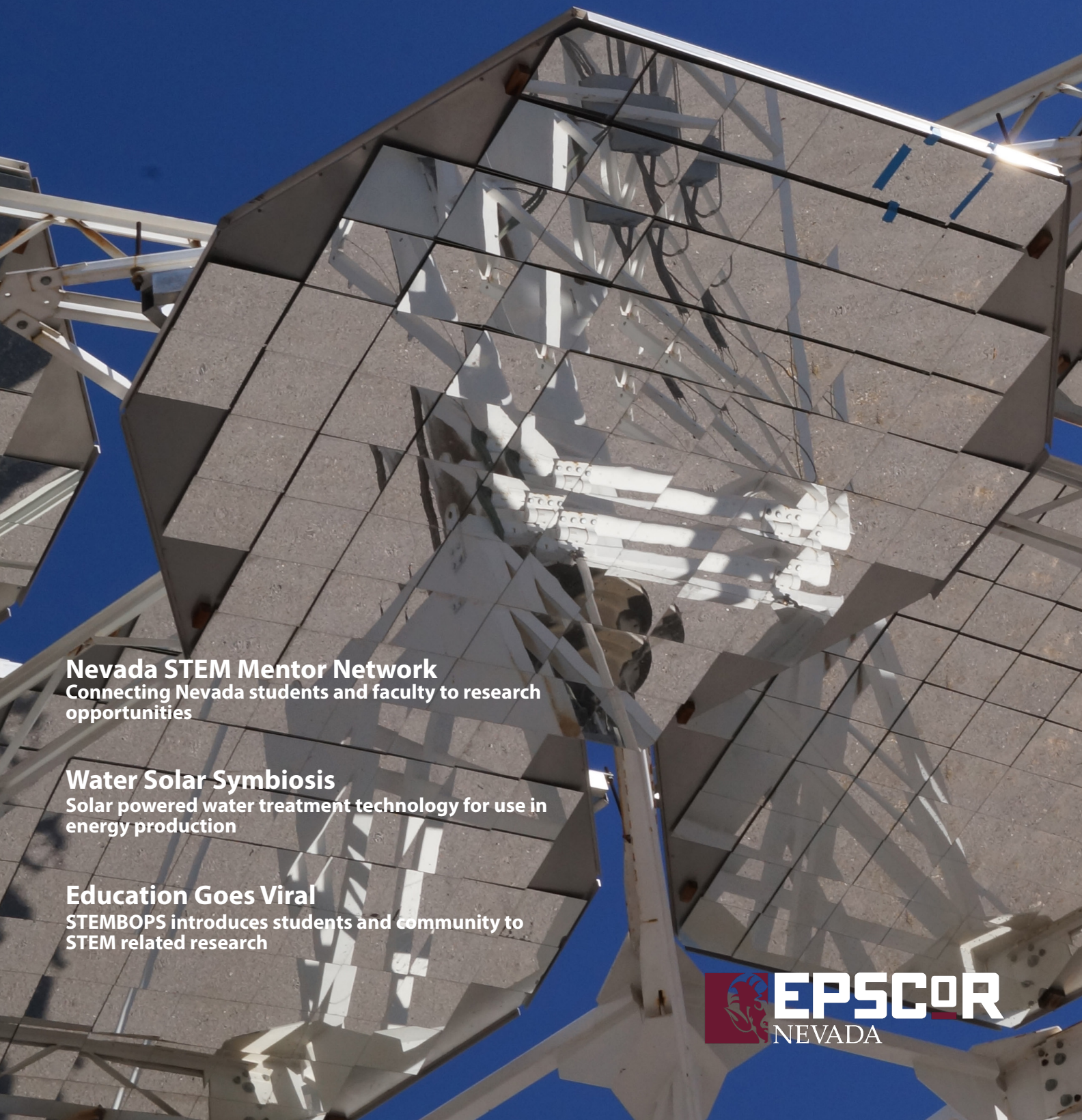
Nevada

DISCOVERIES

NSHE System Sponsored Programs and EPSCoR | Winter 2016



Nevada STEM Mentor Network
Connecting Nevada students and faculty to research opportunities

Water Solar Symbiosis
Solar powered water treatment technology for use in energy production

Education Goes Viral
STEMBOPS introduces students and community to STEM related research

EPSCoR NEVADA

NEVADA STEM
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TRANSFORMING EDUCATION BY

BUILDING LASTING CONNECTIONS

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NEVADA STEM MENTOR NETWORK

MENTOR NETWORK

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- Search for a mentor in our extensive database
- Discover STEM graduate assistant and undergraduate positions
- Research scholarship and fellowship opportunities
- Access to resources for a successful mentorship
- Read about Nevada's trailblazing mentors
- Explore STEM careers
- Look through STEM resources

FACULTY

- Sign up to become a mentor
- Advertise student research opportunities
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NSF Nexus Solar Energy | Water | Environment IN NEVADA — Nevada System of Higher Education 1865 — EPSCoR NEVADA

This material is based upon work supported by the National Science Foundation under Grant No. IIA-1301726.

