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## ENERGIZE NEW MEXICO YEAR 3 ANNUAL REPORT

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NEW MEXICO EPSCoR

JUNE 2015—MAY 2016



New Mexico  
**EPSCoR**



## YEAR 3 ANNUAL REPORT

*Energize New Mexico*

### Designed & Created by

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## MESSAGE FROM THE DIRECTORS

*Bill Michener, Director & Anne Jakle, Associate Director*



In Year 3 of NM EPSCoR's *Energize New Mexico* project, over 260 faculty, students, and staff worked together to continue efforts toward achieving our vision of New Mexico leading the nation in harnessing and promoting sustainable energy resources, cultivating a well-qualified STEM workforce, and developing a sustainable culture of innovation and entrepreneurship.

*Energize New Mexico* participants have hit their stride and are engaging in new collaborations and highly productive research that extend beyond academia and touch thousands of members of the public and New Mexico decision makers. Though they are too numerous to list, a small subset of key Year 3 successes include:

- New scientific discoveries, including advances in algae encapsulation, better understanding of blind geothermal systems in New Mexico, and advances in organic solar cell fabrication
- Over \$17 million of additional research funding brought by to the state by EPSCoR researchers through 18 funded proposals
- 300+ new datasets that were stored, documented, and made discoverable
- More than 5,000 undergraduates, graduate students and citizens were engaged in EPSCoR outreach and education activities

These successes build on past efforts of NM EPSCoR. Since 2001, the state has received over \$118 million in NSF EPSCoR funding, and this investment has translated to tangible gains in research capacity and economic development in the nanotechnology, sustainable energy, and water sectors. Information about achievements, upcoming events, special programs, and other opportunities will continue to be disseminated through our website and mailing list. We invite you to connect with us on [nmepsc.org](http://nmepsc.org) and on our social media sites.

William Michener, Director  
Anne Jakle, Associate Director



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## ENERGIZE NEW MEXICO OVERVIEW

*Year 3 Annual Report*

### ABOUT NEW MEXICO EPSCoR



NM EPSCoR invests in critical facilities, faculty, students, and equipment that allow for long-term impacts on STEM programs and education in the state.



Partnerships help develop a strong culture of innovation, and funding works to build new interdisciplinary and inter-institutional collaborations.



EPSCoR programs increase the size and diversity of the STEM workforce through engagement and research opportunities for primarily undergraduate institutions.



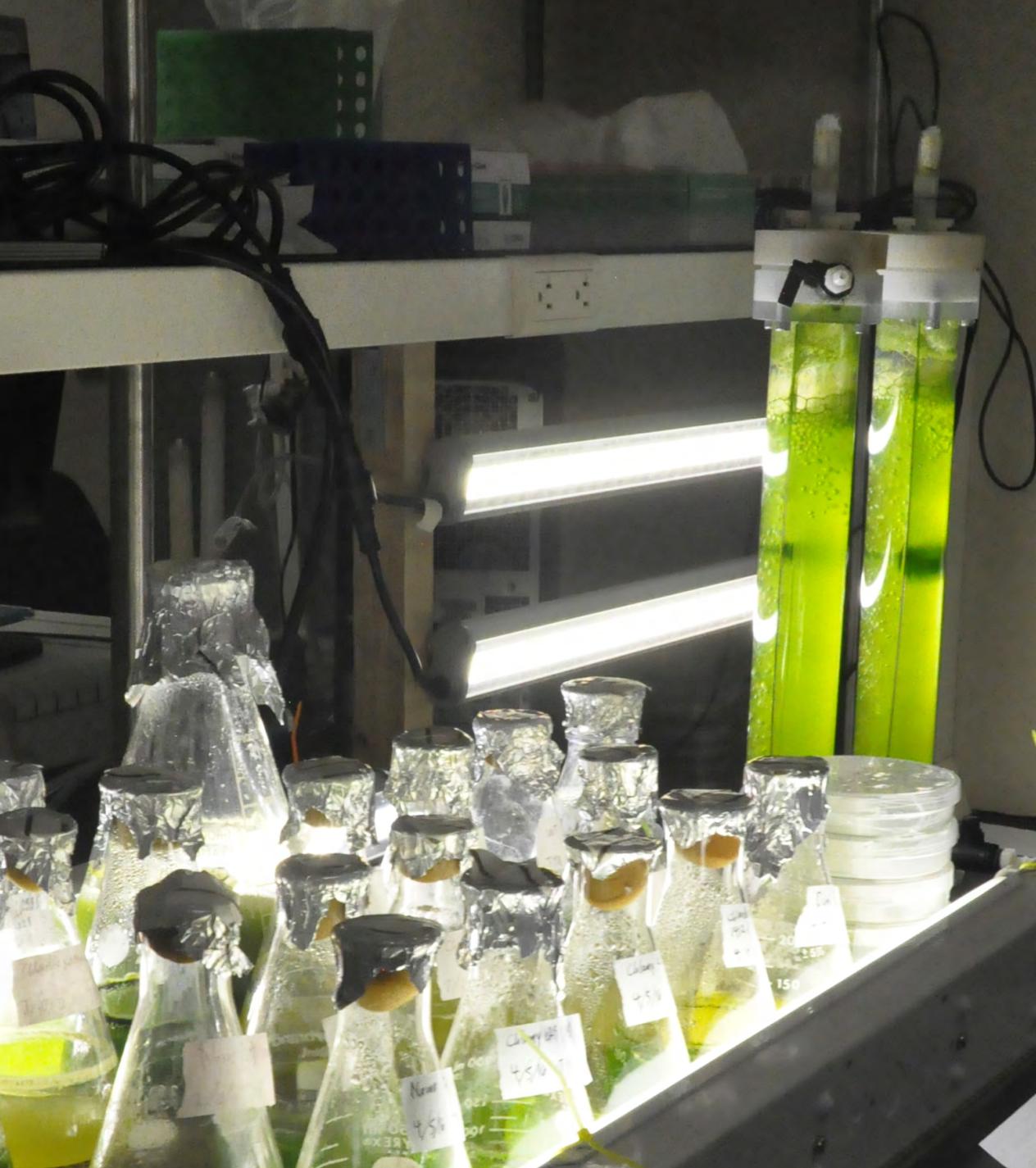
78% of NSF EPSCoR faculty hires remain in their original jurisdictions, thereby creating a return on investment for New Mexico's economy.

