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ASSETS of Arkansas

Winter 2012

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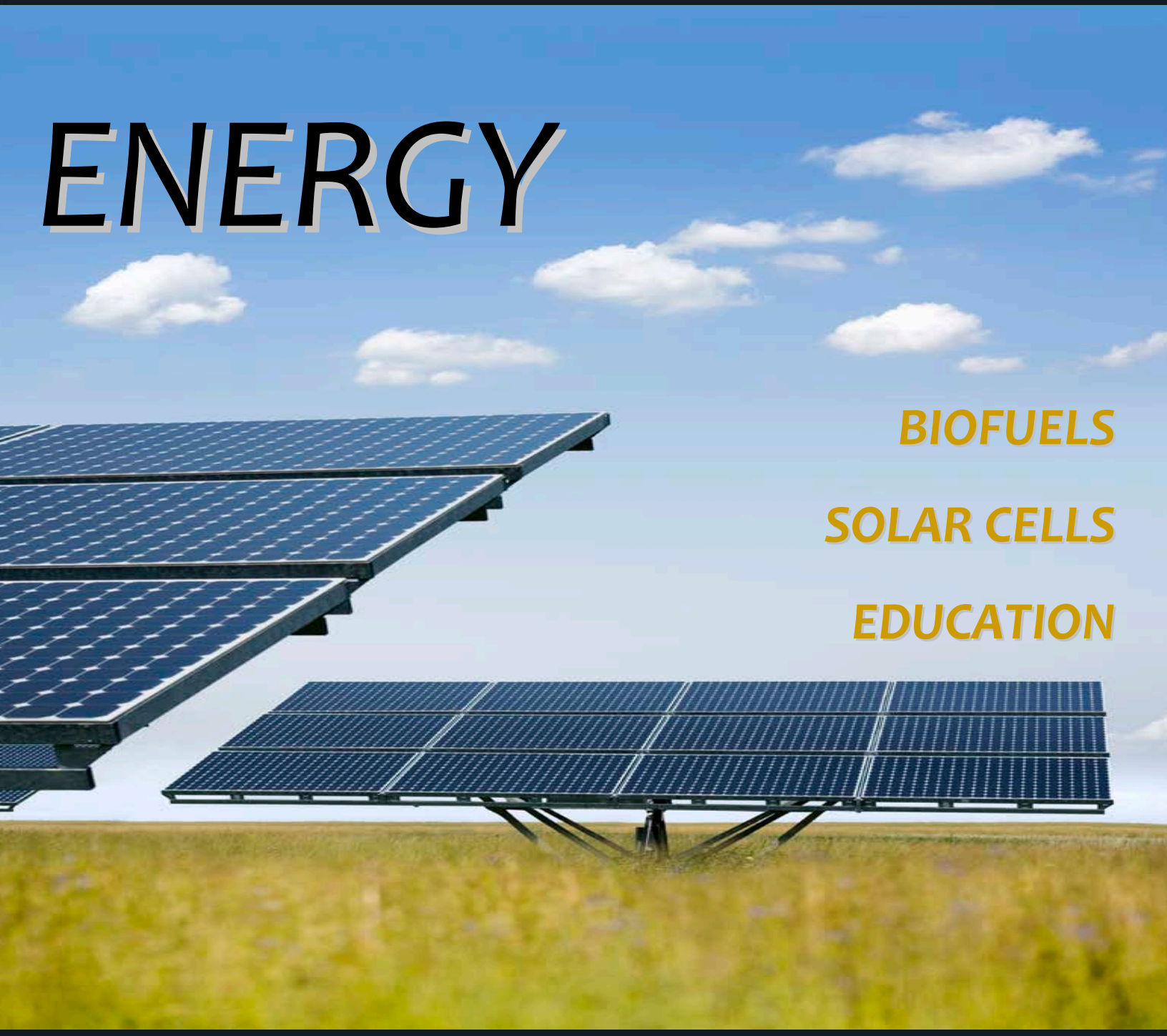
An NSF EPSCoR Project

ENERGY



BIOFUELS

SOLAR CELLS

EDUCATION

ASU ARKANSAS STATE UNIVERSITY

UNIVERSITY OF ARKANSAS

UA FORT SMITH

PHILANDER SMITH COLLEGE THINK JUSTICE

UALR

UNIVERSITY OF ARKANSAS PINE BLUFF

UCA

What is ASSET Initiative?

The Arkansas ASSET Initiative is a multi-institutional, interdisciplinary, state-wide program. Our current project, ASSET II, is designed to strengthen Arkansas research areas with potential for national significance and with major economic development potential. Our three specialty areas include: plant-based production, solar cell technology, and new power electronics.

*The **Arkansas ASSET Initiative** is part of the National Science Foundation's EPSCoR Program. An integral component of the program is entrepreneurial training, support for commercialization of new technologies, and an educational outreach program that targets the STEM pipeline needed to support the advanced technologies workforce.*

P3 ARKANSAS CENTER FOR PLANT POWERED PRODUCTION

GREEN

VICTER Vertically-Integrated Center for Transformative Energy Research

ARKANSAS asset initiative

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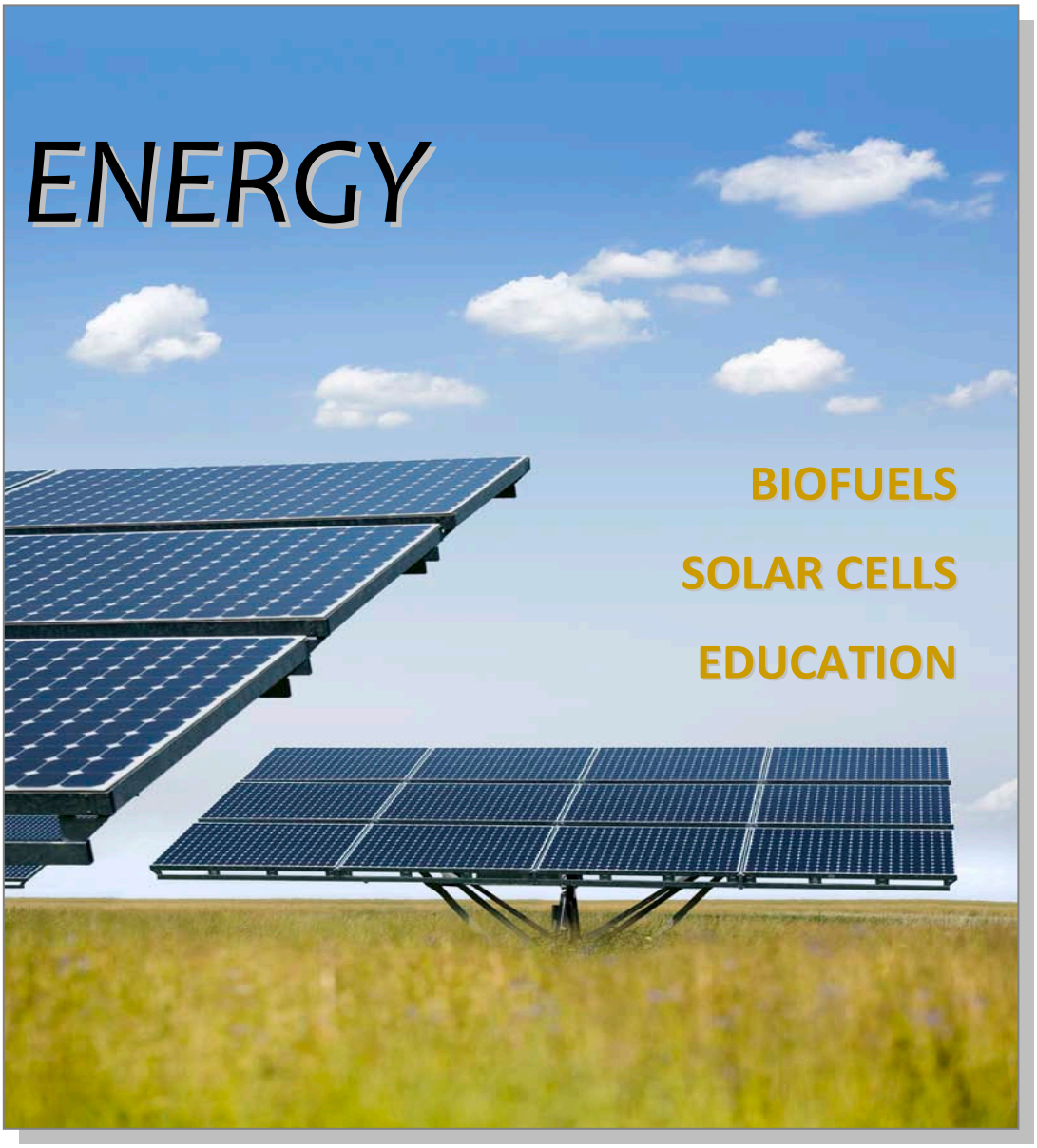