An example of a concentrating solar plant that uses dry cooling is the Ivanpah Solar Plant which is in the California Mohave Desert 40 miles southwest of Las Vegas, NV --K. Grant Photo

Clean and Dry: Water-Free Cooling for Solar Energy

*NEXUS scientists investigate more efficient **dry cooling systems** for thermal power plants*

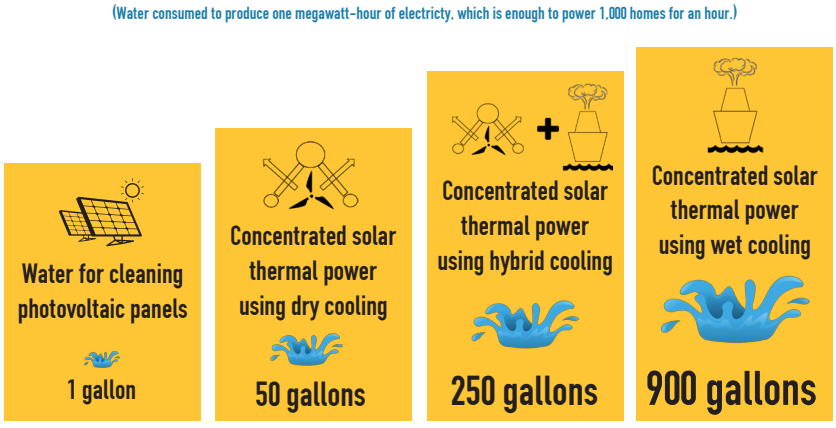
***Editor's Note**: A version of this story, written by Jane Palmer, originally appeared on solarnexus.epscorspo.nevada.edu October, 2016 and the UNLV News Center Nov. 8, 2016.*

Concentrating solar power (CSP) plants provide a clean and sustainable form of renewable energy in the southwestern United States, but the costs on local water resources can be high.

"Water requirements for CSP can include using water in wet cooling towers as well as for washing of mirrors," says NEXUS scientist Dr. Robert Boehm, at the University of Nevada, Las Vegas (UNLV). "The first of these two evaporates water into the ambient air and this can amount to large amounts of water use."

Most solar thermal power plants use mirrors to concentrate the sun's energy to heat a fluid that is used to create steam, which then drives turbines that create electricity. Once the steam passes through the turbine it needs to be condensed and cooled before it can be reused to produce more electricity. Typically, solar thermal developers prefer to use "wet cooling" towers, which involve the constant replenishment of water to make up for evaporative losses.

To counteract this water requirement, researchers have developed dry cooling systems that use air instead of water to condense the steam. These systems use about 90 percent less water, as almost none is lost to evaporation. But despite this advantage, dry cooling



requires more capital investment and reduces the efficiency of the power plant.

To address these challenges, NEXUS faculty Boehm and Dr. Yitung Chen with Ph.D. candidate Kaipo Kekaula, undergraduate student Phillip Vorce, and Research Engineer Rick Hurt at UNLV are using a combination of experiments and computer modeling to improve dry cooling system performance.

"We are trying to minimize the performance penalty that exists in these kinds of systems so that, between the water savings and the performance penalty reduction, this may be more than enough to overcome the capital cost differential between wet and dry cooling," Boehm says.

In the summer of 2015, Boehm and his team finished the construction of a full-sized apparatus to test out modifications to dry cooling systems. "Data from experiments on this system allow us to develop computer models of dry cooling that will give us understanding of broad applications for these kinds of systems," said Boehm.

In particular, the engineers are investigating how different types of cooling tubes might increase the transfer of heat from the steam to the air, allowing the whole concept to become more efficient. They are testing tubes in a variety of configurations and modifications to find out how differences in structure will affect temperature, velocity and pressure for steam, airflow and condensation.

"The experiments we are performing allow us to understand the performance improvements that modifications to the tubes will produce," Boehm said.

In parallel to their experimental efforts the team has developed computer models to simulate how air flows through the system and transfers heat from the tubes. Most previous modeling studies have focused solely on the heat transfer improvements in a single fluid domain, whereas Boehm and his team are investigating the more comprehensive and realistic combined effects of the steam and air.

Ultimately the team's research has the potential to increase the efficiency of dry cooling systems by 5 to 10 percent. It is research that would have wide scale applicability.