### ENERGIZE NEW MEXICO: YEAR 3

The *Energize New Mexico* grant is designed to support shared-use equipment, engage new research and community college faculty, and support the STEM pipeline by training teachers, undergraduate and graduate students, and post-doctoral fellows.

Year 3 of the *Energize New Mexico* grant encompasses all project activities from June 1, 2015 to May 31, 2016. In that time, project components completed 95% of activities set forth in the Strategic Plan. Several project components are ahead of schedule in completing research; overall *Energize New Mexico* is on track to fulfill all research and education objectives by the time the grant ends in 2018. Research findings continue to be communicated broadly through new partnerships with our museum network, a citizen-centric web portal, and vibrant, experiential programs targeting K-12 students.

WHAT IS  
**EPSCoR?**



The Experimental Program to Stimulate Competitive Research began in 1978 when the National Science Board was charged with increasing research in regions of the country that were less able to compete for National Science Foundation research funds. New Mexico joined EPSCoR in 2001, and today EPSCoR funding supports 25 states, two territories, and one commonwealth in

its efforts to build a sustainable research and human infrastructure. Over the last five years, EPSCoR supported over 7,400 faculty researchers and 16,700 students, established over 100 new degree programs including 64 new PhD programs, and engaged over 22,000 K-12 teachers and 300,000 K-12 students in outreach activities. Other EPSCoR investment strategies

include co-funding to facilitate participation of EPSCoR scientists and engineers in NSF-wide programs and initiatives, and supporting workshops, conferences, and other community-based activities designed to explore opportunities in emerging areas of science and engineering, and to share best practices in communication, outreach, planning, and implementation.

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## COMMITMENT TO DIVERSITY

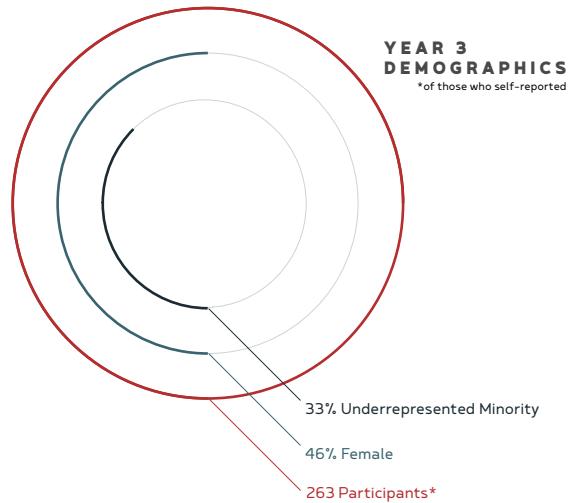
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### YEAR 3 ANNUAL REPORT: OVERVIEW

The Diversity Team continues to follow the Diversity Strategic Plan to direct and coordinate activities toward meeting our goal of 50% underrepresented minorities and women in all project activities. For the third year in a row, we have achieved or exceeded that goal in all participant groups except faculty.

*Diversity Coordinator, Chelsea Chee, was integral in joining 14 other EPSCoR jurisdictions to coordinate outreach and education activities, and promote EPSCoR initiatives at national conferences.*

In partnership with AISES, the Natives in STEM project was launched at the AISES 2015 National Conference to great success. The project aims to increase Native American identity and sense of belonging in STEM by creating and sharing positive images and stories of Native STEM professionals. To date, 16 profiles of Native STEM professionals have been received and two posters have been printed, with over 1500 distributed across New Mexico and the nation. Natives in STEM continues to be promoted at STEM events and conferences around the country.