Powering Our Future

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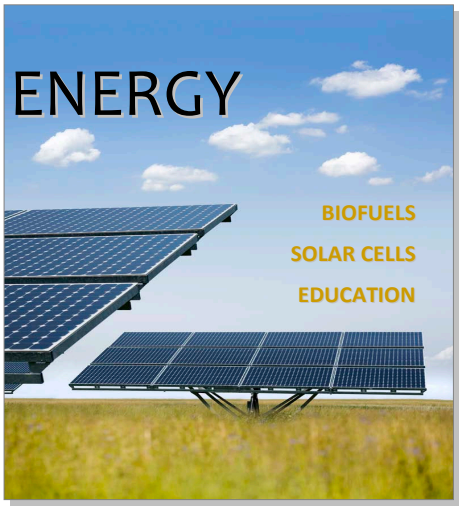

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Director's Welcome

*Arkansas ASSET II, (**A**dvancing and **S**upporting **S**cience, **E**ngineering and **T**echnology), our NSF EPSCoR Track-1 RII project is proud to release our newest edition of* ASSETs of Arkansas. *This edition is a new venture for us, moving into a more interactive media format that we hope will be enjoyed and valued by the readership of our newsletters. This e-magazine format allows us to provide more information and visually stimulating news of our research and educational projects. We are confident that this format will appeal to our "tech savvy" audience as well as our younger readership.*

Within this e-magazine we are featuring the research of our three centers. Our cluster of researchers in plant biotechnology within the Plant Powered Production (P3) Center now has critical mass and is expanding its research capacity around Next-Gen Sequencing. Our research in Generating Renewable Energy with Efficient Nanoplasmonic (GREEN) Solar Cells has made important strides in recent months with amorphous-silicon based solar cells. And our Vertically Integrated Center for Transformative Energy Research (VICTER) has ramped up their collaborative research around devices at the critical interfaces required for integration into the energy grid. More information on the research themes can be found at the recently developed or recently updated websites scheduled for launch on April 1, 2012:

www.plantpoweredproduction.com
www.victercenter.com
www.argreencenter.com

Outreach has always been extremely important to ASSET as we strive to expand our engagement at all levels, K-12 through graduate school. In this issue of our ASSETs of Arkansas, *we feature many of our activities that strengthen STEM teacher skills as well as engage students. ASSET is also working diligently to not only align our K-12 educational activities with our research themes but to also leverage and align with the Governor's STEM Works Program. Aligning with STEM Works is a unique opportunity to supply resources for biotechnology and energy related curriculum into project-based learning within K-12. As part of the Governor's program in the next school year, project-based curriculum will be used in the 10 new STEM Works High Schools (based on the New Tech High School Model), 5 new EAST CORE schools, as well as within the greatly expanded number of schools implementing Project Lead the Way.*

I hope that you will contact us if you see items of interest in our e-magazine. We welcome collaborations. We recognize that we must both leverage resources and share workloads in both research and educational activities if we are to ultimately create synergy and strengthen Arkansas.

-Dr. Gail McClure, Vice President for Sponsored Projects & NSF EPSCoR State Director

CALENDAR & UPCOMING EVENTS

March 5
STEM Coalition Meeting
Arkansas State Library
Little Rock, AR

March 14-16
EAST Conference 2012
Hot Springs Convention Center
Hot Springs, AR

March 15
Entrepreneurial Planning Workshop
University of Arkansas for Medical Sciences
Little Rock, AR

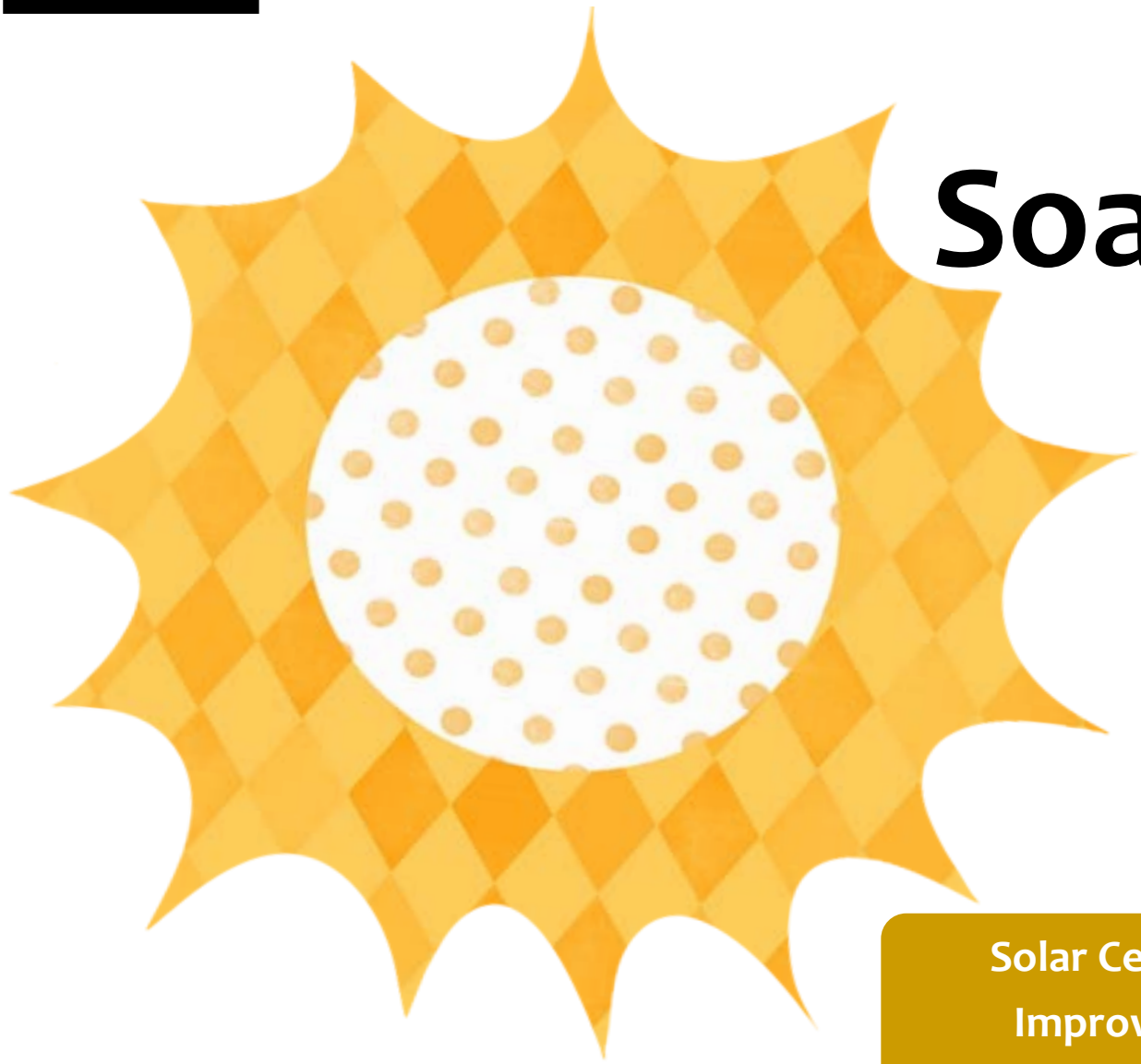
April 14
Arkansas Science Olympiad
University of Arkansas at Little Rock
Little Rock, AR

April 20
19th Annual Arkansas Undergraduate Research Conference
Henderson State University
Arkadelphia, AR

20th Annual Arkansas Space Grant Consortium Symposium
Winthrop Rockefeller Institute
Petit Jean, AR

April 20-21
Arkansas Louis Stokes Alliance for Minority Participation Spring Conference:
University of Arkansas at Pine Bluff
Pine Bluff, AR

May 22-25
3rd Annual Conference of the American Council for Medicinally Active Plants (ACMAP)
Arkansas State University



Soaking Up

Solar Cell Overlay Improves Light Absorption

While solar energy is one of the leading sustainable energy options available today, it is not yet widely utilized by the general public because of the cost. The technology must be cheaper and getting there is the goal of researchers with the Generating Renewable Energy with Efficient Nanoplasmonic Solar Cells (GREEN) Research Center. The Arkansas GREEN Center is producing some of the finest researchers in the country; researchers like Liming Ji, who came to the United States to pursue his PhD in Electrical Engineering at the University of Arkansas. Ji, whose research centers specifically on solar energy, is well aware of the challenges that lay ahead. "The cost per watt of solar energy is still three times more expensive than fossil fuels," he explains. "The most expensive aspect of solar cell production is the preparation of the semiconductor material, which absorbs light energy and converts it into electrical energy." This semiconducting material represents 50% of the total cost to produce a solar cell. Because of this, researchers like Ji are directing their efforts toward improving that aspect of the cell.