"This will work for any type of steam power plant with dry cooling: geothermal, coal, or nuclear, as well as solar," Boehm said. "Our research can have far reaching positive impacts in the power industry."

Fully Completed Dry Cooling System
--R. Boehm Photo

Water Solar Symbiosis

*NEXUS research develops **solar powered water treatment technology** for use in energy production*

***Editor's Note**: A version of this story, written by Jane Palmer, originally appeared on solarnexus.epscorspo.nevada.edu December, 2016.*

Solar power plants need water, but where the sun shines the most in the U.S., water can be a scarce resource. The water required for cooling, or to wash mirrors and panels, could be hard to come by in certain regions of Nevada and thereby pose problems for the long-term sustainability of solar power in the State.

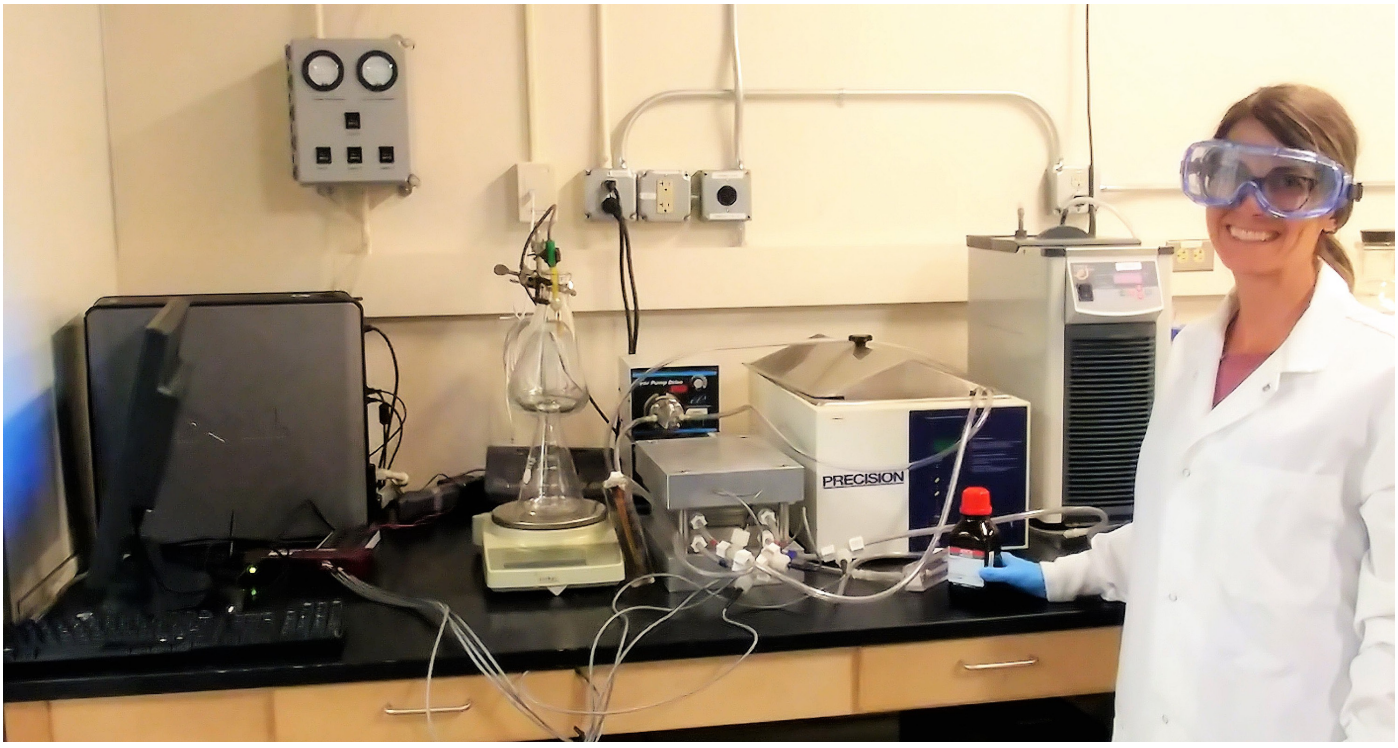
For this reason, NEXUS scientists have investigated the use of impaired waters and other sources of water that ordinarily wouldn't be used for potable purposes in solar energy production. But processing or "cleaning" such water requires energy. Consequently, NEXUS researchers have created an ingenious technology that supports both solar energy and water treatment: This technology uses solar energy to power water treatment and the treated water for cooling and cleaning.