Otakuye Conroy-Ben, Titakuya Ota Win  
- Environmental Engineer & Professor

I AM OGLALA LAKOTA, I AM STEM ♦♦♦♦♦



## PARTNERSHIPS & COLLABORATIONS

Collaboration is at the heart of *Energize New Mexico*. The project supports partnerships among institutions, with national laboratories and private industry, and among multiple disciplines. In Year 3, 21 organizations were involved in the project as participating institutions, including 2 tribal colleges, 2 national laboratories, and 3 museums. 57 organizations were involved as collaborators, including 15 private companies. In addition, nearly 5,300 individuals have been engaged in workforce development and outreach activities in Year 3. The map below shows the reach of NM EPSCoR participating institutions across the state.



# ENERGIZE NEW MEXICO

## METRICS

■  
Year 3 Annual Report

### AWARDS

#### **LAURA CROSSEY, UNM**

2015 IMPACT! Award, NM Network for Women in Science & Engineering  
 2015 Award for Outstanding Contributions, New Mexico Geological Society  
 Award of Outstanding Achievement, American Institute of Professional Geologists

#### **KARL KARLSTROM, UNM**

Award of Outstanding Achievement, American Institute of Professional Geologists

#### **PHYLLIS BACA, SFCC**

2015 New Mexico Women in STEM Honoree

#### **JERILYN TIMLIN, SANDIA NATIONAL LABS**

2015 New Mexico Women in STEM Honoree

#### **ALICE LOY, GCCE**

2015 New Mexico Humanitarian Award

#### **BEN STEIN, UNM GRADUATE STUDENT**

Seaborg Postdoctoral Fellowship at Los Alamos National Labs

#### **CHRIS HIRANI, UNM UNDERGRADUATE**

Best Undergraduate Poster, American Institute of Chemical Engineers Conference

#### **CHERIE DEVORE, UNM UNDERGRADUATE**

2nd Place Student Presentation, Rocky Mountain American Water Works Association Meeting

#### **YANG QIN, UNM**

NSF Faculty Early Career Development Award

#### **FRED PHILLIPS, NMT**

2016 New Mexico Earth Science Achievement Award

#### **DAVID HANSON, UNM**

4th Place Best Scientist from Algae Industry Magazine

#### **LUKE SPANGENBURG, SFCC**

4th Place Algae Ambassador from Algae Industry Magazine

#### **BRIANNE WILLIS, ENMU UNDERGRADUATE**

1st Place, NM Academy of Science Research Symposium Poster Award

#### **VANESSA WARD, UNM UNDERGRADUATE**

2nd Place, NM Academy of Science Research Symposium Poster Award

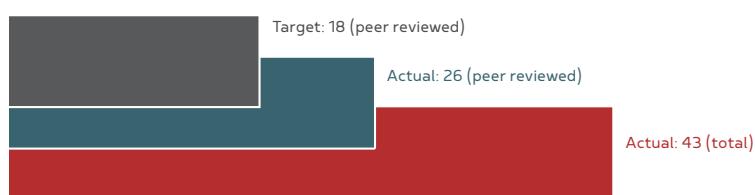
#### **MARIAH KELLY, UNM UNDERGRADUATE**