Continued page 6

The Sun

"The cost per watt of solar energy is still three times more expensive than fossil fuels…"

Graduate Student, Liming Ji, reviews data from solar cell testing.

Through the development of a smaller thin-film solar cell, which uses only 1% of conventional semiconductor materials, production cost is now significantly lower. However, while the size reduction means reduced cost, it also limits the efficiency of light absorption. Herein lies the cusp of Ji's research: to improve light absorption of thin-film semiconductor materials, while keeping the cost down. To do this, the GREEN Center is utilizing a unique approach in which they place an engineered, complex metal structure on either the top or bottom of plasmonic solar cells, a type of thin-film solar cell. When light particles hit the surface, they scatter across the cell, increasing the material's exposure to light. The longer the light passes through the semiconductor, the more absorption occurs. This application mimics the increased efficiency of a thicker, conventional semiconductor without the added size or cost. This cutting-edge solar technology is not yet ready for commercial implementation, but it does have promising development potential. If successful, it could be the answer to the global energy crisis and global warming.

It could also boost Arkansas's economic well being with the creation of new high-tech, high-paying jobs, a fact not lost on researchers like Ji. While he plans to continue his research in solar energy after graduation, there is no guarantee he'll be able to stay in Arkansas to do so. "Research is not limited by the researchers, but by their resources." Still, whether he stays or goes, he is confident in the GREEN Center research and in the efforts of other Arkansas-based research projects. "I have no doubt that the solar energy industry will only grow and thrive in this state."

Contributing Writers: Ashley Spurr & M. Carter

Dr. Alan Mantooth Talks Energy and The Power Grid

"About $60 billion worth of electricity is lost every year in transit or wasted by power converters. Roughly two thirds of the energy generated doesn't make it to your cell phone," said Alan Mantooth, University of Arkansas professor of electrical engineering. In October 2011, Dr. Mantooth spoke at the 22nd Annual National EPSCoR Conference in Coeur d'Alene, Idaho, on optimization of the nation's power grid. The fourth generation smart grid is intended to: lower the loss of energy to 10 percent, prevent rolling blackouts, incorporate renewable energy sources, and enhance grid security, all while maintaining our standard of living. It does all of these things by predicting what the power needs are, from corporations to residential homes.

Dr. Mantooth and his research team are working to integrate renewable solar energy into the power grid that exists today through the Fault Current Limiter (FCL). This technology was originally built for the United States Navy aircraft carriers. If the carriers were hit, the Navy did not want the entire power grid inside the ship to fail; the Fault Current Limiter fixes this problem. The FCL protects power networks from the rolling blackouts by isolating the problem.

To incorporate renewable energy sources into our power grid, the grid must also have systems capable of energy storage. This is due to the fact that the ideal times of sunlight for maximum solar power generation will be opposite to the time that the generated solar power will be needed. Mantooth notes that when the storing capability is implemented into the grid, the energy cost will decrease. One facet of energy storage will be at the community level. The storage of generated solar power will be in a "little green box," which could contain anything, including old hybrid car batteries that still are able to generate power. These storage boxes will be able to help decrease the power bumps that are caused by a shortage of electrical energy.

Another source of solar power research is the EMerge Alliance. One major focus of their research is safe direct electrical current (DC) power distribution. This helps to conserve power that would be otherwise lost in power converters. "We could use the mettle ceiling grids and plug the lights directly to the mettle infrastructure with DC current," said Mantooth. None of these power grid changes will happen overnight, but many researchers are optimistic that these changes will be soon coming. It is worth noting that these changes will have to be made according to region and certain adaptations will have to be thought out. As Mantooth pointed out in his talk "One size just does not fit all."

Contributing Writers: Joanna Wilson, Lachan Layton, and Ashley Spurr

Pictured above is Dr. Alan Mantooth, Principal Investigator for the VICTER Research Center.

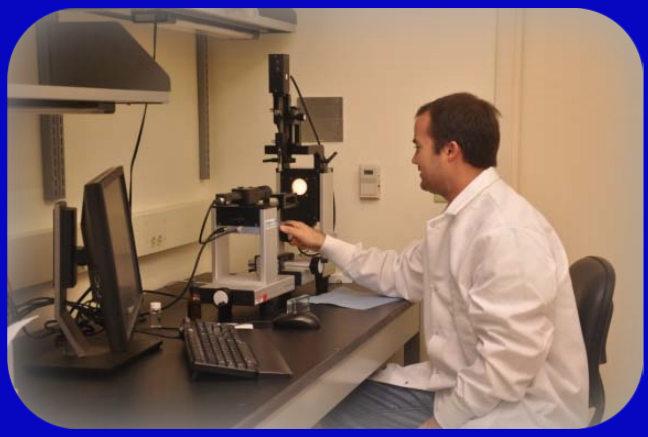
SOLAR PANEL TECHNOLOGY ADVANCES TO THE NEXT LEVEL

New approaches in solar panel coating materials are being developed at the University of Arkansas to improve the efficiency of solar panels. Dr. Min Zou, a project leader with the Vertically Integrated Center for Transformative Energy Research (VICTER), and her graduate students Corey Thompson and Robert Fleming, have proven that the coated glass samples transmit up to seven percent more light than bare glass. This study revealed that up to 90 percent of contaminants, such as dust, were removed from the surface of the coated samples after light rinsing with water, compared to only 48 percent from the uncoated glass. The self-cleaning ability of the coated glass samples is due to their surface superhydrophilicity. In this ongoing study, the superhydrophilicity of the coated surfaces have lasted for 150 days.

Researchers funded through both NSF and NASA-led initiatives are seeking innovations to further the advancement and effectiveness of coating materials in practical applications such as solar panels. Zou's team joins the roster of other peer research institutions, such as Wisconsin and Missouri, in seeking novel approaches to improve solar technology efficiency. As a next step, Zou's research group plans to investigate the antifogging properties of the treated glass.

VICTER is a part of the Arkansas ASSET Initiative, a National Science Foundation EPSCoR project (EPS-1003970) administered by the Arkansas Science & Technology Authority.

Author: Lachan Layton



Graduate student Corey Thompson measures the superhydrophilicity of the coated glass.

VICTER

Vertically-Integrated Center for Transformative Energy Research

2011 P3 SYMPOSIUM

The Arkansas P3 Center's Annual Symposium, 2011, was held in conjunction with the ASSET Initiative Annual Conference on July 26th- 28th, in Heber Springs, AR. Over sixty students, forty-six faculty and staff, and ten invited speakers and external advisory board members were in attendance. The symposium consisted of research specific breakout sessions, organized networking opportunities and a successful student poster competition with undergraduate and graduate student awards.

Invited speakers included: John Howard, PhD, of the Applied Biotechnology Institute, San Luis Obispo, CA; Heike Sederoff, PhD, of North Carolina State University; Lloyd Sumner, PhD, of The Samuel Roberts Noble Foundation, Ardmore, OK; Kent Chapman, PhD, of the Center for Plant Lipid Research, The University of North Texas; Joel Cuello, PhD, of the Department of Agricultural and Biosystems Engineering, The University of Arizona; Gunnar Boysen, PhD, of the Fay W. Boozman College of Public Health, Environmental and Occupational Health, University of Arkansas for Medical Sciences; Gary Thompson, PhD, Penn State; Stanton Gelvin, PhD, and Lan-Ying Lee, PhD, of Purdue University; Amit Dhingra, of Washington State University.