"This technology has the potential to make solar energy a sustainable option in arid, remote locations by utilizing on-site resources, non-potable water and free heat, to meet the clean water needs of the facility," says NEXUS researcher Dr. Sage Hiibel at the University of Nevada, Reno.

The NEXUS technology hinges on a process called direct contact membrane distillation (DCMD), an emerging water treatment technique that can be used to treat many non-potable waters. This technology removes the salt from water by using a semi-permeable membrane that lets only pure water vapor pass through, but not other chemicals or particles.

The team has investigated the working of the system in the laboratory, testing optimal membrane materials, thickness, and pore size. The researchers have also developed a pilot-scale system that they will use to treat solar panel wash waters and other impaired waters at solar energy facilities.

"DCMD and solar are perfect partners - taking heat from the panels and using it to heat up the non-potable water not only



Coral Taylor, University of Nevada, Reno Graduate Student
--K. Salls Photo

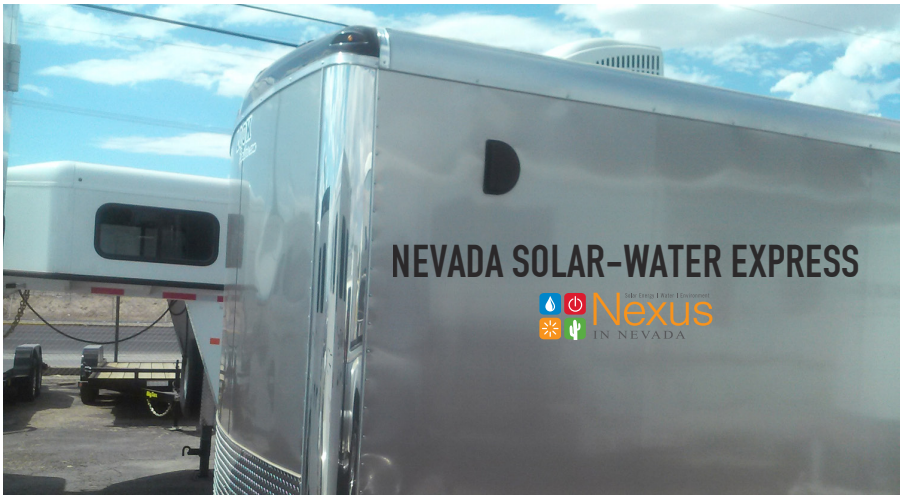
gives DCMD 'free' thermal energy, but it also improves panel efficiency by providing purified water to clean the panels; it's a win-win," Hiibel says.

Having tested the DCMD technology extensively in the lab, the scientists are now installing it in a mobile water treatment trailer, the Nevada Solar-Water Express. The trailer, which can be taken to solar facilities around the region, can treat and clean water onsite, thereby reducing the cost to pump and heat impaired waters. By treating water onsite, the team could potentially expect savings of up to 20 gal/MWh.

"Due to the remoteness of most large-scale solar facilities, bringing fresh clean water in and taking the dirty water out would be incredibly expensive," Hiibel says. "On-site treatment will cut those transportation costs completely, which makes the economics much more favorable."

The trailer also contains a variety of other water technologies that can be used to raise Science, Technology, Engineering and Mathematics (STEM) awareness for visiting students. The trailer has a six-foot awning window for demonstrations, fixed bench-space, a small wet-lab area, module areas for various treatment technologies, and photovoltaic panels on the roof to demonstrate solar energy systems.

"Our goal is to not only provide a sustainable supply of clean water for solar facilities, but also to raise awareness of what is possible in Nevada, build collaborations with other agencies and researchers, and help to educate the public and get them behind clean water and renewable energy here in Nevada," Hiibel says.



Nevada Solar-Water Express --J. Batista Photo

Left: Front of the trailer showing the generator that will be used to power the experiments and also a waste heat source for the membrane distillation system. Right: Solar panels getting ready for installation on top of the trailer, with the top rack for the trailer also in the background. The panels will be used to power a portion of the trailer and the rack will be used for storage and as an elevated source water supply location for the trailer (to gravity feed in to non-pressurized experimental modules in the trailer).-P. Faught Photos

SolarSpring

Pilot-Scale DCMD System
--P. Siegmann, SolarSpring Photo

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Supporting Science Discovery

NEXUS ***Cyberinfrastructure*** *creates the framework for gathering, processing and sharing scientific data*

Editor's Note*: A version of this story, written by Jane Palmer, originally appeared on solarnexus.epscorspo.nevada.edu on July 1, 2016.*

In the arid desert near Boulder City, Nevada, scores of instruments collect a steady stream of climate and environmental data from around, and within, the solar panel arrays that stretch across the landscape. The gathered information will help optimize solar energy efficiency and also minimize future environmental impacts, but first this data needs to be transmitted, processed, understood and interpreted.

