The project also offers summer educational opportunities for undergraduate university students from underrepresented populations, including Native American students, as part of a larger effort to expand the diversity of the state's workforce in the fields of science and technology.

- An RII Track 2 grant, "A cyberCommons for Ecological Forecasting," launched in 2009, is being conducted in collaboration with the state of Oklahoma. The 4-year, $6 million award seeks to build on the states' growing capabilities in ecological observation and analysis, biodiversity, and information and communication technologies. A main objective is to create a large interactive cyberinfrastructure and database for examining and forecasting the impact of global change, due to both natural forces and human activities, on the ecology of the Central Plains. Research topics encompass food and agricultural science, plant pathology, and evolutionary biology. Kansas State University, the University Kansas, Oklahoma State University, and the University of Oklahoma participate in the project.
- An RII C 2 award, "Prairie Light – Next Generation Networking for Mid-Continent Science," is designed to enhance the state's cybernetwork. The 2-year, $1.7 million grant, which was begun in 2011, involves the state's three research-intensive universities—Kansas State University, the University of Kansas, and Wichita State University—as lead institutions. It seeks to increase the reliability and capacity of the Kansas Research and Education Network, which facilitates connectivity, communication, and collaboration among universities, colleges, school districts, and other institutions. The project will also benefit the state's other EPSCoR projects and, more generally, the state's entire research enterprise.

The NIH IDeA program in Kansas consists of an INBRE network led by the University of Kansas Medical Center, the state's preeminent medical research institution. The INBRE, which includes 10 campuses across the state, focuses on a broad research and capacity-building agenda related to cell and developmental biology. The primary goals are to inspire undergraduates to pursue careers in biomedical research and to enhance research capacity through faculty development and retention and the strengthening of research infrastructure. IDeA also supports six COBRE programs, encompassing such research fields as protein structure and function, cancer experimental therapeutics, regenerative and reproductive biology, emerging and infectious disease, liver health and disease, and cancer diagnosis and treatment. The goal is to build sustainable thematic research centers in these research fields.

As with NSF EPSCoR grants, the NIH IDeA program seeks to build upon the state's medical research capabilities in such fields as pharmaceuticals, infectious and emerging diseases, cancer research, and animal and zoonotic diseases. Since 2000, Kansas has received more than $190 million from the IDeA program. The Kansas Economic Growth Act, passed in 2004, has provided hundreds of millions of dollars more.

Kansas's experience with EPSCoR, which just entered its third decade, illustrates several aspects of how these programs can accelerate a state's ability to advance its science and technology agenda. Despite the state's low standing in acquiring federal grant funds when it entered the NSF EPSCoR program, Kansas did have a number of competent research institutions in place. It also enjoyed several areas of research that were recognized for national excellence. The state, moreover, has consistently sought to support its research enterprise and to invest in areas that can both build upon its strengths and, in the process, leverage additional federal R&D funding. While EPSCoR and IDeA do not operate through a single office, there has been a series of carefully drawn and executed comprehensive plans focusing on areas of research that the state intends to pursue to gain a strong national—and even an international—presence for excellence.

The result of this concerted effort has been a rapid increase in Kansas's reputation for research competence in a number of fields. The University of Kansas, for example, has one of the nation's preeminent schools of pharmacy, and the University of Wichita ranks second in the nation in acquiring funds for aeronautical research and development.

A key question for both Kansas and the federal agencies that operate EPSCoR programs is whether Kansas has now attained a level of research capability and competitiveness that would enable it to compete and succeed without the "sheltered" benefits provided by EPSCoR and IDeA.

ECO-CAPACITY BUILDING: MONTANA'S EPSCOR-IDEA PROGRAM

Box B-3
Montana

SOURCE: USGS

Population (2011): 1.0 M

Size: 147,042 sq mi

Gross State Production (FY 2011):$ 37990 M

Four-year Universities: there are two major systems - Montana State University – main campus at Bozeman, five branch campuses - and University of Montana – main campus at Missoula, six branch campuses

First year in the EPSCoR Program: 1980

Montana, one of the original EPSCoR states, has enjoyed a long and active affiliation with EPSCoR programs. In size, the state is the fourth largest state in the nation. In population, it is home to less than one million people. Forty-six of the state's 56 counties are considered to be on the "frontier," home to no more than six people per square mile. Despite the broad environmental impacts rendered by extractive industries, which account for 60 to 70 percent of the state's economy, Montana has one of the nation's most pristine environments.

The combination of Montana's size, sparse population, relatively unspoiled environment, and resource-based economy presents unique opportunities and challenges for building research capacity and competitiveness that are shared by other large, yet sparsely settled, states eligible for EPSCoR.

In 2012, Montana received a record $112.3 million in federal R&D funds. The state's research agenda focuses on biomedicine, energy, and the environment.

A $20 million, 5-year NSF EPSCoR's RII Track 1 project, launched in 2011, is designed to enhance environmental and ecosystem research throughout the state and to position Montana as a national leader in this broad field of study.