Author: Emily Devereux

Plant Immunity Research Funded by NSF

Dr. Lirong Zeng of UALR, P3 Research Group

Lirong Zeng, PhD, molecular plant pathologist, has been awarded funding from NSF's Division of Integrative Organismal Systems for the Role of A Lys63-Specific E2 Ubiquitin-Conjugating Enzyme/Variant In Plant Innate Immunity. The award is estimated at $423,783, to span from September 2011- August 2014. In this project, Zeng will characterize key components of lysine 63-linked ubiquitination in plant immunity, which is of fundamental importance to the understanding of the regulation of plant immunity by the ubiquitination system. This research will assist in efforts to unravel biological processes and proteins that are controlled by lysine 63-linked ubiquitination, knowledge of which is very limited at present. Integral to this project is training of post-doctoral, graduate and undergraduate students from minority groups that are underrepresented in science; incorporation of findings from this project to a dual-listed undergraduate-/graduate-level laboratory course taught at UALR, where minority students currently make up over 30% of the student population; and partnering of the investigators with the Arkansas Cooperative Extension Service to distribute findings from this project to the general public and stakeholders. Zeng is the P3 ASSET I faculty hire at UALR. His research focuses on the identification and characterization of genes and signal transduction pathways involved in rice and tomato immunity, especially the roles and molecular mechanism by which the ubiquitination system regulates defense responses in these plants.

For more information on this award click here.

Author: Emily Devereux

Researcher Works to Reduce Cost of Biofuel Production

Chuan Lau, a graduate researcher at the University of Arkansas, is researching biofuels as a solution to the growing global need for sustainable energy sources. Petroleum, a fossil fuel toxic to most life forms, currently functions as the world's primary source of energy, and is a non-renewable resource with deleterious planetary effects that will be felt for generations. For these reasons and others, petroleum makes an unsustainable and undesirable source of fuel. The perpetuating force driving its continued use is the cost efficiency of its production relative to other energy options. It was this knowledge that drew Lau to study biofuels with the Plant-Powered Production (P3) research team.

Lau studies a variety of plant species researching and characterizing the depolymerization of hemicelluose into xylose. More simply put, he studies how these plants break down complex sugars into simple ones (hemicellulose to xylose in this case) which ultimately results in ethanol – a basis for biofuels. After these plants break down complex sugars into simple ones, the sugars are converted into ethanol through the process of fermentation. But, researchers like Lau face a challenge when dealing with laboratory ethanol production in that the chemicals used to break down the hemicellulose create a lot of undesirable chemical by-products. By gaining a more comprehensive understanding of this process, Lau and other researchers can supply the industry with application methods to optimize operating conditions, maximizing ethanol production with less chemical by-product, and lowering operating costs. The implications of efficient biofuel production are vast, but they certainly include improved environmental conditions, economic stimulation, and reduced dependence on foreign oil. While some U.S. companies are already producing ethanol, the cost to produce gasoline is still much less. As researchers collaborate with industry leaders to improve ethanol production processes & yields, the public can anticipate a competitively priced, environmentally-safe replacement for gasoline.

Born in Malaysia, Chuan Lau first heard about the University of Arkansas through an education fair where he learned of Fayetteville's college- town atmosphere, and the idea of attending university in the home state of former President Clinton intrigued him. After arriving in Arkansas, he joined the P3 research team, a group supported by ASSET (Advancing & Supporting Science, Engineering & Technology), the state's Experimental Program to Stimulate Competitive Research (EPSCoR), funded by the National Science Foundation (NSF). This funding has enabled the university to purchase equipment such as the Centrifugal Partition Chromatographer (CPC) that not only improves the analytical capabilities of researchers, but saves money on costly experimental components. The CPC purifies the complex sugars used in Chuan's experiments. According to him, purified complex sugars typically cost upwards of $20,000.00 per 1g, but because the team can now purify their own, the cost is reduced to about $2.00 per 1g. When asked about the greatest lesson learned through this research experience, Chuan replied, "Understanding the overall biofuel process and how my research efforts fit into the overall picture, because knowing the influence my research will have on subsequent processes can help me think more logically when designing my experiment(s)." Lau expects to receive his Doctorate in Biological Engineering in May 2012, after which he plans to continue his biofuel research in either academia or the private sector. For further information on this research project, contact Dr. Julie Carrier (carrier@uark.edu) at the University of Arkansas.

Author: Ashley Spurr

Chuan Lau uses a pulsed amperometric detector (PAD) instrument (left) that allows him to detect and quantify different types of sugars, as well as a Centrifugal Partition Chromatographer (CPC) (right) that allows him to purify complex sugar from lower-cost raw materials. This equipment was purchased with EPSCoR (Experimental Program to Stimulate Competitive Research) funding, a program of the National Science Foundation.
Pictures courtesy of Kris Bunnell, Ph.D candidate at the University of Arkansas.

Biotechnology Research Generates Safer Plant-Based Pharmaceuticals

Walter Acosta is a Costa Rican native currently pursuing his PhD. in Molecular Biology from Arkansas State University. His interest in genetic engineering and microbiology began in high school after reading an article about the world's first successfully cloned sheep, Dolly. The suggestion of increased global crop production through genetic engineering caused Acosta to shift his educational focus toward agricultural sciences. As part of the Plant Powered Production (P3) research team at Arkansas State University, his current research revolves around the treatment of a genetic disorder called Lysosomal Disease. Lysosomes are the "trash cans" of a cell, and these organelles get rid of cellular waste. In order to do this, the body must produce enough of a particular enzyme to enable this process. When the body fails to sufficiently produce these enzymes, the waste cannot be expelled from the cell resulting in a variety of detrimental physical symptoms ranging from enlarged organs to mental retardation. According to Acosta, there are over 40 different Lysosomal Diseases affecting about 1 in 10,000 people. His research focuses on just two of the forty types: [1]Gaucher's Disease and [1]Hurler's Disease.

A patient suffering from Lysosomal Disease must turn to pharmaceutical companies to provide enzyme supplement for their body's insufficient production and until recently, the process for generating these enzymes has been extremely costly and potentially unsafe. For years, these supplemental enzymes have been grown in mammalian cultures (or cells) alongside a carrier protein used to transport the enzyme into the patients' cells. The annual patient cost for mammalian culture enzymes totals a whopping $300,000.00, and according to Acosta, that makes this the most expensive drug in the world. In addition to the hefty price tag, mammalian cells are susceptible to viral contamination, which can then be passed on to unsuspecting patients. Because of such of occurrences, the FDA requested researchers focus on plant-based cultures to produce the desired enzymes. Plant-based cultures pose no risk of viral contamination, and are estimated to yield a reduction in patient cost from $300,000.00 to about $75,000.00 annually. Pharmaceutical companies are now offering this type of plant-based enzyme in several countries outside the U.S., but the FDA does not currently sanction either form of enzyme therapy for public use.

Continued on page 12

Walter Acosta collaborates with a fellow researcher in the P3 laboratory at Arkansas State University.

For his research, Acosta inserts human genes into fully developed tobacco plants, after which the plants can produce these therapeutic enzymes in an astonishing 48 hours. To accomplish this, he dips the entire tobacco plant into agrobacterium; this bacterium contains the desired enzymes, as well as his team's unique carrier proteins, plant lectin. He then vacuum infiltrates the plant, takes the plant out of the agrobacterium, and two days later the leaves are full of the desired enzymes and carriers. The team then freezes the leaves until they are ready to process. Because of such advanced technological procedures, patients need no longer wait the traditional weeks and months for the plants to grow into maturation. The incredible turn-around time of this process has exciting implications for those who depend on this medication. In July of 2011, after determining the enzyme production was successful, the P3 team obtained blood samples of patients suffering from Lysosomal Disease, and all treated samples exhibited a correction of the disorder. In a joint venture with Arkansas State University, P3 researchers will begin treating mice that possess Lysosomal Disease with the plant cultured enzymes to further solidify their research findings.