Enter the NEXUS Cyberinfrastructure (CI) initiative, which focuses on providing the critical information framework for conducting research at the nexus of solar energy, water and the environment. CI researchers build the tools for data management and data processing to be used by both scientists and educators.

"Data is our main concern: from acquisition to storage to presentation to processing," says NEXUS scientist Dr. Sergiu Dascalu, a professor in the Department of Computer Science and Engineering at the University of Nevada, Reno (UNR). "Cyberinfrastructure's goal is to support, facilitate, and accelerate high quality research and education."

In addition to providing a foundation for the NEXUS project, CI will increase Nevada's cyber capabilities for interdisciplinary research and education by developing advanced tools for data visualization, mining, and security.

"Our CI project is important because it develops capacities that we didn't have in the past before in Nevada," Dascalu says.

After scientists collect vast quantities of data in the field, they need to process this information in the labs in Las Vegas and Nevada. Both the field sites and the labs create a flow of information into CI's "end-to-end" system.

"At one end we have research sites and research labs and in the middle we have our network," Dascalu says. The network then transmits the data to the Nevada Research Data Center (NRDC), which is based in UNR with an associate computing facility at the University of Nevada, Las Vegas. "About every five minutes we have 900 new measurements and data is flowing into the NRDC as we speak," he says. These network capabilities are enhanced by the statewide digital microwave backbone infrastructure managed by the Nevada Seismological Laboratory (NSL), a NEXUS CI partner.

One of the goals of the NRDC is also to provide tools for educators to communicate the many aspects of climate science and, in addition, the CI team is committed to providing opportunities for both undergraduate and graduate students.

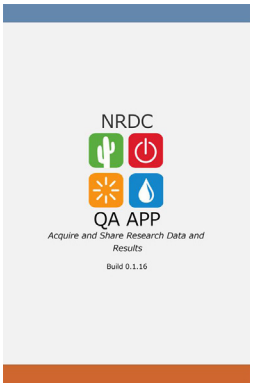
Students get to work on real problems and directly contribute to the CI mission. For undergraduate students Hannah Munoz, Samantha Grant, Matthew Salivar, and Royal Stewart at UNR that meant designing an app for the Android mobile platform for gathering climate data in the field. Instead of laboriously recording the data in a logbook and then having to transfer a day's information onto a networked computer, now field technicians can simply use the app to gather the data and this quality assurance app streams the data to the NRDC, where it will be stored."Our objective is to provide the field technicians with an effective method of creating documentation for their work and also provide them with a positive and satisfying experience when servicing these stations," Munoz says.

Currently, Dascalu sees the CI team as two thirds the way through the objectives they outlined in the original NEXUS project proposal. In the last third of the project they'll expand

--L. Brazfield Photo

their capabilities for data visualization and simulation and consolidate the strong foundation they have already laid down. Another important goal for the CI team is to increase their integration with a variety of interdisciplinary NEXUS research activities.

"Our goal is to sustain the project beyond 2018 and have it evolve through the years for the benefits of scientists, students, educators and the public," Dascalu says.



NRDC QA APP
Homepage Screenshot

How technicians recorded data before the APP, Ben Trustman, Graduate Student, University of Nevada, Reno
--S. Strachan Photo

How technicians record data after the APP, Scotty Strachan, Technician, University of Nevada, Reno
--S. Strachan Photo