3rd Place, NM Academy of Science Research Symposium Poster Award

1,559  
TOTAL FOLLOWERS



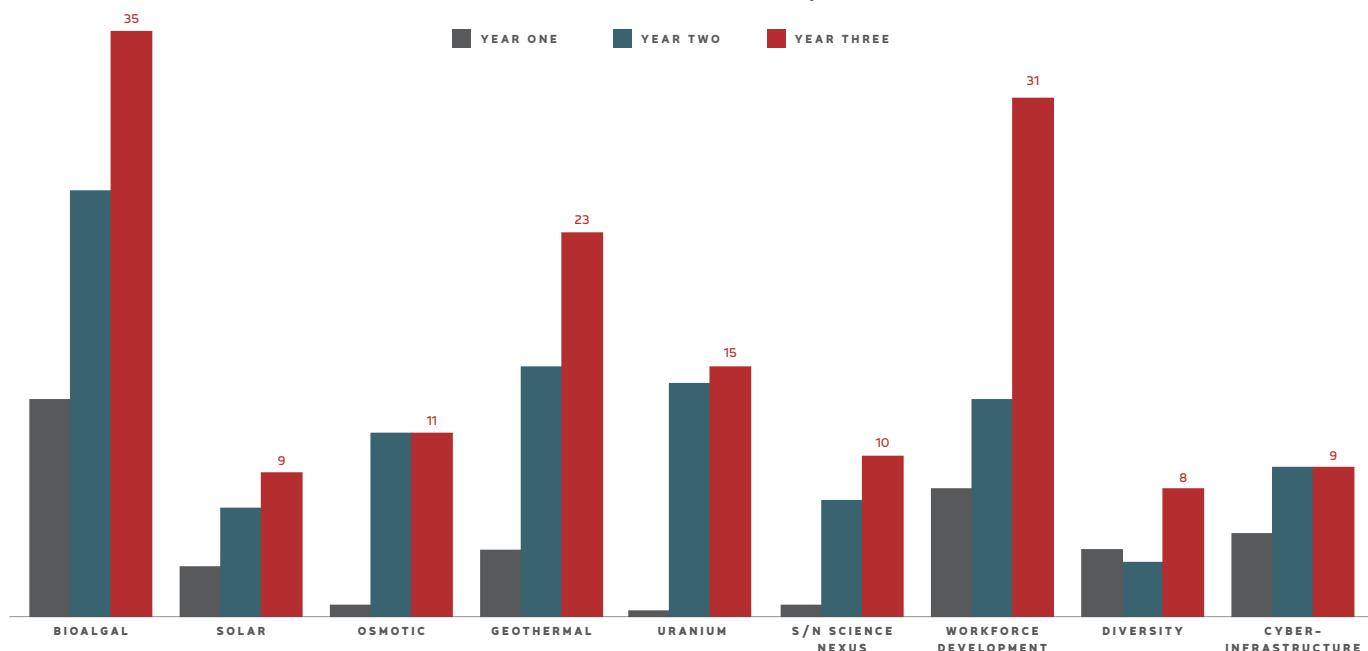
### PUBLICATIONS



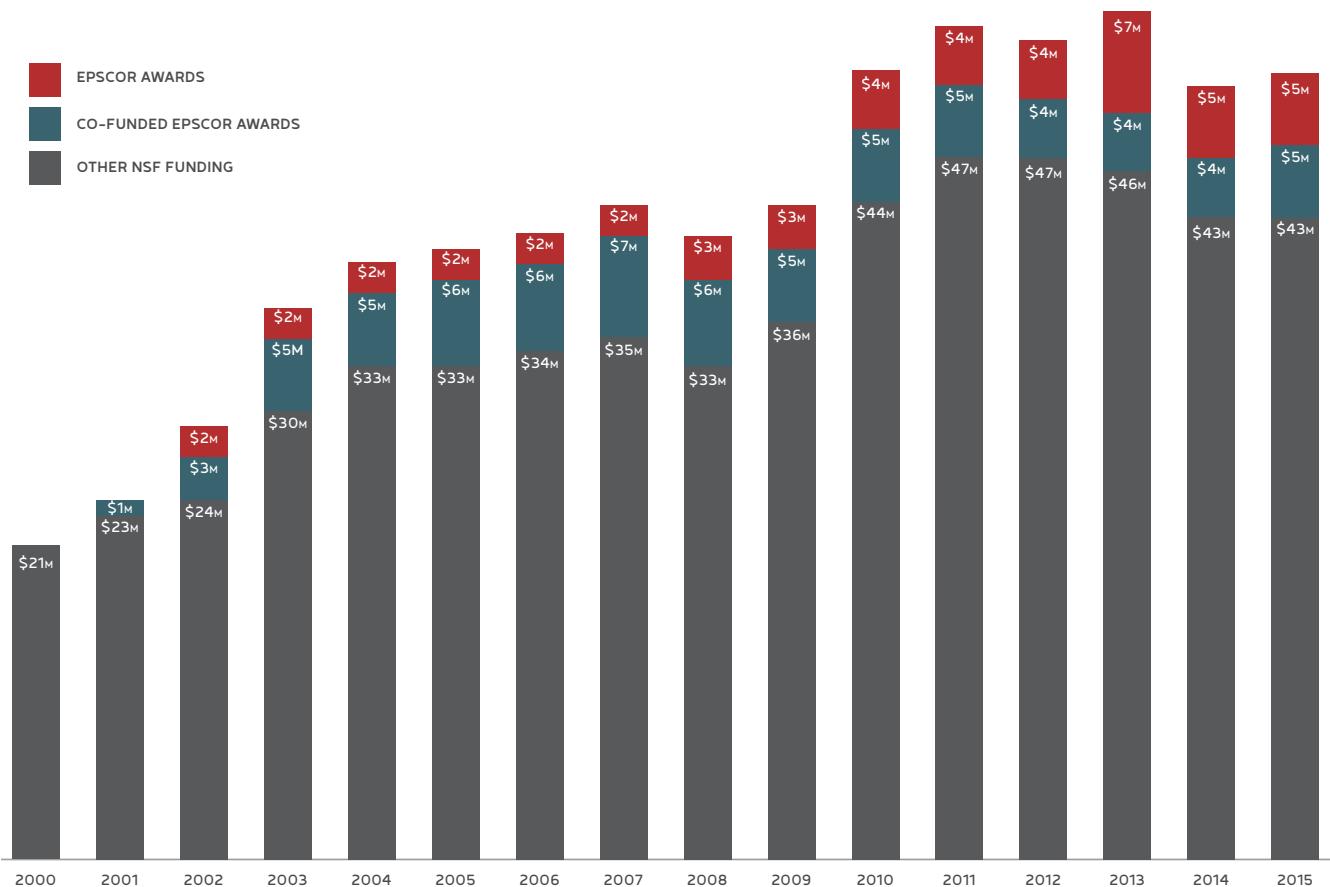
### PROPOSALS



### PRESENTATIONS BY COMPONENT, YEARS 1-3



### NSF FUNDED AWARDS IN NEW MEXICO



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YEAR 3  
**RESEARCH**

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*Energize New Mexico* utilizes an “all of the above” approach to energy research to ensure multiple pathways to a sustainable energy future for New Mexico. The six science components, plus Cyberinfrastructure, work toward achieving specific strategic goals based on sustainability, efficiency, and resource utilization, while minimizing risk to water and negative impacts on the environment.



CLOCKWISE FROM TOP: Dr. Nirmala Khandan looks on as his student Ambica samples from an outdoor algal raceway at NMSU; Ondine Frauenglass (R) in front of photobioreactors at SFCC; The Algal Turf Scrubber raceway at ENMU; John Roesgen (PhD student, UNM) prepares algae for encapsulation

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## ENERGIZE NEW MEXICO BIOALGAL ENERGY

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YEAR 3 ANNUAL REPORT: RESEARCH



The climate is changing rapidly, and the world needs new fuel alternatives to oil and gas without wasting resources, especially water. The Bioalgal Energy Development component of *Energize New Mexico* looks for solutions that make use of non-traditional organisms and contaminated water in order to generate knowledge about algal biology and practical applications of biofuels.

In Year 3, the team moved from the laboratory to field conditions. Three research sites—NMSU, ENMU, and SFCC—grew algae with local groundwater, produced water from oil and gas drilling, untreated city wastewater, dairy farm wastewater, and cheese whey

wastewater. The growth of the algae *Galdieria sulphuraria* was shown to remove nitrogen and phosphorus from the wastewater. NMSU deployed an algal-based wastewater treatment system as an experiment with the Las Cruces Wastewater Treatment Facility. Also, team members across the state used experimental photobioreactors to improve algae biomass as a potential for fuel.