The grant has led to the creation of the Montana University System Institute on Ecosystems, a joint venture led by Montana State University and the University of Montana. About 45 percent of the budget is invested in research, focusing largely on the impact that climate change is having on the region's ecosystems. The scale of the investigations ranges from microbial communities to mountain landscapes. Species and ecosystem vulnerabilities to climate change are prime aspects of the research.

In addition to the Montana State University and the University of Montana, the state's two research universities, other members of the network include the state's undergraduate universities and tribal college. A key goal of the project is to forge strong and enduring collaboration among the state's research and educational institutions. Another key goal is to promote educational opportunities for students from primary through graduate school. Particular focus is placed on encouraging educational and workforce diversity in science and technology, with special attention given to Native Americans, who constitute 6 percent of the population and are the state's largest minority group. To advance this goal, the Montana University System Institute on Ecosystems works closely with the state's seven tribal colleges, providing fellowship opportunities and classroom and fieldwork experience for Native American students. In addition, EPSCoR funding enables the institute to oversee the Girls Collaborative Project, a nationwide project that encourages young female students to pursue careers in science, technology, engineering, and mathematics.

About 16 percent of the EPSCoR budget for this project is spent on diversity issues and another 10 percent is spent on workforce development. In addition, the institute devotes about 10 percent of the budget to public outreach as part of a larger effort to educate the citizens of Montana about the challenges posed by rapid ecological change and the impact that these changes are having on the state's environment and economy.

Montana's EPSCoR program is housed within the State Office of Higher Education and is led by the Montana University System Science and

Technology Committee, a government board responsible for creating an integrated framework for advancing science and technology across the state. In its strategic plan, the committee has identified the environment and ecosystem services as one of Montana's strategic research areas. It views this EPSCoR project as the cornerstone of this effort.

An NSF RII Track 2 collaborative initiative between Montana and Kentucky embraces similar research themes to the RII Track 1 award. Begun in 2009 and scheduled to continue through 2013, the $3 million initiative is developing a state-of-the-art cybersystem to track and analyze weather and water systems. The goal is to make the data accessible to researchers throughout the country. The EPSCoR-sponsored VOEIS (Virtual Observatory and Ecological Information System), an open-access cyberinfrastructure designed to acquire and analyze large weather- and climate-related environmental datasets, will serve as the hub of the informatics system. Hosted by Montana State, VOEIS works closely with sensor networks and remote data transmission sites operated by consortia members in both states.

The NIH IDeA program also has a large presence in Montana. MT INBRE is a biomedicine research network comprising Montana State University, the University of Montana, six undergraduate universities, and the state's seven tribal colleges. It focuses on such basic medical research issues as the pathogenesis of infectious disease. The network also examines public and environmental health issues of particular importance to the state and region—for example, reservoir ecology and disease, environmental contamination and public health on Indian reservations, and the forces driving health disparities. The state has four COBREs with thematic research agendas encompassing zoonotic and emerging diseases, cellular mechanisms and systems biology, structural and functional neuroscience, and environmental health services.

Montana has also obtained funding from other federal EPSCoR programs. For example, it has received NASA EPSCoR awards to develop and test radiation-tolerant flight computers and to study the effects of aerosols on the Earth's climate. DOE EPSCoR has funded research and graduate training grants related to carbon mitigation through geological storage. In the past, DOD and EPA also funded Montana research through its EPSCoR-like programs.

EPSCoR and IDeA expenditures have proven instrumental in shaping and advancing the state's research agenda. The funding has helped foster collaboration among the state's widely dispersed research and educational institutions. New information technologies have had a transformative impact on this effort. At the same time, the increasing focus that both the U.S. and global research communities have placed on issues related to the environment and ecology have provided states such as Montana with unprecedented opportunities to serve as "open air" laboratories for the study of such critical issues as climate change, the spread of infectious diseases, and the state's ecology. The universities and research centers that lead these efforts have envisioned large roles for themselves not only within the scientific community but also within society. Objectives extend beyond science to social change. The Montana

System Institute of Ecology, for example, is seeking not only to do excellent research but also to engage and educate the people of Montana in ways that can help them cope and adapt to the ecosystem changes that are taking place.

As the strategic plan of Montana EPSCoR states, the goal is to "catalyze scientific cultural change and take Montana to the next level of national competitiveness in ecosystem sciences." A key issue is whether the progress that has been made in improving research capacity and, to a lesser degree, research competitiveness can be sustained, in light of the broad responsibilities in research, education, and public engagement that the institute—and by extension MT EPSCoR—currently embraces.