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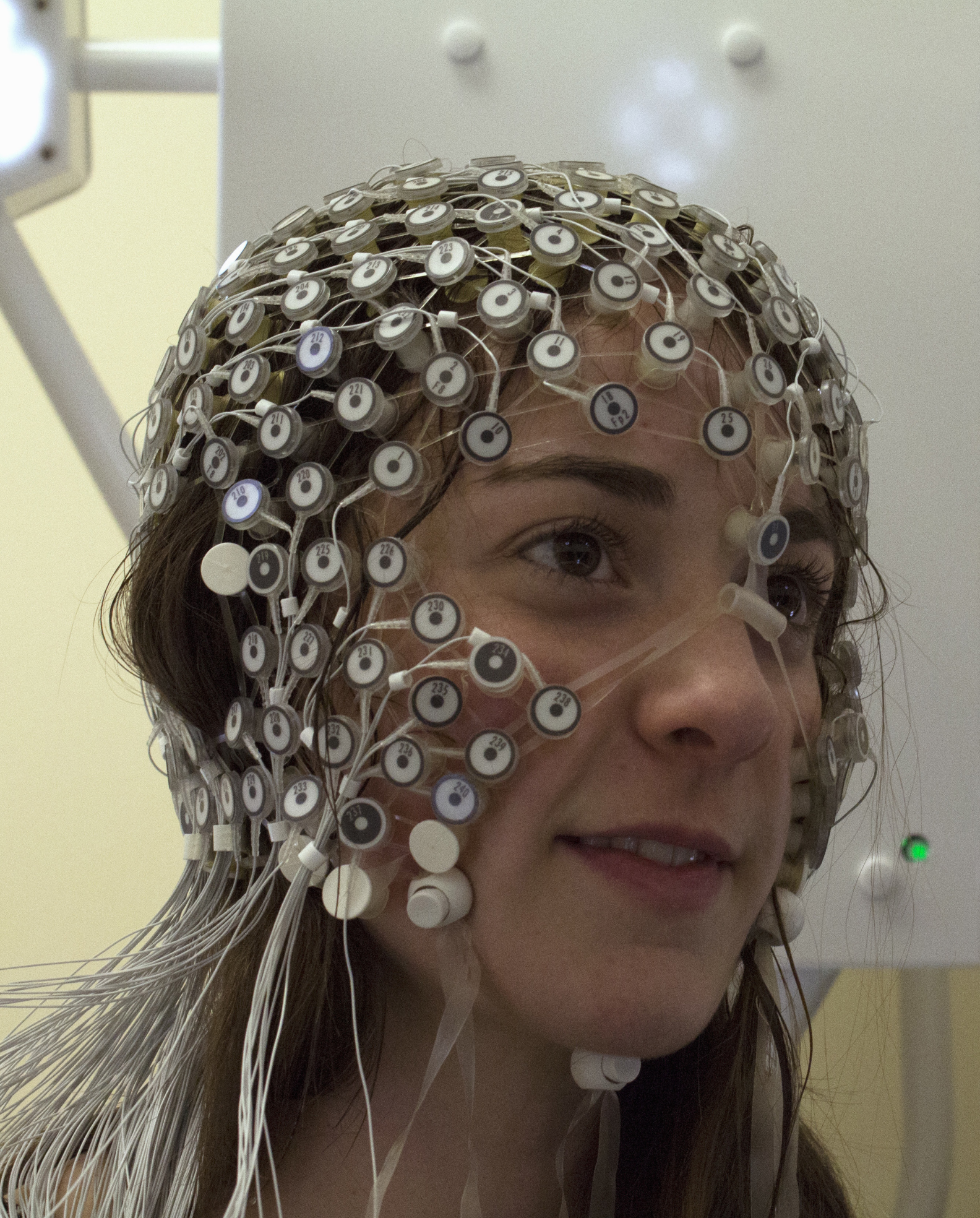

Education Goes Viral

*How the NEXUS **STEMBOPS** program is introducing students and the community to STEM related research*

Giselle Serate, Davidson Academy, 3-D Printed Robotic Hand
--D. Bowman Photo

***Editor's Note**: A version of this story, written by Jane Palmer, originally appeared on solarnexus.epscorspo.nevada.edu April, 2016.*

It's been a little over a year and a half since Giselle Serate and Juliana Anderson of Reno's Davidson Academy made a video explaining 3-D printed robotic hands, but since then the high school students have flocked to make these educational resources accessible for all their peers.

"We were only originally supposed to be making these videos with three Davidson Academy students each year, " says NEXUS researcher Nancy LaTourrette, a lecturer in computer science and engineering at the University of Nevada, Reno (UNR). "But we're working with 11 students now and even more kids are coming to me and saying 'Can you fit me in on this project?'"

LaTourrette initiated the Science, Technology, Engineering and Math Bilingual Online Peer Sessions (STEMBOPS) program in 2014, as part of the NEXUS workforce development mission, which supports growth in STEM fields. The program pairs pre-college, undergraduate and graduate students with NEXUS researchers, who act as mentors introducing the students to science and engineering in the lab. The students make videos about their experiences and the concepts they learn, which can then be viewed by their classroom peers.

The STEMBOPS students don't just create videos, they write white papers to show that they have understood the technical aspects of the science. And then, as if these accomplishments weren't challenging enough, they create the videos in Spanish, as well as English. The ultimate goal is that the videos will be taken to schools and can also be used to introduce the greater community to science and technology concepts.

LaTourrette hopes the bilingual versions of the videos will help involve Hispanic communities in securing a future STEM workforce. "I like to think of it as 'K through Gray'- that these videos can reach an audience from kindergarten all the way through the community-at-large," LaTourrette says.

By involving the community, LaTourrette hopes that more parents will spur their children to go into STEM fields. Likewise, by encouraging female students into the STEMBOPS program, LaTourrette hopes to boost the numbers of women interested in science and engineering.