As a poster contest winner at the Annual ASSET (Advancing & Supporting Science, Engineering & Technology) Conference, Mr. Acosta was one of three graduate students to represent Arkansas at the National EPSCoR Conference in Coeur d'Alene, Idaho, October 24th through the 27th. At this nationwide competition of doctoral candidates, his research garnered first place in his category. EPSCoR, or Experimental Program to Stimulate Competitive Research, is a nation-wide program funded by the National Science Foundation. Because of EPSCoR funding, P3 researchers have not only purchased essential equipment, but team members with seemingly unrelated discoveries are providing beneficial research applications for one another. And, through this experience, Acosta has come to understand the importance of academic research, and in particular governmental support of that research. When he first began studying biology, friends questioned his reasoning for not going into medical school, to which he replied, "Being a doctor, you might see 1,400 patients a year, [roughly] 60,000 over the course of your life. But, with a discovery like this, I can help thousands and possibly millions of people. That's what I want, to help people…millions if possible." In the future, Acosta plans to continue his research in academia or the private sector. To find out more about this research, please contact Dr. Carole Cramer at ccramer@astate.edu.

Author: Ashley Spurr

Picture provided by Emily Devereux

Solar Cell Modification Enhances Functionality and Cost-Efficiency

As part of the Vertically Integrated Center for Transformative Energy Research (VICTER) Team, graduate student Drew Fleming works to adapt the nano materials and surface engineering of thin-film solar cells to produce a less expensive, better functioning product capable of supporting the transition from fossil fuel based energy to renewable solar energy. As with any manufacturing process, solar cell production occurs over several development stages. This group of VICTER researchers is unique in that they focus on improving both the first and last of those stages: the materials and the packaging.

In solar cell packaging, the last, outermost component is a piece of glass. Like any surface exposed to the elements, the glass tends to get dirty, reducing the influx of light and potential energy generated by the cell. This means that a dirty glass surface will cause the cell produce less energy than a clean surface. Semiconducting materials are the central, most vital part of any solar cell; their job is to absorb light and convert it into electrical energy. In addition to the optical transmittance limitation, there is another challenge facing solar cell efficiency: the reflectivity of semiconducting materials.

Graduate researcher, Drew Fleming is pictured working in the lab at The University of Arkansas.

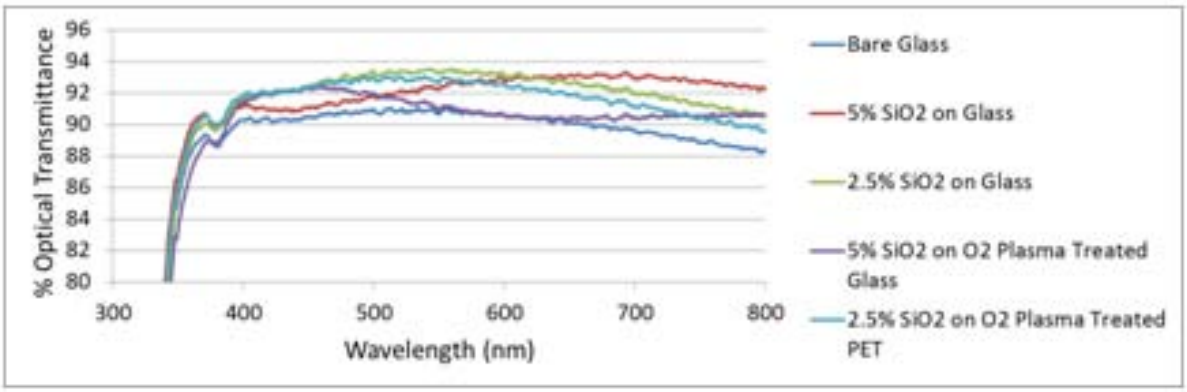
According to Fleming, the most effective and cost efficient semiconducting materials tend to be very reflective, at times up to 30%. These two deficiencies reduce the overall energy production of the cell. To combat this during the materials stage, the VICTER team is working to develop anti-reflective coatings for the tiny, thin-film semiconducting materials. "The materials we are using are much smaller than most people would realize. [We have] particles & films with dimensions of 100 nanometers (nm). That is a hundred to a thousand times smaller than the thickness of a human hair," said Fleming. Their materials work is still in the early phases of development, but the technique shows promise.

The most market-ready aspect of this VICTER team's research pertains to packaging applications, called surface wetting modifications. Surface wetting refers to modifying the way in which water interacts, or forms droplets, on a surface. The team has been hard at work creating a surface that combines superhydrophilic (water loving) and superhydrophobic (water hating) properties. On a superhyrdrophilic surface, the water preferentially spreads into a thin uniform sheet, but on superhydrophobic areas the water balls up into spherical droplets and will not adhere to the surface. Additionally, these cell surfaces are engineered with a slight roll-off angle, so as water droplets form on the cell, they will roll down the incline picking up dirt and debris as they go right over the edge, essentially creating a self-cleaning façade. Through these efforts, this VICTER research group is well on their way to producing a less expensive and better functioning solar cell.

Superhydrophilic Surface on Glass for Self-Cleaning and Anti-Fogging | **Bare Glass** | **Superhydrophobic Surface on Glass for Self-Cleaning**

EPSCoR (Experimental Program to Stimulate Competitive Research), is a nation-wide program funded by the National Science Foundation. Through this grant and financial support, the VICTER team has secured unlimited access to the nano-fabrication laboratory at University of Arkansas, without which, they would have been unable to engineer their surface wetting modifications. The increased emphasis on research actually brought Drew back to Arkansas to continue his education. While he completed his undergraduate degree in Mechanical Engineering at the U of A, he left for Illinois to pursue his Masters; that is until he learned about the research efforts developing after he left. He returned one semester later and has since helped generate exciting advances in efficient, cost effective solar cells. When reflecting on his experience, Fleming said, "At the end of the day, everyone on the VICTER team is genuinely concerned about improving solar cell technology…they want it to be successful and there is a lot of potential." To learn more about this research, please contact Dr. Min Zou (mzou@uark.edu) at the University of Arkansas.

Author: Ashley Spurr



Silica coatings used to modify the surface wetting properties also enhance the optical transmittance in the visible spectrum.

Analyzing High-Light-Inducible Proteins

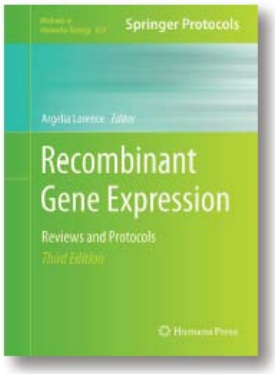
Qingfang He, PhD, UALR P3, has been awarded funding from NSF's Division of Molecular and Cellular Biosciences for the Functional Analysis of the High-Light-Inducible Proteins (HLIP) in Synechocystis PCC 6803. The award is for August 2011 to July 2014 and is funded at $451,460. His goal is to determine the molecular mechanisms by which photosynthetic organisms protect themselves from high intensity light. The research focuses on analysis of the functions of a family of four high light-inducible proteins (HLIP) in the model organism Synechocystis PCC 6803.

HLIPs resemble the light-harvesting chlorophyll a/b-binding proteins of higher plants in their primary sequences. They have been proven to be essential for cyanobacteria to survive exposure to high light. It may also play a critical role in higher plants as well. Overall, his research will improve understanding of the mechanisms for survival of photosynthetic organisms under high light conditions and will eventually enhance the ability to develop rational strategies for engineering plants or algae for better stress tolerance.

Author: Emily Devereux

P3 Researcher, Qingfang He, reviews data in his office at the University of Arkansas Little Rock.

P3 Researcher Edits New Book on Recombinant Gene Expression



Recombiant Gene Expression (above) was edited by P3 Researcher and professor of Chemistry, Dr. Argelia Lorence (below).

Argelia Lorence, Associate Professor of Metabolic Engineering at Arkansas State University, Arkansas Biosciences Institute (ABI), and the Department of Chemistry and Physics, recently edited the third edition of Recombinant Gene Expression Reviews and Protocols. In this 649-page volume, expert researchers in the field detail robust methods used to study recombinant gene expression. These include methods and techniques for bacteria, lower eukaryotes, fungi, plants and plant cells, and animals and animal cells. Written in the highly successful Method in Molecular Biology ™ series format, this new book includes review chapters introducing each model system and specific chapters that list the necessary materials and reagents, (step-by-step), readily reproducible laboratory protocols, and key tips on troubleshooting and avoiding known pitfalls.

