

DOE-NREL Minority University Research Associates Program PV Research Accomplishments

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ABSTRACT

Since 1995, the DOE-NREL Minority University Research Associates (MURA) Program has encouraged minority students to pursue careers in science and technology. Through partnership with these universities, undergraduate students work with principal investigators participating in subcontracted research under NREL's University and Exploratory Research Project. During the school year, undergraduate and graduate students are involved in solar technology-related research at the universities and are awarded internships in industry or at national laboratories such as NREL during the summer. This paper describes the progress and accomplishments of the MURA Program universities.

1. Objectives

The focus of the DOE-NREL Minority University Research Associates Program (MURA) is to encourage undergraduate minority students to pursue careers in science and technology while participating in DOE/NREL-sponsored research projects.

Once accepted into the program, students can work on a research project for between one and three years. The program provides year-round renewable energy research opportunities and continuous mentorship through faculty and professional researchers at workplaces such as the NCPV at NREL.

Students involved in research excel in the classroom and are committed to contributing to sustainability through the development of renewable energy technologies. The program helps retain minority students in the science and technology areas and enables many students to reach their educational and career goals.

2. Technical Approach

2.1 History

The MURA program is an expansion of the former DOE-NREL Historically Black Colleges and Universities (HBCU) PV Research Associates Program, which began in 1995. The expanded program includes tribal colleges and universities, as well as those serving native Hispanics, Alaskans, and Hawaiians. In the past ten years, the program has sponsored more than 100 undergraduate students to participate in research projects. In addition, more than 13,000 high school, middle school, and elementary school students have benefited from renewable energy

campus and summer academies that program undergraduates and graduate students facilitated.

These activities have produced many research accomplishments and success stories. Several MURA students have gone on to graduate school to master their skills in fields such as physics, chemistry, architecture, and engineering. Others are now working in industry and government labs, using the knowledge and expertise they gained as DOE-NREL Research Associates.

The most valuable outcome of the program has been to inspire students to excel in their scientific quest for knowledge. Students leave the program with the desire to share their excitement about solar technologies with their local and international communities.

2.2 Selection and Program Outline

Outstanding science and technology majors are selected by faculty at their universities to participate in a solar technology research project during the school year. Then, students are awarded summer internships in industry or at national laboratories such as NREL during the summer.

At the close of the summer internship, program advisors, students, and host professionals participate in an annual Renewable Energy Academic Partnership (REAP) Review Meeting and Conference to discuss their research papers and future opportunities, as well as the national and global role of renewable energy in ensuring a secure and sustainable environment.

2.3 FY 2006 Universities: Projects and Progress

Eight minority-serving universities have been awarded subcontracts. Six are HBCUs and two are Hispanic-serving universities. The universities and projects are listed below.

2.3.1 Southern University

"Energy Conversion and Storage Devices: Solar Energy Research and Education." Undergraduate students majoring in physics, chemistry, and engineering are gaining research skills and training in (1) photo-electrochemical production of hydrogen and hydrogen energy, (2) nanocrystalline thin-film semiconductors for PV devices, and (3) high-energy and high-power-density electrochemical cells. The students have successfully completed academic work in the spring 2006 and fall 2006 semesters. The PI has published four papers related to the energy conversion and storage devices in the refereed journals and four papers in the International Conference Proceedings

published by World Scientific Co. Students have been depositing thin films of these nanocrystalline bulk materials synthesized on single-crystalline substrates using the pulsed laser deposition technique.

2.3.2 University of Texas at El Paso

"Fabrication, Characterization, and Modeling of Solar Cells." Student/faculty teams are investigating the fabrication, characterization, and modeling of solar cells. Students continue work on three projects at UT El Paso. The project has progressed in training students in these diagnostic techniques, and their results are discussed in three FY 2006 publications in refereed journals and international conference proceedings.

2.3.3 Fisk University

"Development of Quantum-Dot-Sensitized ZnO and TiO₂ Nanorod-Array Solar Cells." Research has focused on the development of silicon quantum dots for advanced solar cells with maximum efficiency, while minimizing power losses and solar cell degradation caused by thermal effects. Fisk researchers have developed a new pulsed electron beam deposition technique to fabricate semiconductor and metallic quantum dots (e.g., CdTe, PbTe, and Ag). They have also successfully grown ZnO nanowires of different diameters and lengths. In 2006, seven journal articles were published and eight posters were presented at international conferences and symposiums. Richard Mu won the best paper presentation award at the 15th International Photovoltaic Conference in October 2005.

