

2. Project Summary

Tennessee NSF EPSCoR plans to improve the competitive standing of Tennessee Science, Technology, Engineering, and Mathematics (STEM) researchers, with sustainable improvements in the capacities of Tennessee alternative energy technologies. This will be accomplished by expanding productive Tennessee STEM research cyberinfrastructure and diversifying participation in STEM by Tennessee institutions, organizations, and researchers.

Tennessee has long played an important role in America's energy needs ranging from the creation of the Tennessee Valley Authority in 1933 to being home to Oak Ridge National Laboratory, the U.S. Department of Energy's largest national laboratory dedicated to science and energy. Under the leadership of Governor Phil Bredesen, Tennessee has been tasked to return to these roots by implementing programs that encourage energy efficiency and conservation and capitalize on our core strengths in renewable energy as a platform to maximize economic growth in the 21st century.

Tennessee formulated a Science and Technology (S&T) Plan in February 2006, titled *The Tennessee Innovation Roadmap*. The *Roadmap* identified focus areas for economic, technology and workforce development which included energy/environmental/transportation technologies. An update of the Tennessee S&T plan, titled *R&D Vision 2020*, identifies that Tennessee could build capacity and become a national leader by focusing on two primary strengths: 1) Alternative Energy Technologies and 2) Pharmaceutical Sciences, leveraging our unmatched supercomputing and advanced materials strengths as enabling technologies.

Tennessee is embracing the *S&T Plan* with significant funding in alternative energy technologies. This includes a \$70 million Tennessee Biofuels Initiative and a \$20 million investment to recruit top faculty to Tennessee in science and technology resulting in five Governor's Chair positions with research specialties related to energy conversion, storage and/or efficiency. Additionally, the U.S. Department of Energy has created a \$135 million Bioenergy Science Center at Oak Ridge National Laboratory and the TN office of Economic and Community Development recently announced a \$62.5million Volunteer State Solar Initiative. A June 2009 report, funded by the Pew Charitable Trusts, found Tennessee as one of only three States with a large and fast-growing clean energy sector of their economy.

Despite these investments, the Tennessee S&T Plan identified four barriers to success: **1)** Limited access to human resources needed to build a critical mass; **2)** geographical parochialism; **3)** limited industrial base for synergistic development and commercial partnership; and **4)** an insufficient technically competent workforce. Eliminating these hurdles requires a shift in culture to one of collaboration between our many diverse institutions and is a central theme of this proposal.

We propose developing a research infrastructure project, *Tennessee Solar Conversation and Storage Using Outreach, Research and Education* (TN-SCORE) to overcome these barriers by integrating state investment, diversify research collaboration geographically, ethnically, gender-wise and throughout educational levels, with leveraged NSF support.

The overall theme of TN-SCORE has been separated into three main scientific thrust teams: **Thrust 1.** Advanced Solar Conversion and Innovation, **Thrust 2.** Components and Devices for Energy Storage and Conversion and **Thrust 3.** Nanostructures for Enhancing Energy Efficiency. The organization of these research thrust areas will address a major issue for the nation and will enable a *true* shift in **diversity** and **workforce development** culture in TN. Twenty-two Network Nodes will be formed and represent individual diversity (26% female) as well as institutional diversity (10 public/private, large/small institutions). Both public and private historically black colleges and universities (HBCUs) are represented within the network nodes. Competitive programs are included to engage additional

institutions such as secondary schools (SS) and research universities, with particular emphasis on two-year community colleges and four-year colleges and universities. Students will be drawn from institutions across the state with high numbers of first-generation students, rural and economically disadvantaged students. Over 125 significant Outreach activities to K-12 institutions from the three thrusts are planned. Specific programs are proposed for high school teachers as well as summer opportunities for outstanding rising college freshmen.

Both the research activities and the desire to broadly disseminate results to a wide variety of stakeholders require an extensive cyberinfrastructure. Connectivity to underserved, higher education institutions within the state will provide a diversity of research participants. TN EPSCoR also defines cyberinfrastructure as more than just connecting researchers via advanced networks; it is about engaging participants in the generation of knowledge. Our evaluation and assessment plan displays our intent to increase the use of web technology via streaming video lesson plans and webinars of research thrust modules. Our External Engagement Plan includes communicating project benefits and results to several constituencies. We will develop and participate in workshops with students drawn from public and private institutions across the state to translate science into understandable concepts applicable for delivery to K-12 classroom students and the general public. Lesson plans, hands-on exercises and supporting materials including workforce/career information to promote student career options as well as media releases for the lay public and the legislators within the state will be developed. All of these efforts will include deliverable modes based upon a state-wide cyberinfrastructure.