STRONG ASSETS AND PERSISTENT POVERTY: NEW MEXICO'S EPSCOR-IDEA PROGRAM

Box B-4
New Mexico

SOURCE: USGS

Population (2011): 2.1 M

Size: 121,589 sq mi

Gross State Production (FY 2011):$ 79414 M

Four-year Universities: The New Mexico state university system includes six campuses

First year in the EPSCoR Program: 2001

As New Mexico's Governor Susana Martinez notes in *Technology 21: A Science and Technology Roadmap for New Mexico's Future*: "New Mexico is a state rich in science and technology assets and capabilities." It has a solid public university system led by the University of New Mexico, New Mexico State University, and New Mexico Tech. It is a state with large military installations, including Kirtland, Holloman, and Cannon Air Force Bases, and the White Sands Missile Range, where technology and research play important roles in fulfilling the facilities' missions. And it is home to the Los Alamos and Sandia national laboratories, which pursue world-class research in a broad range of fields, including biomedicine and bioscience, climate change science, information and computational science, nanotechnology, nuclear and renewable energy, nuclear weaponry, and space technology. The combined annual budgets of Los Alamos and Sandia—$4.6 billion—approach the state government's annual budget ($5.9 billion in 2013) and represent nearly 6 percent of New Mexico's annual gross domestic product.

Few states with such a small population—New Mexico has just 2.1 million people—can boast such expansive scientific know-how and capabilities. The state ranks first in the number of Ph.D. scientists and engineers as a percentage of population, second in the nation in R&D intensity (the share of company investments in R&D compared to sales), and sixth in the nation in science and engineering graduate students per capita.

Yet, at the same time, the share of New Mexico's population living in poverty is among the highest in the country. In 2012, it stood at 22.2 percent for individuals. Only Mississippi's poverty level is higher. New Mexico, moreover, ranks 47th in the nation in the percentage of children living in poverty and 44th in the nation in high-school graduation rates. More than 60 percent of the state's students qualify for free or subsidized school meals.

Many reasons account for New Mexico's strong showing in science and questionable showing in economic well-being. Jobs in New Mexico's largest industry—tourism—are often low paying. Agriculture, which employs a large number of farm laborers, remains a staple of the economy. Resource industries, another significant aspect of the economy, suffer from boom-and-bust cycles. And government, which employs one-quarter of New Mexico's population, has recently suffered significant cutbacks, particularly at the state level.

New Mexico's participation in EPSCoR began in 2001. The state's most recent NSF Research Infrastructure Improvement Track 1 award—a 5-year, $20 million grant launched in 2008—has focused on the impacts of climate change on northern New Mexico's water resources. Project participants include the University of New Mexico, New Mexico State University, New Mexico Tech, and New Mexico Highlands University. The primary goals are to establish a meteorological and hydrological observational network comparable to that in other western states and to develop an advanced computational system for collecting and analyzing climate change data.

Other NSF EPSCoR grants are designed to complement and advance the goals of the RII Track 1 grant. For example, a $2 million RII Track 2 award, issued in 2010, provides funds for the creation of a Tri-State Western Consortium, composed of New Mexico, Nevada, and Idaho. The consortium is dedicated to collaborative projects focusing on regional climate change issues. A $1.7 million RII C 2 award, also issued in 2010, focuses on improving broadband connectivity in tribal and regional colleges in New Mexico, including Navajo Technical College, Northern New Mexico College, and Western New Mexico College. A primary objective is to enhance access to statewide data on issues related to climate change and water.

New Mexico's EPSCoR grants extend beyond data collection and scientific analysis to encompass science education and workforce diversity issues. An array of programs focusing largely on climate change and water issues is designed not only to improve the learning environment but also to increase enthusiasm for science (especially for climate change and water issues) among New Mexico's student population. These programs include a summer teachers' institute, undergraduate fieldwork and research initiative, the development of climate change curriculum for primary and secondary school students, and infrastructure seed grants for tribal and regional colleges to improve their access to electronic information networks as critical research tools.

Project advocates also express a keen interest in engaging in policy discussions and in influencing state policies on climate change and water. As the New Mexico EPSCoR Web site states: "Having a well-informed populace is critical for this research project to achieve one of its goals—transforming policy making in New Mexico by providing tools needed for science-driven water policy decisions."

New Mexico's EPSCoR projects encompass a broad research agenda, ranging from studying the impact of climate change on snow packs, snow melt, and runoff in the state's high-elevation watersheds, to improving hydrologic and climate models in mountainous regions, to examining the impact of traditional water management systems (*aquequias*) on water conservation and use. The objectives largely focus on how scientific knowledge can assist policy makers in their efforts to design and implement fair and equitable water resource allocation policies in ways that promote economic growth.

The NIH IDeA program, which like NSF EPSCoR began in 2001, is built upon a series of COBREs that concentrate on immunology, molecular biology, neuroimaging, and brain functions. The centers—currently three in number—pursue research in a wide range of fields that includes, for example, analyses of the neural mechanisms that account for impaired cognition, antiviral therapies for Hepatitis C, and treatments for Schistosomiasis.