The team continues to challenge current methods of growing algae, including the study of encapsulation of algae cells. Recent experiments at UNM show gel encapsulation increases the lifespan of the algae by protecting the cells from germs while boosting its metabolism. Ideally, this will help make harvesting lipids, the oily part of the algal biomass used to make fuel, easier and less expensive. NM EPSCoR funding provided the core equipment of a SEED Facility at NMSU, and provided UNM with a state-of-the-art supercritical fluid chromatograph to analyze algae lipids for the new Facility for Metabolic Chromatography.



Hanqing Pan, PhD student at  
NM Tech under Dr. Michael Heagy,  
uses the EPSCoR-purchased  
solar simulator in her lab

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## ENERGIZE NEW MEXICO **SOLAR ENERGY**

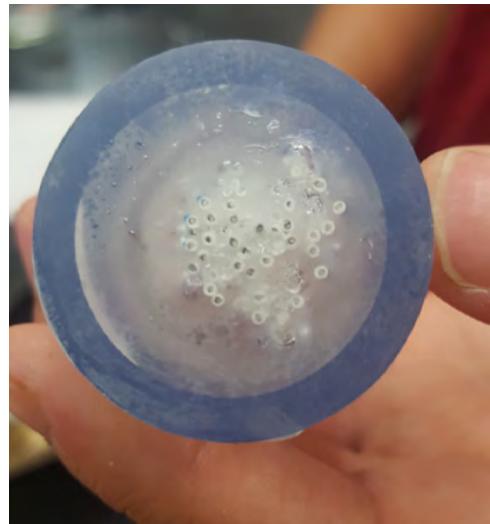
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### YEAR 3 ANNUAL REPORT: RESEARCH

The *Energize New Mexico Solar Energy* team formed to address challenges involved in making solar energy a sustainable and practical investment. The team is specifically focused on the effectiveness and efficiency of solar energy devices, and the feasibility of alternatives to fossil fuels by using solar power to convert carbon dioxide into methanol.

*With over 300 days of sunshine every year, New Mexico is prime real estate for solar energy research. Energize New Mexico utilizes these abundant solar resources to meet our energy needs and stimulate economic development.*

The Center for High Technology Materials at UNM now includes a fully operational magnetophotoluminescence facility. The facility will be used to characterize nanoparticle catalysts that can convert CO<sub>2</sub> into alternative fuels, and ultimately will help to design more efficient organic solar photovoltaic cells. Working at the molecular level, researchers at UNM, NMSU, and NM Tech continue to study how bonding between certain types of material can result in high energy output from the molecules, called excited state lifetimes.