A well designed roadmap to reach research goals, as identified in the Tennessee S&T Plan, will be reviewed on a regular basis for correction in course. The multitude of activities to date has resulted in an evaluation and assessment plan with 27 specific metrics that will be monitored on a regular basis. Upon notification of grant award, an experienced external reviewer will be engaged to review the metrics and the evaluation plan to ensure it provides a comprehensive review and a management tool for corrective action. The consultant will conduct quarterly audits throughout the life of the RII program. The audits will be sent to the TN EPSCoR Director who will incorporate them into reports provided to the TN EPSCoR Management Team and state-wide EPSCoR Steering Committee. Appropriate incentives and penalties to funding recipients for reaching (or lack of reaching) goals will be administered.

Sustainability is ensured through new hires, proposal writing activities, commercial engagement and continuation of partner funding. Minimally, this includes four new junior faculty positions in the research thrust areas, a goal of 28 proposals, 15 invention disclosures, 39 externally funded internships, 24 Ph.D.s granted, and 180 undergraduates mentored. Uniting the research while building a diverse workforce for technology-based economic development will lead to additional partnering/funding opportunities. There are several programs seeded through this NSF EPSCoR that will be maintained after the duration of the program by the hosting institution.

A management structure has been constructed to provide top down project management efficiencies, via the state-chartered Tennessee Strategic Research Board (TSRB), with an equally important bottom up research-based guidance, the Research Thrust Leaders and an external technical advisory board, to ensure successful execution of the S&T Plan. The TSRB is a twelve member board that embodies the senior research leadership from across the state, representing academe, industry and government. They assist in establishing cooperative and collaborative associations between universities, research organizations, and private enterprises in Tennessee for the purpose of coordinating research and development programs that will aid in the creation of new products, services and jobs in Tennessee. The model's connecting element is the Tennessee EPSCoR Management Team (TEMT), which will report directly to the TSRB, and is comprised of a representative from all three Tennessee Higher Education Systems, all three Tennessee geographical regions, and all three Research Thrusts. The TEMT will handle day-to-day activities of TN

EPSCoR. This includes not only NSF EPSCoR, but also DOE, NASA and other Federal EPSCoR activities.

Intellectual Merit

One of the most important challenges facing our society is the development of renewable and environmentally clean energy sources that supplant our reliance on fossil fuels. Therefore, the **intellectual merit** of the three thrust areas is as follows:

Thrust 1: Current materials for solar energy conversion are limited by high fabrication energy costs, limited efficiency, and geo-political limitations of starting materials. As the era of fossil fuel dependence ends it will be necessary to have new, more sustainable methods and materials for solar energy capture and conversion. This is an area rich in opportunity illustrated by the three complementary approaches highlighted.

Thrust 2: The development and use of state of the art electrochemical energy storage and conversion devices which are critical areas of national interest and need. Network nodes will be developed around two primary technologies, electrochemical energy storage (batteries, supercapacitors) and conversion (fuel cells) devices.

Thrust 3: The development and use of nanostructures to enhance energy efficiency. Specifically to synthesize, fabricate, characterize and implement nanostructures with the aim of enhancing energy efficiency in solid state lighting and solar energy conversion.

Broader Impact

Tennessee EPSCoR has functioned at a high capacity with a completely volunteer committee. While those efforts are greatly appreciated and have led to many successful endeavors, a more sustainable impact is proposed. This proposal establishes a well-organized infrastructure and staff who have a consistent appreciation of improving the competitive standing of Tennessee STEM Researchers while disseminating the importance of basic research throughout the Tennessee citizenry.

Additional impact comes from all three Research Thrusts establishing an aggressive, inclusive outreach and workforce development approach. This enhances the value-added research capacity while creating a *culture of collaboration* across the state to eliminate a geographical parochialism. It reaches the next generation of scientists by using the laboratory as a classroom to educate which in turn addresses an insufficient technically competent workforce in this national interest area. The approach displays a model that builds a critical mass by providing research opportunities for diverse and underrepresented students and/or faculty that otherwise might not be available in the state of Tennessee. The resulting scientific findings and technology based economic development will be a model that will be valuable for NSF in supporting development in other jurisdictions.