In addition, the NIH IDeA program supports an Institutional Network of Biomedical Research Excellence that includes New Mexico State University (the lead institution), University of Mexico, New Mexico Tech, the National Center for Genome Resources, Eastern New Mexico State University, San Juan College, New Mexico Highlands University, and Dine College. More than 33 INBRE research groups are involved in research ranging from genomics to pathogens to bioinformatics. Basic research and clinical studies focus on such diseases and ailments as cancer, strokes, seizures, epilepsy, traumatic brain injury, and cerebral palsy.

New Mexico has also received EPSCoR grants from the DOE, NASA, and USDA to study topics ranging from an examination of the strength and resiliency of aeronautic materials to the impact of climate change on soil chemical composition. EPSCoR-like grants provided by mission-oriented federal agencies showcase the broad range of activities conducted by the state's research community. Yet, by virtue of their size and scope, NSF EPSCoR and NIH IDeA programs have dominated the state's involvement with the initiative.

New Mexico's NSF and IDeA programs have sought to draw on the state's world-class capabilities and assets in a broad spectrum of fields in science and technology, including computational science, information and communication technologies, nanotechnology, and bioscience. The effort has shown how EPSCoR and IDeA programs can help advance and expand programs in fields of research in which a state already has considerable intellectual strengths and state-of-the-art laboratory facilities.

But New Mexico also offers a cautionary tale on the role that world-class science can play in state efforts to promote economic development. Clearly, the presence of such valuable scientific capabilities and assets has had a significant impact on research in New Mexico. Thanks largely to federal investments, science and technology play an oversized role in the state's economy, well beyond what you would expect given New Mexico's small population. Nevertheless, the large presence of world-class research facilities has yet to ripple through the entire state as evidenced by the high rates of poverty and relatively low wages.

Serving as a bridge from research excellence to economic growth has emerged as a primary goal of EPSCoR programs. With world-class scientific facilities already in place, New Mexico provides an excellent test case on how this relationship may play out. The state's proposal for an NSF EPSCoR RII Track 1 grant (2013–2018), which focuses on "the nexus of energy, water and environment" issues, could serve as a valuable learning tool for understanding the strengths and weaknesses of EPSCoR programs as they seek to advance their twin goals of building research capacity and promoting economic growth. New Mexico highlights the complexity inherent in harmonizing these challenges. Investments in research are critically important, but other factors matter as well.

BUILDING ON A SOLID FOUNDATION: RHODE ISLAND'S EPSCOR-IDEA PROGRAM

Box B-5
Rhode Island

SOURCE: USGS

Population (2011): 1.05 M

Size: 1,214 sq mi

Gross State Production (FY 2011):$ 50091 M

Four-year Universities: there are several universities, the most prominent of which are private, such as Brown University and Rhode Island School of Design.

First year in the EPSCoR Program: 2004

Rhode Island's eligibility to participate in EPSCoR and EPSCoR-like programs (the state first joined NSF EPSCoR in 2004) does not deny its considerable strengths in science and technology. The state boasts nationally recognized research in such fields as oceanography and marine science, public health and medicine, and advanced manufacturing. It has a well-educated and skilled workforce (40 percent of the workers in the private sector are employed in the high-wage industry sector). It is home to a number of elite universities, including Brown University and the Rhode Island School of Design. The University of Rhode Island is a national leader in oceanographic research and education, and Roger Williams University has established a national reputation in marine law. Defense-related research in Rhode Island is driven by the U.S. Naval College and the Naval Undersea Warfare Center in Newport, both world-class military research institutions.

Rhode Island's eligibility for EPSCoR is due, in part, to its size (it ranks 43rd in population and 50th in area). The state, however, has turned its small size into an asset (at least in part) by letting its proximity and history serve as a template for collaboration that has helped to advance its research agenda, especially in areas of long-standing strength. These advances have taken place, thanks in part, to funds provided by the federal government through its EPSCoR programs.

An NSF EPSCoR RII Track 1 award, a 5-year, $20 million grant launched in 2010, supports a network of nine colleges and universities in Rhode Island that is dedicated to strengthening the state's research capabilities and competitiveness in the field of marine life sciences. Specifically, the research seeks to better understand how marine life may be affected by climate change. The network comprises two research universities (Brown University and the University of Rhode Island [URI]) and seven undergraduate universities (Bryant College, the Community College of Rhode Island, Providence College, Rhode Island College, Rhode Island School of Design, Roger Williams University, and Salve Regina University). There are three core facilities: the Genomics and Sequencing Center at the University of Rhode Island Kingston, the Center for Genomics and Proteomics at Brown University in Providence, and the marine Life Science Center in Narragansett.

The ultimate goal is to have Rhode Island emerge an international leader in understanding and anticipating the response of marine organisms and marine ecosystems to climate change. Molecular and cellular biology, genomics, computational biology, and state-of-the-art data visualization are among the research fields anchoring this effort. Key questions being addressed include: What has been the response of marine life to climate variability? How are the structure and function of coastal marine food webs being reoriented in response to climate change? How will global change affect the ecology of marine pathogens and parasites?