L to R: NM Tech undergrad Cassandra Sanchez makes adjustments as she fabricates hollow fiber membranes; Hollow fiber membranes encased in fiberglass and ready for lab deployment.

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## ENERGIZE NEW MEXICO OSMOTIC POWER

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YEAR 3 ANNUAL REPORT: RESEARCH

While the quest for alternative fuel continues, the world still depends on oil and gas. That's why the Osmotic Power component of *Energize New Mexico* is trying to make oil and gas extraction more efficient. A large part of New Mexico's economy depends on oil and gas drilling in various parts of the state, but billions of gallons of water are produced in the process. Called "produced water," it is often discarded due to the high concentration of organic and inorganic matter in the water (such as salt) called dissolved solids. The Osmotic team—in collaboration with the Bioalgal and Geothermal teams—researches how to use produced water

to generate clean energy through a process called PRO, Pressure Retarded Osmosis. PRO uses membranes as filters that remove dissolved solids. Students and faculty create much of their equipment by hand in the lab, and the membrane fabrication process is itself environmentally friendly because the team uses green solvents to create the membranes. Past PRO research focused only on seawater with 7% dissolved solids, and data on highly saline water with higher dissolved solid concentrate was simply unavailable. During Year 3, osmotic team members have, for the first time, evaluated osmotic power potential using highly saline water

with 10% dissolved solids.

Two small-scale osmotic power generation testing systems were designed and built to test the performance of distillation membranes, created with polyvinylidene fluoride (PVDF) and tested with multiple PRO experiments to maximize salt rejection and the flow of water, and prevent fouling (blockages) and leaks.

The Osmotic team also leads the way in collaborations. Along with the Geothermal component, the Osmotic team partnered with Masson Greenhouse, an industrial greenhouse in Radium Springs, NM that uses geothermal energy to power their greenhouse and hopes to use fabricated membranes to clean hot springs water for use. Apache Corporation continues to provide produced water to the team, and Trevi Systems is now an industry partner on membrane fabrication.

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## ENERGIZE NEW MEXICO URANIUM TRANSPORT & SITE REMEDIATION

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YEAR 3 ANNUAL REPORT: RESEARCH

Inadequate understanding of how uranium reacts to and moves in natural and contaminated environments, which results in an inability to control the movement of uranium in the environment during and after mining, is a critical roadblock to its sustainable utilization as a safe and sustainable energy source in New Mexico. As part of their continued efforts for the *Energize New Mexico* grant, the Uranium Transport & Site Remediation research team promotes collaborations among university scientists working on fundamental uranium biogeochemistry, engineers, applied geologists, regional resource managers, and tribal leaders concerned with mineral resources, contamination of the surrounding area, and remediation.

In Year 3, scientists from UNM, NM Tech, and the New Mexico Bureau of Geology made significant progress characterizing the extent of contamination from legacy uranium mining and milling and how it spreads in groundwater, surface water, vegetation, and soils on the Laguna Pueblo and Navajo Nation.

### Crossing Cultural Borders to Protect People and the Environment

Data from New Mexico EPSCoR-supported research in the Navajo Nation that was published in *Environmental Science & Technology* convinced local leaders to place new sites on their Priority List for environmental remediation. Researchers have built lasting collaborations with state and federal regulatory agencies to investigate the impacts of legacy uranium mining on tribal lands in west-central New Mexico.

In the last year, the team documented elevated concentrations of uranium and co-occurring metals in abandoned mine wastes on Native American lands. For example, uranium concentrations in water from a seep on the Blue Gap Tachee site were up to 5 times the EPA's drinking water limit and suggest that abandoned mine wastes can be a major source of potential metal exposure to local people and livestock. Results from this and other research sites near the Jackpile Mine on the Laguna Pueblo are being shared and translated to the Native American communities at Tribal Council and chapter meetings.