2.3.4 Howard University

"PV and Renewable Energy Research/Training for Optimal Power Management and Distribution." At the university's Center for Energy Systems and Control, researchers are looking at ways to develop automation, as well as strategies to improve the power management and distribution of power driven by renewable resources. The team has proposed and tested the "Intelligent Customer Distribution System" using different indices to help in the management and monitoring of power system networks. A program was developed to expose high school students to the application of PV through ongoing research, and a Renewable Energy Education Curriculum has been initiated.

2.3.5 North Carolina Central University

"Investigation of Photovoltaic and Thermoplastic Semiconductors." Experimental and numerical-modeling approaches were used to train selected students in research in fabricating and characterizing various bulk and nanophase PV materials and also to facilitate energy-dependent, effective-mass approximation basic research and training of students in energy-related technologies. Students used energy-

dependent, effective-mass approximation and applied the finite element method to solve the confined energy problem for an InAs/GaAs quantum ring (QR). It was found that for the narrow QRs, the non-parabolic effect does not considerably affect electron states, however, the effective electron mass in both the QR and substrate changes significant.

2.3.6 University of Texas at Brownsville

"Design, Development, and Implementation of Simulation Tools for Analysis of Solar Concentrating Systems." Student/faculty teams are validating a computer-simulation tool, Tonitih, which will provide a sophisticated and efficient software environment for the design and analysis of solar concentrating systems. UTB has launched an effort to develop the documentation of Tonitih. They have identified and are analyzing available Open Source tools to assist in that endeavor.

2.3.7 North Carolina A&T University

"Performance Testing and Utilization of Photovoltaic Energy in Residential Environments." Students have investigated and evaluated a grid-connected PV system in a residential area of Greensboro, NC. The grid-connected PV system was simulated using the TRNSYS model. The performance of this PV system was analyzed and compared for three different PV modules (thin film, polycrystalline, and single crystalline). The TRNSYS simulation illustrated the trade-offs in choosing different modules for a specific PV system. On a per kW basis, the above three systems have increasing efficiencies (5.2%, 10.9%, and 13.1%), decreasing surface area requirements (18.5, 9.16, and 7.6 m²), and increasing system cost (\$4,511, \$5,900, and \$6,153). The conclusion is that if roof area is not a limiting factor, thin-film modules are the best choice. However, if roof area is limited, monocrystalline modules are indicated.

2.3.8 Central State University

"Renewable Energy Technology and Technology Transfer in Developing Countries." Students participate in a basic research program designed to introduce them to the practical application of renewable energy technology in the fields of economic development and various modes of transportation. During April and May 2006, ten Central State University undergraduates successfully completed an introductory renewable energy laboratory course designed to introduce science and engineering students to research concepts and products associated with renewable energy technology. The goal was to increase the pool of Central State University science, technology, engineering, and mathematics majors that would become eligible to participate in Central State's NREL-supported renewable energy program for the fall semester, 2006. During the spring semester, three Central State

University graduates completed a 7-month internship at NREL.

3. Results and Accomplishments

Eight minority-serving universities will complete awarded contracts in the MURA Program in early FY 2008. The faculty and students presented and/or published more than 20 papers and posters in FY 2006. The REAP Review Meeting was held August 7, 2006, in conjunction with the 16th Crystalline Silicon Workshop in Denver, CO. Presentations generated interesting discussions, which demonstrated great enthusiasm by participants toward the individual projects. The DOE NREL MURA Program continues to receive worldwide recognition for its unique efforts.

4. Conclusions

Within the past 10 years, many minority-serving universities and their students have benefited from MURA. For many undergraduate students, acquiring a degree in science/engineering—and participating in MURA—has evolved into a passion for a career in solar energy technology research and development. By combining research experience at the university with consistent mentorship and summer internships, the program facilitates the creation of a diverse and competent workforce for existing and developing solar technologies.

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