Now that the STEMBOPS students have created a significant body of work, the goal is to get the videos out into the community where they can start doing some good, LaTourrette says.

STEMBOP Videos
http://sensor.nevada.edu/Nexus/Education/STEMBOPS

Morgan Heath-Powers, Davidson Academy, Neuroscience
--Photo courtesy of H. Huh and NIH, NIGMS, Center for Biomedical Research Excellence (COBRE) under grant number P20 GM103650

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Nexus IN NEVADA

Graduate Student Capstone Course and WC-WAVE Meeting

National Science Foundation RII Track 2 participants from Idaho, Nevada, and New Mexico gathered in late May in Incline Village, Nevada to attend the final Western Consortium for Watershed Analysis, Visualization and Exploration (WC-WAVE) Meeting and Graduate Student Capstone Course. The WC-WAVE meeting focused on developing new proposals and publications based on WC-WAVE results. The capstone course was hands on testing technology, modeling and virtualization tools developed through the WC-WAVE project.

Self-Reported Biggest Takeaways

1. Professional development for our undergraduate students was outstanding as they were able to present and be treated like peers with graduate students and faculty.

2. The interaction between CI and Watershed lead to a better understanding of what it takes to implement CI for science modeling.

3. How important a little bit of science education and funding can go a long way to improving student learning at two year institutions.

4. As part of the Undergraduate Visualization and Modeling Network (UVMN), the individual discussions with colleagues about how they are applying visualization techniques in their classrooms.

5. It helped many people understand the process of watershed modeling and visualization from start to finish.

6. Learning about the needs of the scientists who will be using Virtual Watershed Platform (VWP) will allow me to design a more accessible interface, which will be explored in my Master's thesis.

Top L to R: Gayle Dana, Nevada EPSCoR Project Director; Jennifer Edmonds, Nevada State College and Rui Wu, Graduate Student, University of Nevada Reno; Navajo Tech drone; Gladys Valentin, Graduate Student, University of Nevada, Reno and Elliot Burns, Undergraduate Student, Navajo Tech

Left: Dan Cadol, New Mexico Tech, Aaron Vanderpool, Undergraduate Student, Sierra Nevada College, and Andy Rost, Sierra Nevada College --M. Casella Photos

WC-WAVE
IDAHO EPSCoR · NEVADA EPSCoR · NEW MEXICO EPSCoR

Dr. Jay Arnone

Associate Project Director, Nevada NSF EPSCoR

Nevada NSF EPSCoR announces the new associate project director, Dr. Jay Arnone. After a statewide NSHE search, the Vice Presidents of Research approved the recommendation made by the search committee to appoint Arnone. Dr. Arnone will take on this role and continue his work at Desert Research Institute where he is a research professor in the Earth and Ecosystem Sciences division primarily studying how global change, including climate change, is affecting the ecology of terrestrial ecosystems.

As the associate project director, his main focus in the first year will be to work with the project director and Nevada EPSCoR office to develop a competitive proposal for the next Track 1 NSF solicitation. The pre proposals have already been received and reviewed and the topical area has been selected which aligns with the Governor's sector for renewable energy and will build research infrastructure for Nevada.

Dr. Arnone is very familiar with NSF and NSF EPSCoR. He was instrumental in designing and establishing, under the Nevada NSF EPSCoR "Climate Change" project, the Nevada Climate and Ecohydrological Assessment Network (NevCAN) whose major purpose is to quantify how climate varies and is changing across the ecosystems of the Great Basin and how this variability affects ecosystem processes that control water availability and supply. During his 18 years at DRI, Dr. Arnone has received NSF grants of over $3.4M as PI and $1.3M as a Co-PI. He looks forward to maintaining this record of success with NSF as Associate Project Director of NSF EPSCoR in Nevada.

Dr. Arnone and his group's research has ranged from controlled-environment studies to large-scale field experiments evaluating effects on ecosystem biogeochemical processes of global change factors such as exposure to elevated atmospheric CO2 levels, climatic extremes, invasion by exotic plant species, and decreases in species biodiversity. His research has allowed him to work in temperate forests of New England and tropical forests of Panama, Oklahoma tallgrass prairie, high alpine meadows and lowland temperate pastures in Switzerland, the riparian ecosystems of the Copper River Delta on Prince William Sound in Alaska, to the high desert systems of the Great Basin and the shrub stepped ecosystem of the Mojave Desert in Nevada. Before arriving in Reno in 1998, Jay spent eight years at the University of Basel's (Switzerland) Botanical Institute in the Department of Plant Ecology. He received a B.S. in Forestry from the University of Vermont and a Master of Forest Science, Master of Philosophy, and Ph.D. from Yale University's Graduate School and School of Forestry and Environmental Studies. He and his wife, Lynn, have three boys, one living in each of the time zones east of Nevada (Billings, MT; St. Paul, MN; Cambridge, MA).