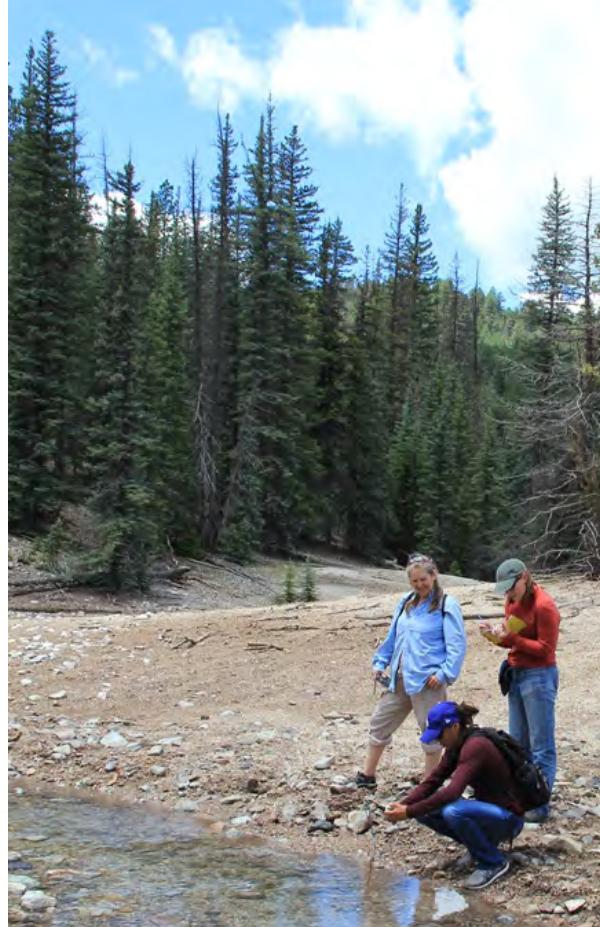
Because of relationships established through the Energize New Mexico project, the New Mexico Environment Department reached out to the NM EPSCoR Uranium researchers

after the 2015 Gold King Mine spill on a tributary of the Animas River (an environmental disaster associated with the spill of 3 million gallons of mine wastewater and tailings) for independent analysis of the impacts on tribal lands and waters. In addition, outreach efforts to K-12 students at Laguna Pueblo have fostered interest in STEM learning and have inspired young Native American scientists.



NM EPSCoR Uranium Transport & Site Remediation research team faculty and students from the University of New Mexico, New Mexico Tech, and Laguna Pueblo at the Jackpile-Paguate Mine, Laguna, NM

**TOP:** Team members from UNM and NM Tech examine a well that is part of the Jemez hydrothermal system; STEMAP participants take water samples from hot springs in the Jemez. **BOTTOM:** The MT system deployed north of Truth or Consequences; Dr. Shari Kelley (Bureau of Geology) smiles during her field presentation



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## ENERGIZE NEW MEXICO GEOTHERMAL ENERGY

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YEAR 3 ANNUAL REPORT: RESEARCH



New Mexico is a geologically-active state, and is ranked 6th in the nation for geothermal energy potential. While some surface evidence exists for large geothermal systems, such as hot springs, more detailed information lies below the ground. In order to determine the viability and longevity of these systems, *Energize New Mexico* includes a Geothermal Energy component. The team addresses the potential of these systems to create sustainable energy and the economic implications of such systems.

After undergoing intensive training in Year 2, the geothermal team deployed the Zonge Magnetotelluric (MT) system in Year 3 over



the Socorro Magma Body and in areas near Truth or Consequences. The MT system helps the team detect possible geothermal structures underground and allows for temperature estimation. After detecting a low-resistivity anomaly in the rock above the Socorro Magma Body, the team determined that geothermal resources have good potential for direct use of heat such as greenhouses, spas, and direct heating of buildings, but the resources are not likely to be at a temperature high enough to sustain electrical power in New Mexico's current economy.

Real-time monitoring of selected systems in the field is currently underway and the team is expanding, allowing for new modeling and mapping of these systems. The MT equipment is expanding its use to image deep brackish and saline water resources, and the team is the first to deploy a CO<sub>2</sub> flux monitor to measure and evaluate changes in CO<sub>2</sub> release from underground along the Rio Grande Rift.

# ENERGIZE NEW MEXICO **SOCIAL & NATURAL SCIENCE NEXUS**

## YEAR 3 ANNUAL REPORT: RESEARCH

New Mexico's energy industries are important to the economy, yet are constrained by environmental impacts and water resources. Powerful, integrative modeling tools are needed to evaluate energy development and source viability in light of water, environment, and socioeconomic considerations. The Social & Natural Science Nexus team works toward developing a cutting-edge multidisciplinary model that links natural and human systems to better understand the trade-offs that occur between different energy and economic development choices while considering the potential for socioeconomic, environmental, and water use sustainability.

This research considers interactions and feedbacks between the social and natural sciences in order to determine the sustainability and acceptability of energy production and use. The results will enable policy makers and researchers to compare and/or integrate information across many areas to address questions to help New Mexico develop its energy resources in a sustainable way.

# The New Mexico Dynamic Statewide Water Budget

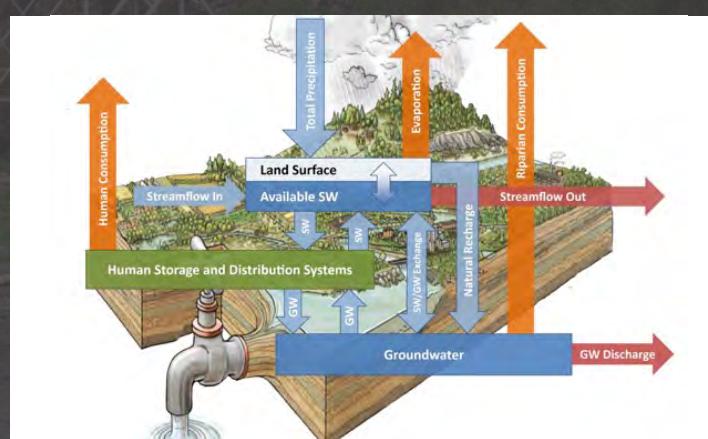
NM EPSCoR supported the Water Resources and Research Institute at NMSU to create a Dynamic Statewide Water Budget (DSWB) system dynamics model. System dynamics is an approach to model complex systems over time. The DSWB is a model that will support local and regional planning of New Mexico's limited and critically important water resources.