High caliber research teams from sixteen countries (USA, Mexico, Germany, Italy, UK, Netherlands, Austria, Spain, Hungary, Greece, Tunisia, Slovenia, Estonia, China, Japan, and India) contributed chapters to this book. Among the USA teams participating are the ones led by multiple ASU researchers, including Carole Cramer (Biology and Agriculture), Beth Hood (Biology and Agriculture), Fabricio Medina-Bolivar (ABI and Biology), Maureen Dolan (ABI), Giuliana Medrano-Condori (ABI), Jay Xu (ABI and Agriculture), and Brett Savary (ABI and Agriculture). Recombinant Gene Expression: Reviews and Protocols, Third Edition has been published by Springer and can be purchased as a hard copy or e-book on Amazon.com.

P3 Scanalyzer Training

During the week of October 3-7, 2011, Dr. Ralph Schunk, Technical Services Manager from LemnaTec (Würselen, Germany), provided training to graduate students, staff, and faculty affiliated with the P3 Center on the recently acquired Scanalyzer HTS system. This instrument comprises an enabling and powerful technology for the performance of high throughput plant phenotyping. The Scanalyzer HTS, housed at the Arkansas Biosciences Institute at Arkansas State University, is the first instrument of its kind available to any academic institution in the USA. Until now, this technology has been only accessible to large plant biotech companies. The Scanalyzer HTS is equipped with four imaging units: visible, fluorescence, and near infrared cameras, and a laser for measuring plant height. This instrument allows P3 scientists to perform such vital activities as: quality control analysis on large seed collections and monitoring plant size, chlorophyll distribution, and water content in hundreds of plants in a non-destructive manner. This instrument is available to all P3 participants and will be used to drive the uncovering of discoveries in new and existing collaborative projects.

Author: Emily Devereux

VICTER Power Box Brings Energy and Sustainability Education to Classrooms

The VICTER Power Box provides the teacher and classroom with a fully developed, hands-on set of classroom activities that breaks down energy and sustainability concepts. The VPB also provides an opportunity to educate our students on the state of our nation's power grid. There will be a series of Power Boxes designed to develop understanding regarding energy including: (1) the nature of energy; (2) how energy is generated, (3) how energy is used and other issues as the project develops and needs are identified in additional areas. The box will include materials, equipment and reference information to provide direction and support to instructors as they implement the Power Box initiative in their classrooms. We will work with teachers during the professional development work sessions to develop lesson plans which will follow a constructivist model where students are active participants in their learning. The students will also experience the process of using an inquiry approach as each Power Box launches the students into investigations in energy development, utilization and sustainability. Teachers will receive professional development to equip them with the background and skills to effectively implement Power Box curriculum in their classrooms.

7. Instructional practices and materials will be introduced that encourage teachers to expand their repertoire beyond deductive approaches to incorporate experiential science learning and questioning to enhance their students' conceptual understanding (Lederman, 2009).

6. Teachers will be exposed to exploratory experiences, training and materials to help reverse the trend of teachers who fail to inspire their students in STEM disciplines due to the lack of professional development and necessary instructional resources (President's Council of Advisors on Science and Technology, 2010).

5. Teachers will participate in science experiences to help close the achievement gap in science performance and provide science for all students. The goal is to enhance the scientific thinking of teachers, and in turn, increase their skill and ability to similarly impact the scientific thinking of their students (Trundle, 2009).

4. Teachers will be introduced to innovative practices that enhance learning in the STEM disciplines and encourage students to consider careers in engineering and technology through (1) exposure to the work of engineers and (2) support to take this information and create lessons geared to elementary- aged students (Nugent, Kunz, Rilett & Jones, 2010).

Contents:

The materials contained in the Power Box will be selected and utilized in hands-on exploratory science learning strategies to facilitate demonstration experiences that illustrate, clarify and enhance understanding of the nature of energy, how it is generated, how it is used and other issues including sustainability.

RATIONALE

1. Teachers will participate in experiences to develop and strengthen their skills to create learning environments and instruction that will engage and facilitate their students' understanding of how the world operates, increase their ability to collect and analyze data, apply and test their ideas, and improve overall attitudes toward science learning. (Trundle, 2009).

2. Teachers will engage in hands-on experiential science explorations to expand their understanding and improve their capacity to promote positive and affective responses to science learning in their students which is critical to improved academic performance in science (Butler, 2008).

3. Engineering based demonstrations will allow teachers to participate in demonstrations with materials that facilitate an understanding of engineering as the application of science and math and to physically represent abstract concepts in ways that show how this learning impacts everyday life (Swift & Watkins, 2004).

Author: Marta Collier

Renewed Teacher Enthusiasm Promotes Interactive Learning

The STEM Leadership Academy, a teacher professional development workshop organized by Audubon Arkansas with support from the Arkansas Science & Technology Authority, brought together teachers from across Central Arkansas to engage with the outdoors and one another. Through this interactive workshop, participants learned, collaborated and shared creative ideas for encouraging scientific curiosity among their students, particularly focused on the natural sciences. Mary Smith, Audubon Director of Education, led these enthusiastic teachers through various experiments and activities that they could easily adapt for use in a classroom setting. The STEM Leadership Academy took place over a six-day period, and during that time, several areas of natural science were emphasized. Water being one of those areas, attendees were shown how to conduct simple, as well as complex tests on the water of Lake Ouachita. Most of these educators plan to incorporate the simple water test into their lesson plans during the 2011-2012 school year. Testimonials from several of the 20+ daily participants describe an atmosphere of sharing, collaboration and enthusiasm.

One such testimonial came from David Rouby, teacher of Environmental Science and Chemistry at Hall High School. "Getting together with like-minded people rejuvenates me," said Rouby. He explained that not unlike many teachers struggling to engage their students, he, at times, experiences a sense of detachment or isolation. He values this annual workshop because he is able to connect and collaborate with others in similar situations. Peggy O'Connell, a Gifted and Talented Science Teacher at College Station Elementary, is excited about her involvement with Audubon, as well as her school's close proximity to the Little Rock Audubon Center. "Students are deprived of experiences in nature," says O'Connell, and thanks to her involvement with Audubon, she now knows effective ways to strengthen student appreciation for nature and demonstrate the value of outdoor exploration. Additionally, O'Connell says she has learned what tools are necessary for her students to properly examine and explore the shared ecosystem of these two institutions. Fellow educator, Angela Stanford of the Gardner Magnet School in Hot Springs described the challenge of getting her students connected to the outdoors in this way: "Kids have a nature deficit disorder. When we do a hands-on, outdoor activity at first they aren't interested, but by the end they are excited and asking lots of questions!" She went on to say that as students become more curious, she encourages them to pursue STEM related studies and careers.

The overarching theme of connecting education to the outdoors was poignantly articulated by Mary Smith of Audubon Arkansas who said, "When you see it, touch it, smell it – you remember it." This was the third STEM Leadership Academy offered through Audubon Arkansas, and while activities vary from year to year, participants continue to leave with more knowledge and fervor than when they arrive. The enthusiasm and collaboration amongst teachers, in addition to the knowledge gained, promises to empower them with fun, effective ways to engage their students. For more information on this professional development workshop, please contact Mary Smith at Audubon Arkansas.

Author: Ashley Spurr

For the first time, Peggy O'Connell, Gifted and Talented Teacher at College Station Elementary, paddles a canoe during a group activity at the STEM Leadership Academy.

Biotechnology Kit Delivers Biofuels Education

Significant advances in plant biotechnology have increased the need for qualified, experienced professionals in the associated STEM related career fields. To encourage students to enter these lucrative careers, they must be exposed to cutting-edge biotechnology research early on. Increasing their knowledge and understanding of plant biotechnology, will not only increase the likelihood of continuing into a STEM career, but will also make them more competitive in an ever expanding job market. Plant biotechnology is integrated into many areas/fields of our global society. Specific examples include agricultural crop improvement, plant-based vaccines/therapeutics, bioinformatics, pollution remediation, human food & nutrition, and biofuel production. Furthermore, with agriculture being a major industry in Arkansas, providing Arkansas students with an understanding of plant biotechnology is critical to the success of modern agriculture in our state.