The grant also invests in faculty development, student training and public education and awareness. In addition, grant funds will be used to expand the activities of the Rhode Island EPSCoR Academy, launched in 2006 with a previous NSF EPSCoR grant. The academy will increase the number of graduate fellowships and provide additional opportunities for networking activities among participating institutions.

Rhode Island has also received substantial funding—$42 million since 2001—from the NIH IDeA program to build research capacity, largely by mentoring junior faculty and supporting university students. INBRE, which is based at the URI College of Pharmacy, consists of six partnering universities in addition to URI: Bryant College, Brown University, Providence College, Rhode Island College, Roger Williams University, and Salve Regina University. Research conducted by the network concentrates on such fields as molecular toxicology, cell biology, and behavioral science. Prime capacity-building activities include faculty development and student training for undergraduates, graduates, and postgraduates.

Rhode Island also has a number of NIH COBREs: for cancer research development at Rhode Island Hospital; for perinatal biology at the Women and Infants Hospital of Rhode Island; for skeletal health and repair at the University of Rhode Island; for new approaches to tissue repair at the Roger Williams Medical Center; for new stem cell biology at Roger Williams Hospital; for perinatal biology at Brown University; and for genomics and proteomics at Brown University. Rhode Island's COBREs focus on medical research issues ranging from gastrointestinal cancer to cartilage and joint health to tissue repair and therapy to cardiopulmonary development in fetuses, newborns, and infants.

In addition to NSF EPSCoR and NIH IDeA, Rhode Island has pursued funding opportunities presented by other EPSCoR programs. For example, Brown University and the University of Rhode Island have been awarded grants from DOE EPSCoR to explore degradation mechanisms for lithium ion batteries and devise strategies to improve battery energy densities and life cycles. The effort entailed close collaboration with both national laboratories and private companies such as BASF and General Motors. Brown University also received a grant from the DEPSCoR program to improve sensing abilities of night-vision goggles as well as a NASA EPSCOR educational research grant award for faculty development and student support.

Overall, Rhode Island's EPSCoR programs illustrate how these funds can be put to use not just to build capacity from the bottom up but also to deepen and expand areas of existing research strength. The question is whether these federal funds are supplementing (and therefore boosting state research investments) or substituting (and therefore replacing) potential funds that may have been available from elsewhere. When states like Rhode Island are eligible for federal EPSCoR and IDeA, it is hard to know where the line between EPSCoR and non-EPSCoR states should be drawn.

FINDING A NICHE OR TWO: SOUTH CAROLINA'S EPSCOR-IDEA PROGRAM

Box B-6
South Carolina

SOURCE: USGS

Population (2011): 4.7 M

Size: 32,020 sq mi

Gross State Production (FY 2011):$ 165785 M

Four-year Universities: there are eleven colleges are universities, six of which are public, including two technical colleges and The Citadel.

First year in the EPSCoR Program: 1980

South Carolina is one of the five original EPSCoR states and has been an active participant in the programs ever since. Universities in South Carolina have been awarded grants from NSF EPSCoR and NIH IDeA, as well as from EPSCoR programs managed by the USDA, DOD, DOE, EPA, and NASA.

Between 2002 and 2009, South Carolina received more than $100 million in federal funds for the construction of research space. That is more than Wisconsin, Washington, DC, Michigan, North Carolina, and Connecticut combined. To coordinate its efforts to secure federal research funds, South Carolina relies on a joint EPSCoR-IDeA Committee. The state has enjoyed long-standing effective leadership, which has proven instrumental in generating statewide backing and enthusiasm for the program. Supportive state government officials have authorized funding to help build the state's research capacity. South Carolina has pursued a strategy in which EPSCoR and IDeA awards tend to reinforce the state's carefully focused efforts to build scientific capacity and competitiveness in select fields.

Proponents have sought to utilize the combined federal-state investments in research to:

- Build infrastructure that encompasses both brick-and-mortar projects (for example, support for the Advanced Tissue Biofabrication Center) and the hiring of faculty. Since 1990, EPSCoR-IDeA funds have allowed South Carolina to create and fill 95 junior tenure track faculty positions.
- Forge close collaboration among the state's three Ph.D.-granting universities (Clemson University, Medical University of South Carolina, and the University of South Carolina)—as well as continual interactions both with and among the state's other institutions of higher education—to advance education, community service, public outreach, and statewide research capabilities.
- Strengthen science education and public awareness of science by supporting mentoring and training programs for junior faculty, granting graduate and postgraduate fellowships, providing opportunities for summer internships for undergraduate university and high school students, developing innovative primary and secondary school curricula, and organizing media workshops for print and broadcast journalists.
- Engage students from demographic groups that have been underrepresented in the fields of science and technology. EPSCoR and IDeA work closely with historically black colleges and universities in South Carolina to organize workshops and provide research experience for students from these demographic groups.