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NASA EPSCoR

Advanced computer vision, robotics, and visualization algorithms for improving planetary exploration and understanding

Dr. George Bebis, professor of Computer Science and Engineering at University of Nevada, Reno and his statewide team including Dr. David Feil-Seifer at the University of Nevada, Reno, Dr. Emma Regentova at the University of Nevada, Las Vegas and Dr. Eric V. McDonald at Desert Research Institute completed a NASA EPSCoR research CAN.

The "Advanced Computer Vision, Robotics and Visualization Algorithms for Improving Planetary Exploration and Understanding" was funded in 2011 for $750,000 with state special projects match of $375,000.

The UNR team developed a new technique for horizon line detection using machine learning to aid in determining rover location and orientation. They also worked on detecting craters from orbital images by developing a novel methodology that employs convex grouping for extracting candidate crater regions and machine learning for verifying them. The UNLV team developed new techniques using GPU boards as well as an interactive rock segmentation and quantification (RSQ) tool to reduce image noise. The RSQ tool allows users to select an area of interest, segment rocks of interest, and calculate various rock properties based on color, texture, and shape. The DRI team employed image and elevation data analysis techniques for mapping rover mobility over a landscape that exhibits variable surface lithology and geometries.

The research faculty members have strengthened collaboration with NASA as a result of this NASA EPSCoR project and worked with the Intelligent Robotics Group (IRG) at NASA Ames. Research results have been incorporated in student classes and seminars have been provided by invited NASA researchers. Highly qualified students have been involved in this project as research assistants or summer interns.

Research performed in several areas including: (1) robot localization, (2) landmark detection, (3) human-robot collaboration, (4) terrain characterization, (5) path planning and navigation, and (5) visualization. This project has enabled Nevada to build research capacity in areas of strategic importance to NASA while at the same contributing to NASA's research priorities.

Sample results illustrating our horizon line detection approach: City data set (row1), Basalt Hills data set (row2) and Web data set (row 3 through 5). Detected horizon lines are highlighted in red/green.

Return on Investment from this NASA EPSCoR CAN

- **$7.4 million**
- **11 awards to Nevada with follow-on funding**
- **18 publications in peer-reviewed journals**
- **20 research students**

Background image credit: Karen Teramura, UH IfA

Nevada System of Higher Education Sponsored Programs
EPSCoR NEVADA

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RETURN SERVICE REQUESTED

From the director

Every funded project has a beginning, middle, and an end but it is the journey and the story to be told throughout the project that is compelling. We have amazing faculty, students, technicians, and administrators that are the main characters throughout this Discoveries magazine.

New beginnings are underway for the NSF EPSCoR program with the announcement of the new Associate Director, Dr. Jay Arnone who will start in January. The Nevada NASA programs also developed a new NASA programs website portal which centralizes the EPSCoR and Space Grant Consortium programs to be synergistic at https://nasa.epscorspo.nevada.edu/. This new year rolls out the exciting STEM Mentor Network website that has been redesigned for the end user to be engaged and provide resources for faculty and students.

The NEXUS project funded by the National Science Foundation EPSCoR, Track 1 project is in the middle of their five year cycle and so many stories are beginning to unfold. The research being done focuses on the Solar Energy-Water-Environment Nexus in Nevada. Our researchers are investigating topics from efficient dry cooling systems for thermal power plants to solar powered water treatment technology for energy production. Technicians and students are working with the faculty researchers from Nevada institutions to create the framework for processing and sharing scientific data. The moments are being shared through collaborations, NSF Science360, NEXUS Newsletter, videos and retelling the story to our community. These Discoveries will impact Nevada beyond the project.

As all good stories must come to an end, the NSF EPSCoR, Track 2 WC-WAVE project completed their capstone with consortium members from Nevada, Idaho and New Mexico. Their Discoveries brought them together in Incline Village, NV to wrap up their three year program successes. Over 20 consortium students presented their research at a poster session and opportunities were available for hands on engagement for students, faculty, and researchers to become part of the virtual technology and to piloting drones over the lake.

The success of our programs is reliant on the dedicated faculty, researchers, students, technicians and administrators that it takes to make these programs happen. No matter if it is $100 to $100 million it takes everyone to come together to collaborate and work together and we are glad to be able to share just some of our stories.

Warmest Regards,

Lori M. Brazfield

Lori M. Brazfield, MBA
Director, System Sponsored Programs and EPSCoR

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