The reality is that often advances in biotechnology remain indiscernible to the general public including local science teachers and their students. The limited knowledge flow of these new ideas and concepts from plant biotechnology to K-12 science education creates a formidable gap that blocks teachers and students from benefiting in an awareness of this rapidly changing field of science technology that has a significant presence and impact in our state. This gap may lead to the fallacy that new biotechnology advances are too difficult to teach, are too time-consuming for the classroom.

Moreover, this gap creates a void in diversity of biotechnology career fields in which women and other underrepresented student populations have difficulty overcoming. Therefore, it is the goal of the P3 BTNB program to decrease the void between plant biotechnology research and K-16 STEM educators by providing the scientific content knowledge, instructional techniques, and resources that are not currently available to them in their classroom. The broader impact of the BTNB project is to have a ripple effect on the colleagues of the participating teachers and to positively affect student achievement, attitude, and interest in STEM careers at both the high school and college levels.

"The P3 BTNB provides...a fully developed hands-on set of classroom activities that integrate current plant biotechnology techniques...In biofuels, environmental and agricultural sustainability..."

The P3 BTNB provides the teacher and classroom with a fully developed hands-on set of classroom activities that integrate current plant biotechnology techniques with topical issues in biofuels, environmental and agricultural sustainability, and the Arkansas educational frameworks. The "box" includes all supplies, instruments, protocols, and a teacher's manual. The BTNB enables access to instrumentation typically beyond a teacher's budget, with instructions and protocols that ensure that both the equipment and experiments work in a grade-appropriate manner in the classroom. The kit is typically checked out for two weeks to a teacher and then resupplied for the next user. The teachers must be trained and certified for each BTNB.

Education Coordinator for the P3 Research Center, Shea Harris demonstrates the Biotech in a Box kit for a fellow ASSET Participant.

Establishing the P3 BTNB program at UAPB

In contributing to the efforts "to expand the STEM-enabled skills of Arkansas' students with special emphasis on underrepresented populations…" this mini-grant is expanding the pool of trained BTNB instructors and increasing distribution of the new P3 BTNB classroom kits throughout Arkansas.

The ABI/P3 BTNB program (funded by P3 NSF EPSCoR) at ASU is creating a kit focused on hands-on, inquiry-driven plant biotechnology techniques. However, most STEM teachers lack the knowledge of these techniques and awareness of focused plant research included in them. This workshop will provide the "beta-testing" opportunity necessary in enabling us to incorporate any modifications and improvements into the P3 BTNB kit and instructional materials prior to initiating BTNB training in Spring 2012 that is outlined of this mini-grant. At present there are BTNB trained teachers in 14 Arkansas counties and if we are successful in recruiting more funding partners we hope to continue the expansion of this program.

Author: Shea Harris and Photographer: Marta Collier

2011 Annual NSF Conference

This NSF EPSCoR Participant checks out the portable 3-D visualization device on display at the 2011Annual Conference.

Strengthening the STEM Workforce Pipeline

The 2011 NSF EPSCoR Conference featured several plenary sessions focused on workforce development. One plenary session focused on the ever-present problem of storing research data. An initiative by the Office of Cyberinfrastructure at the National Science Foundation will provide integrated resources for science and engineering researchers in order to create a more data-savvy 21st century workforce. The CE-21 initiative is one that will help create a cyberinfrastructure workforce to tackle the issue of unusable data. "You've got data, but data is not information and it's not the same as knowledge," said Jose Munoz, chief technology officer for NSF's Office of Cyberinfrastructure (OCI). "Data is very much the elephant in the room," Munoz said. "It's the thing that everybody knows about, but nobody really wants to talk about because we don't really know how to handle it." According to Munoz, the issue with data is its sheer volume. "It's doubling every two years. For 2011, we expect 1.8 exobytes worth of data," Munoz said. "That's about 200 billion HD movies and for one person trying to watch it 24 hours a day it would take them 47 million years. " Munoz also said that another concern is that all this data will have to be stored, processed, and used to gather information from, something that could be aided by the application of a better organized, easily accessible cyberinfrastructure. "The bad thing is, a lot of this data is unstructured. It's just out there," Munoz said. "There is no indexing, no comfortable way of getting to that data and processing it and using it." However, Munoz also said that NSF recognizes that data infrastructure services as essential to long term research assets that are fundamental to today's science. "NSF is interested in how to get data moving into the space of information and then from that extract knowledge because that's where we move things forward," Munoz said. NSF considers not just the amount of data, but the software to be part of this "data challenge" as well. "As we develop software…we also have to recognize that in order to make the scientific method work, the software that we use and the libraries that are created have to be part of that documentation process," Munoz said. Munoz also said that in the wake of this data explosion, software must be made available and sharable because it provides opportunities for multidisciplinary collaborations.

Continued on next page

Another Workforce Development session featured panelists discussing steps their individual organizations' are taking to promote STEM education and establish an experienced, prepared workforce. Panelist Jamai Blivin, CEO and president of Innovate-Educate, discussed how working with private and public partnerships to foster science, technology, engineering and math education is essential in implementing a model that works for individual states that have own their policies and regulations. "This connects STEM students with jobs, creating a workforce more prepared to contribute to an innovative economy," Blivin said.

Stephanie Smith, vice president for academic affairs at Delaware Technical and Community College, then discussed administrative aspects of implementing a lasting STEM education that will prepare students for a changing workforce. "Historically community colleges have been overlooked as an access point for students to enter the technologically sophisticated workforce of science professions," Smith said. But, community colleges focus both on career preparation and transfer success. They are uniquely positioned to prepare graduates with the competences needed for entry-level jobs in science, technology and research as well as for transfers to bachelor degree programs and beyond.

Lastly, the floor was given ton Steven Zipkes, principal of Manor New Technology High School in Manor, Texas, who talked about project-based learning models and innovative teaching methods that have helped his school effectively prepare students for technical work in STEM-related careers. "Often times we focus on *what* we teach, but what we need to focus on is *how* we teach," said Zipkes. He explained the influence of project learning on students in this way: "When students are given autonomy and creativity [in project-based learning] they're pulling information from all different places," Zipkes said. "They are engaged and understand that what they've learned has an application."

The Workforce Development track was spear-headed by Dr. Gail McClure, Project Director for the Arkansas ASSET Initiative. The intent of this special component of the conference was to bring relevant issues affecting the STEM Workforce Pipeline to the front of our efforts in STEM education.

Author: Joanna Wilson

Traditional dancer performs for audience at the 22nd Annual NSF Conference. (Picture by Marta Collier)

P3 Researcher Mentors National Conference Poster Winner

Gabriela Rodriguez-Gonzalez, an undergraduate at the University of Puerto Rico-Mayagüez campus did an internship under the mentorship of Dr. Argelia Lorence (Arkansas Biosciences Institute, Arkansas State University) this past summer. Ms. Rodriguez-Gonzalez won the best poster award in the cell biology category at the Annual Biomedical Research Conference for Minority Students, an event held in St. Louis, MO from November 9-12, 2011. Gabriela won this recognition with her work entitled "Myo-Inositol oxygenase expression in tobacco leads to plants with enhanced biomass and vitamin C content" (G Rodriguez-Gonzalez. CL Nessler, and A Lorence). She was also distinguished with a second award in the interdisciplinary science category at the same event.

Author: Emily Devereux

P3 and Arkansas Research Alliance

Several P3 participants were invited to take part in a conference sponsored by the Arkansas Research Alliance (ARA). P3 researcher Elizabeth Hood chaired the steering committee which organized the program: "Bioenergy and Biobased Products" session, held October 23-25, 2011. This was the third conference in the ARA Research Conference series which also featured the topics of Food Security and Sustainable Agriculture.

The Arkansas Research Alliance (ARA) conducted a study in 2009 that highlighted nine areas of emphasis (enterprise systems computing, distributed energy network systems, optics and photonics, nano-related materials and applications, sustainable agriculture and bioenergy management, food processing and safety, personalized health research sciences, behavioral research for chronic disease management, and obesity and nutrition) in which AR researchers have expertise. The ARA, led by Jerry Adams, and in partnership with the Winthrop Rockefeller Institute, has supported three pilot research conferences. Each Track was intended to bring together small groups of around 24 participants in an effort to build strategic relationships between Arkansas industry and academic researchers in driving economic development and commercialization in each of the identified focus areas. This invitation-only conference was designed to be a first step in promoting dialogue and encouraging follow-up on activities that include a wider group of individuals from across the state's many institutions and businesses in working together to advancing economic growth in Arkansas.