A 5-year, $20 million NSF EPSCoR Research Infrastructure Improvement Track 1 grant, awarded in 2009, has been a key component of South Carolina's efforts to become an international leader in organ printing. Research focuses on computer-generated biological material designed to create "engineered" functional tissues and organs derived from human cells. So-called biofabrication depends on scaffold-free, self-assembling biological frameworks.

A key goal of the South Carolina Alliance for Tissue Biofabrication is to design and create a three-dimensional tree-like vascular supply system that can sustain the generation of bioengineered tissues and organs to treat and potentially cure such diseases as diabetes, kidney and heart failure, and atherosclerosis.

The project has helped to expand the Medical University of South Carolina's bioprinting program into a statewide alliance comprising 11 institutions. Specifically, project funds have been used to hire 22 new faculty and create a new degree program in biomedical engineering, construct new buildings and purchase new equipment, support the creation of an electronic network facilitating the development of state-of-the-art databases in biofabrication and vascular technology, foster workforce development and diversification, devise an innovative curriculum for instructing K–12 students about biofabrication based on e-textbooks and Internet access, nurture national and international academic-industrial collaboration, and organize media workshops on biofabrication research and applications.

Federal expenditures have helped to spur state legislative action to enhance research in the state, including passage of the Centers of Economic Excellence Act in 2002 and the Research Universities Infrastructure Act in 2004, which have provided funding for the recruitment of faculty and the building of research facilities. The latter led to the construction of research centers in regenerative medicine and tissue biofabrication, which are now housed at the Medical University of South Carolina Bioengineering Building. The centers opened in 2011.

Other examples of projects receiving support from EPSCoR programs include:

- An NIH INBRE award, first granted in 2005 and renewed in 2010, to develop a biomedical research network comprising the state's three research and graduate-degree institutions (Clemson University, Medical University of South Carolina, and the University of South Carolina) and seven predominantly undergraduate institutions (Claflin University, the College of Charleston, Francis Marion University, Furman University, South Carolina State University, University of South Carolina Beaufort, and Winthrop University). The network is pursuing 28 research projects, ranging from studies of nanoparticles for enhancing drug delivery to improved treatment of Alzheimer's and Parkinson's disease to the role that plaque plays in clogging and weakening arteries and increasing the risk of heart attacks and stroke. The project is designed to increase research capacity through undergraduate training and junior faculty support. The goal is not only to strengthen research capacity and competitiveness but also to build a strong and lasting foundation for mentoring and teaching.
- Four COBREs have been established at the Medical University of South Carolina for the study of cardiovascular disease; oral health; lipidomics and pathobiology; and oxidants, redox balance and stress signaling. An

additional COBRE has been established at the University of South Carolina for the study of colon cancer.

- With support from DEPSCoR, the University of South Carolina has developed and analyzed large datasets for applications in homeland security and national defense.
- With funding from NASA EPSCoR, Clemson University, Michelin, Milliken, and the NASA Jet Propulsion Laboratory have forged an R&D partnership to design and test rover wheels for lunar and Martian exploration.
- With funding from DOE EPSCoR, Clemson University established strong ties with researchers at Oak Ridge and Savannah River national laboratories to design protective coatings for nuclear fuels to reduce the amount of dangerous nuclear wastes and improve the safety of nuclear energy production.

South Carolina's experience with EPSCoR and IDeA illustrates how federal R&D funding, when aligned with strong state support and academic leadership that carefully identifies and aggressively pursues new and largely unexplored research fields, can help build "niche" scientific capacity and competitiveness that matches—and sometimes exceeds—the level of research being conducted at institutions in non-EPSCoR states.

C
Statement of Task and Congressional Mandate

This appendix outlines the full statement of task that Congress requested the National Academy of Sciences (NAS) ad hoc committee responsible for this report to complete. It also outlines the roles and responsibilities of the National Science Foundation (NSF) and NAS in the project and describes how these responsibilities align with their broader mandates. The report was mandated under the America COMPETES Reauthorization Act of 2010.

The Charge from Congress

An ad hoc committee will review and evaluate the Experimental Program to Stimulate Competitive Research (EPSCoR) and EPSCoR-like programs of seven federal agencies: Department of Defense, Department of Energy, National Aeronautical and Space Administration, National Institutes of Health, National Science Foundation, Department of Agriculture, and the Environmental Protection Agency. The committee will evaluate the management and effectiveness of the programs in achieving their goals; explore how well they are integrated with other activities and initiatives of the respective agencies; and assess how well the overall efforts align with the larger federal mission of nurturing the health and productivity of the nation's scientific and engineering research enterprise.

The Responsibilities of the National Science Foundation

This study was mandated by the America COMPETES Reauthorization Act of 2010, which specifies the following NSF responsibilities:

A. Coordinate EPSCoR and other EPSCoR-like programs to maximize the impact of Federal support for building competitive research infrastructure in efforts to achieve an integrated Federal effort;

B. Coordinate agency objectives with jurisdictional and institutional goals in efforts to obtain continued non-Federal support of science and technology research and training;

C. Develop metrics to assess gains in academic research quality and competitiveness in science and technology human resource development;

D. Conduct a cross-agency evaluation of EPSCoR and EPSCoR-like programs and their accomplishments. This evaluation will include, but not be limited to, program management, investment strategies and their effectiveness in building research capacity, and the effectiveness of strategies to increase the number of new investigators receiving peer-reviewed funding, to broaden participation of underrepresented groups in science and engineering, and to empower knowledge generation, dissemination, application, and national research and development competitiveness;

E. Coordinate the development and implementation of new, novel workshops, outreach activities, and follow-up mentoring activities for researchers at colleges and universities in EPSCoR jurisdictions in order to increase the number of proposals submitted to and funded by the agencies;

F. Coordinate the development of new, innovative solicitations and programs to facilitate collaborations, partnerships, and mentoring activities among faculty at all levels in non-EPSCoR and EPSCoR jurisdictions;

G. Conduct an evaluation of the roles, responsibilities and degree of autonomy that Program Officers or Managers (or the equivalent position) have in executing EPSCoR programs and EPSCoR-like [programs], and the impacts any differences may have on the number of EPSCoR faculty participating in the peer review process including, the percentage of successful awards by EPSCoR jurisdiction and individual researcher; and

H. Conduct a survey of colleges and university faculty at all levels regarding their knowledge and understanding of EPSCoR, and their level of interaction with and knowledge of their respective Jurisdictional EPSCoR Committee.

The Responsibilities of the National Academy of Sciences

The legislation mandates a National Academy of Sciences study to address the following topics:

A. A delineation of the policies of each Federal agency with respect to the awarding of grants to EPSCoR States;

B. The effectiveness of each program towards achieving respective goals;

C. Recommendations for improvements for each agency to achieve EPSCoR goals;
D. An assessment of the effectiveness of EPSCoR jurisdictions in using awards to develop science and engineering research, education, and infrastructure; and
E. Any other issues that address the effectiveness of EPSCoR as the National Academy of Sciences considers appropriate.

Questions Developed to Direct the Study

The committee will explore the following questions:

- What is the mission of the program as intended by Congress?
- Is this mission incorporated into the program designs of NSF, NIH, and the other agencies?
- Are these programs organized appropriately to achieve their goals?
- Are the programs integrated with other agency activities?
- What are the specific outcomes they are aiming to produce, and are they succeeding?
- Are the programs achieving their stated goals?
- What metrics are being used to evaluate success? Are these metrics appropriate and sufficient?
- Is this a cost-effective way to achieve these goals?
- Are any adjustments needed to the overall mission of the program to improve its effectiveness in contributing to the strength of the national research enterprise?
- What changes are needed in the individual agency programs to improve their effectiveness?

D
Biographical Sketches of Committee Members

The following are brief biographies of the members of the National Academy of Sciences (NAS) ad hoc committee responsible for this report.

William (Bill) Spencer [NAE] *(Co-Chair)* is chairman emeritus of the International SEMATECH Board. He served as chairman of the SEMATECH and International SEMATECH boards and president and chief executive officer of SEMATECH. Dr. Spencer has held key research positions at Xerox Corporation, Bell Laboratories, and Sandia National Laboratories. He received the Regents Meritorious Service Medal from the University of New Mexico in 1981; the C. B. Sawyer Award for contribution to *The Theory and Development of Piezoelectric Devices* in 1972; and a citation for achievement from William Jewell College in 1969, where he also received a doctor of science degree in 1990.

Dr. Spencer is a member of the National Academy of Engineering, a fellow of the Institute of Electrical and Electronics Engineers, and serves on numerous advisory groups and boards. He is a member of the Committee on Science, Engineering, and Public Policy at the National Academies. He was the Regents Professor at the University of California in the spring of 1998 and has been a visiting professor at the University of California, Berkeley, School of Engineering and the Haas School of Business since the fall of 1998. He is a research professor of medicine at the University of New Mexico. He received his A.B. degree from William Jewell College, M.S. degree in mathematics and Ph.D. in physics from Kansas State University.

Norine E. Noonan *(Co-Chair)* is Professor of Biology at the University of South Florida St. Petersburg (USFSP) and Director of the Advanced Placement Summer Institute at USFSP (endorsed by the College Board). From 2008 to 2013, she served as the Vice Chancellor for Academic and Student Affairs at USFSP. She previously served as the Dean of the School of Sciences and Mathematics at the College of Charleston, and as Vice President for Research and Dean of the Graduate School at the Florida Institute of Technology in Melbourne, Florida.