P3 Center Director Carole Cramer, who served on the steering committee, and Maureen Dolan both participated in the "Nutritional Food Supply" Track of the Healthy Arkansas Conference held this past April, 2011. Arkansas-based food industry leaders included Walmart, Riceland Foods, Tyson Foods, and others, as well as university researchers from around the state, were among the participants. Discussions included how Arkansas university research competencies and emerging technology might be applied in meeting the challenges faced by the food industry in response to improving human health and creating 21st century job opportunities.

Author: Emily Devereux

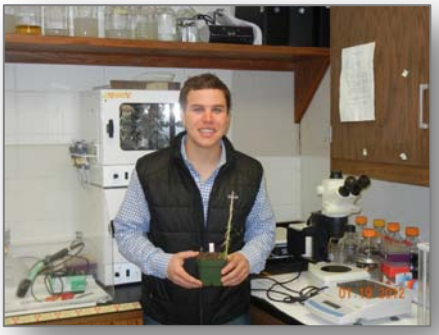
P3 Student Defends MS Thesis

On November 15, 2011, Jessica Yactayo-Chang successfully defended her thesis to obtain a MS degree in Chemistry from the Department of Chemistry and Physics at Arkansas State University. Her thesis is entitled "Stable co-expression of vitamin C enhancing genes for improved production of a recombinant therapeutic protein, hIL-12, in Arabidopsis thaliana*". This work, funded by the Plant Powered Production Center and a sub-award from the AR-INBRE, is a collaborative effort between the Lorence and Dolan Laboratories located in the Arkansas Biosciences Institute at Arkansas State University. Ms. Yactayo-Chang obtained evidence demonstrating the positive role of elevated vitamin C content in stable Arabidopsis (*Arabidopsis thaliana*) and tobacco (*Nicotiana tabacum*) plants for the accumulation of human interleukin 12, a valuable therapeutic protein.*

Author: Emily Devereux

SURF AWARDS 2012

The 2012 ASSET Initiative Student Undergraduate Research Fellowships, or SURFs, are designed to support the research endeavors of undergraduate students connected to the research areas of ASSET. This highly competitive grant was recently awarded to 16 students from across the state. Each student presented a research proposal with the support and guidance of a faculty advisor. Students have one year to conduct their research and submit their findings. Arkansas is fortunate to have such talent among our young researchers. The Arkansas Science & Technology Authority partners with the Arkansas Department of Higher Education in the granting of STEM SURF awards whenever funding is available. To find out more about these projects, please visit ASTA.Arkansas.gov.



Pictured are 2012 SURF Awardees, (from left to right) Top row: Joseph Simpson, UA; Jonathan Radin,ASU; Kevin Tran, UAFS; Second row: Jessica Bailey, ASU; Robert Cutler, HSU; Chase Purnell, UA.

Winners not pictured: Geoffrey Lueken, UALR; Daniel Brinker, UCA; Christopher McDaniel, UA; Michael Joseph Earls, ASU; Peter Killeen, UA; Carson Munn, ASU; Samuel Bonney, UALR; John Bowman Kelley, UAM; Nathan Probst, UAM; and Karen Ramey, UA.

GROWING GREEN

It should come as no surprise that Arkansas is leading the way in practical solutions to reducing food costs for families. Across the natural state, large industrial agriculture shares the landscape with smaller scale growing operations, many of which utilize nurseries and greenhouses to produce crops and extend growing seasons. Greenhouses are usually thought of as large, square, glass houses bursting with leafy greens and produce. While this is true of some designs, it does not reflect the possibilities afforded by creative engineering and clever design. Limited space, high energy costs and localized pests continue to present challenges for growers who need innovative solutions now.

One such innovation is the ASSET Initiative Solar Design Competition for middle and high school students conducted in partnership with the Environmental and Spatial Technology (EAST) Initiative. The competition asked students to design solar-friendly greenhouses using computer aided drafting software and submit fully assembled models with an explanation of how their design would benefit their local community. The competition required students to demonstrate an understanding of engineering and biological processes. Along with a small team of his peers, Greenland High School senior and grand-prize winner, Jeff Overdorf, crafted a simple, space-saving greenhouse from recycled materials, ideal for urban homes or gardening-challenged individuals.

Four other projects were awarded in the junior and senior divisions reflecting creative and practical applications for our next generation, small scale greenhouse designers. Greenhouses serve as resources for training and teaching future horticulturalists, botanists, and farmers. These small to medium size greenhouses provide community members and educators with hearty sources of nutrition, while also serving as hubs of learning and innovation. Click here to access the State Plant Board's list of licensed greenhouses to locate one near you.

Author: Ashley Spurr

Student Competitors

Greenland High School
Jeff Overdorf
Daniel Dabney
Tyler Self
Sheridan Eggestein
Pottsville High School
Darrell Henderson
Jacy Allen
Morrilton High School
Nick Allred
Green Forest Middle School
Cesar Canales
Andrew Wilson
Mena Middle School
Jodeci Ingoglia

Volunteer Judges

Arkansas State University
David Kwangkook Jeong
University of Arkansas
Erik Johnson
Drew Fleming
University of Arkansas at Little Rock
Brian Berry
Shawn Bourdo
Dever Norman
Johnathan Armstrong

Grand Prize winning design from Greenland High School on display in the workshop.

Authority Welcomes New Team Members

Elza Albert

The Arkansas Science & Technology Authority is pleased to announce Elza Albert as the new ASSET Accountant. Elza has a BBA from Henderson State University. Prior to joining the Authority, Elza worked as an accountant and program auditor for the Department of Workforce Services for 4 years. Elza first began his Arkansas state career with the Department of Finance Administration as a cashier. Prior to pursuing a career with the state he worked as a mental health technician at Pinnacle Pointe Hospital devoting great energy to troubled youth for 7 years. During his time at Pinnacle he assisted the recreational therapy and marketing departments.

Elza was born and raised in Little Rock, Arkansas and is now the father of 3 children. He enjoys sports and working out, but most importantly spending time with family and keeping them all active.

Ashley Spurr

The Arkansas Science & Technology Authority is pleased to announce Ashley Spurr as the new Communication Intern. Ashley is an Environmental Science major, Anthropology minor, at the University of Central Arkansas. With an emphasis in biology, Ashley plans to research fungal mycelium as an effective soil remediation tool. Her areas of interest are soil/water remediation, sustainable food production, , agro-ecology, as well as Cultural and Environmental Anthropology. Previously a Communication major, she uses skills in administration to help fellow community members organize a grass-roots environmental education event called Conway EcoFest. This is a free, annual event that focuses on interactive, hands-on learning for people of all ages.

Ashley was born and raised in East Tennessee. Her love for nature and the outdoors was nurtured at the foothills of the Smoky Mountains. Ashley came to Arkansas in 2008 and has enjoyed the many state parks and volunteering opportunities available to her. Last summer she volunteered at Heifer Village in Little Rock. In her free time she enjoys hiking, listening to music, writing, and watching movies. After graduation, Ashley plans to pursue her Master's degree in either Environmental Remediation or Environmental Anthropology.

Lachan Layton

The Arkansas Science & Technology Authority is pleased to announce Lachan Layton as the new STEM Intern.

Lachan is a Biological Physics Major and an Applied Mathematics major at the University of Central Arkansas. She has participated in many outreach activities promoting the STEM Residential College including Bear Facts Day, speaking engagements in local elementary schools, and hosting science nights to get students excited about pursuing careers in STEM fields.

Lachan was born in Little Rock and attended Mount Saint Mary's Academy where she discovered her love for science and math. She also has varied interests outside of the scientific field. She has performed at the Arkansas Repertory Theater and has been an apprentice blacksmith under her grandfather's tutelage. In her spare time, she also enjoys reading and indulging a passion for fine arts such as dancing and music.

Lachan plans to continue her physics and mathematical education efforts after graduation and hopes to continue reaching out to local communities in an effort to promote STEM fields.