Between her service at Florida Tech and Charleston, Dr. Noonan served as the presidentially Assistant Administrator for Research and Development at the U.S. Environmental Protection Agency under President Clinton. Prior to joining Florida Tech, Dr. Noonan was Chief of the Science and Space Programs Branch, Energy and Science Division, at the Office of Management and Budget (OMB) in Washington, DC, and oversaw programs at the National Science Foundation, National Aeronautics and Space Administration, Smithsonian Institution, Office of Science and Technology Policy, and National Gallery of Art. She had a prominent role in developing and implementing civil space policy as well as monitoring and evaluating federal research and development, including education. She received two Special Performance Awards and an Outstanding Service Award from OMB.

Dr. Noonan is a member and Fellow of the American Association for the Advancement of Science (AAAS) and was a member of the AAAS Board of Directors (2002-2006) and the AAAS Council (2005-2008). Her professional activities have included membership on six NSF Advisory Committees, several study committees of the National Research Council, and the AAAS review panel on NSF Science and Technology Centers. In October of 2005, she received the NASA Public Service Medal. Dr. Noonan received her B.A. in zoology from the University of Vermont, summa cum laude, and her M.A. and Ph.D. degrees in cell biology from Princeton University..

Roger Beachy [NAS] is professor of biology at Washington University in St. Louis and executive director (interim) of the Global Institute for Food Security at the University of Saskatchewan (Canada). He was Scripps Family Chair in Cell Biology at the Scripps Research Institute (1991–1999) and founding president of the Donald Danforth Plant Science Center (1999–2009). Dr. Beachy was appointed director of the National Institute of Food and Agriculture at the U.S. Department of Agriculture (2009–2011). He is a member of the U.S. National Academy of Sciences (1997), was elected to the NAS Council (2003), and served as a member of the Editorial Board of the *Proceedings of the National Academy of Sciences*. Dr. Beachy is a Foreign Associate of the Indian Academy of Sciences, the National Academy of Science, India, and The World Academy of Sciences (TWAS); he is a fellow at the American Association for the Advancement of Science, the American Academy of Microbiology, and the Academy of Science of St. Louis. Dr. Beachy is known for his work in plant virology and molecular biology and agriculture biotechnology. In 2001 he was awarded the Wolf Prize in Agriculture, and in 1991 he was a recipient of the Bank of Delaware's Commonwealth Award for Science and Industry. He received awards from the American Society of Plant Biologists, the American Phytopathological Society, among others. He serves or has served on the Board of the International Crops Research Institute for the Semi-Arid Tropics in

Hyderabad, India, the Advisory Board of BIOTEC in Bangkok, Thailand; on advisory boards of venture capital funds, and boards for a number of companies and institutions.

Richard (Dick) F. Celeste is the president emeritus of Colorado College, where he served until 2011. He was the U.S. ambassador to India from 1997 until 2001. He was a managing partner in the consulting firm of Celeste & Sabety, Ltd., after serving as governor of Ohio from 1983 to 1991. He is a current member of the Policy and Global Affairs Committee with the National Academies, and has served on the NRC's Committee on Science, Technology, and Law; the Government-University-Industry Research Roundtable; and the Coordinating Council for Education. He graduated magna cum laude from Yale University, where he remained for one additional year as a Carnegie Teaching Fellow. In 1961 he was a Rhodes Scholar at Oxford University. He returned to Yale in 1963 for graduate study, working as curriculum advisor and part-time civics teacher.

Robert Duncan is the vice chancellor for research at the University of Missouri. He previously served as a professor of physics and astronomy at the University of New Mexico (UNM), visiting associate on the physics faculty of the California Institute of Technology (Caltech), joint associate professor of electrical and computer engineering at UNM, and associate dean for research in the College of Arts and Sciences at UNM. Dr. Duncan has published extensively in low temperature physics, and he has served as a principal investigator on a fundamental physics research program for NASA. As director of the New Mexico Consortium's Institute for Advanced Studies at the Los Alamos National Laboratory, he has worked to fund major conferences and summer schools in quantitative biology, information science and technology, energy and environment, and astrophysics and cosmology. He has chaired the Fundamental Physical Sciences Panel for the Committee for the Decadal Survey on Biological and Physical Sciences in Space with the National Academies. Dr. Duncan is a fellow and life member of the American Physical Society (APS). He was named the Gordon and Betty Moore Distinguished Scholar in the Division of Physics, Mathematics, and Astronomy at Caltech in 2004, and has recently chaired both the APS's Topical Group on Instrumentation and Measurement and the International Symposium on Quantum Fluids and Solids.

Irwin Feller is professor emeritus of economics and former director of the Institute for Policy Research and Evaluation at Pennsylvania State University, where he has been on the faculty since 1963. Dr. Feller's current research interests include the evaluation of public sector research and development programs; economics of academic research; the role of universities in technology-based economic development; and the evaluation of federal and state technology programs. He is one of the nation's leading authorities on these topics. He is the author of *Universities and State Governments: A Study in*

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