For the first time, the DSWB synthesizes water supply and demand information from across the state into a single, easily accessible location, and in such a way that users can view information at a variety of spatial scales. The model provides mass balance calculations for river basins and water planning regions across the state, which is critically important information for water planners, particularly in light of climate change.

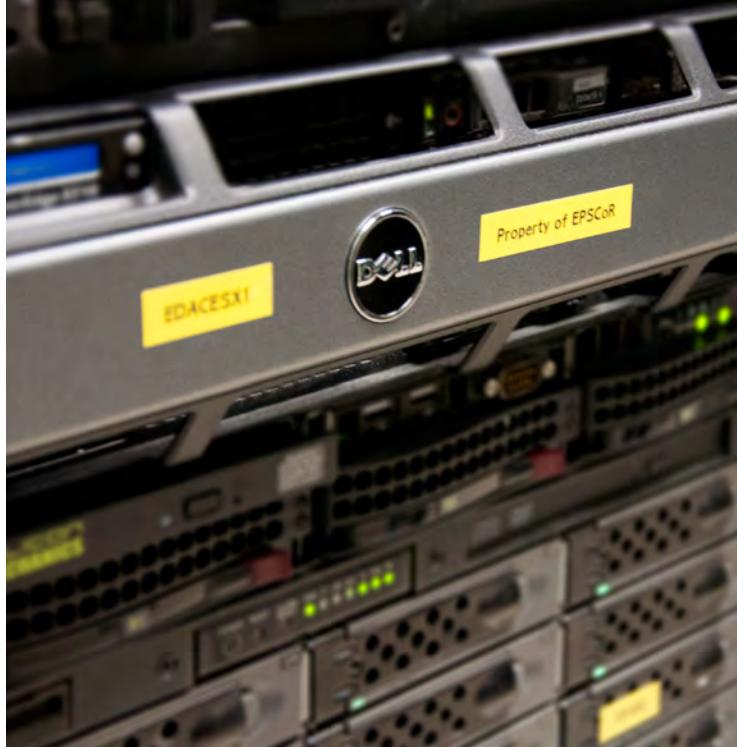
Some of the new information developed includes statewide assessments of recharge to groundwater, levels and storage changes of groundwater, remotely sensed/modeled precipitation data, and surface water flow statistics. Of particular interest, new research is adding to our understanding of evapotranspiration rates in New Mexico, an important component of the water balance that previously was only modeled or estimated. EPSCoR-supported graduate students have been trained in system dynamics modeling and have begun research on case studies in the Lower Rio Grande

watershed that will be integrated with the DSWB to inform trade-offs between water availability and energy and agricultural production.

The DSWB is the first major step in completing a larger statewide, interdisciplinary system dynamics model that will integrate social and natural sciences by joining three energy/water nexus budgets: energy, social preferences, and water. It will ultimately be part of a living web-based State Water Plan housed at the New Mexico Interstate Stream Commission.



*Schematic of the New Mexico Dynamic Statewide Water Budget system dynamics model. Thirteen different inputs/outputs form the core water budget terms*



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## ENERGIZE NEW MEXICO **CYBERINFRASTRUCTURE**

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YEAR 3 ANNUAL REPORT: RESEARCH

Cyberinfrastructure (CI) plays a critical role in *Energize New Mexico*, enabling collaboration across all project components, and creating a simple process to discover and use the learning modules and data NM EPSCoR develops. Each *Energize New Mexico* team has a CI team liaison to better support research and data management efforts so research findings can be included in the EPSCoR data portal.

***Through the Energize New Mexico grant, NM EPSCoR is making it easier for scientists, educators, and the public to discover, acquire, and use data.***

In Year 3, the CI team developed a process for metadata (data about data) entry, as well as a data transfer process and interface for the project's integrated data storage portal. The team consolidated data management, analysis, and visualization tool descriptions into the portal and developed a database model for capturing metadata for external data sources. NM EPSCoR is currently a DataONE Tier 4 member node, allowing for collaborations with national and international data networks. The team also initiated a collaboration with the Open Science Framework to develop use cases for expanding the capabilities of its platform to support private cloud platforms for shared data management.

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YEAR 3

## EDUCATION & OUTREACH

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Part of *Energize New Mexico*'s vision includes creating a well-qualified STEM workforce while promoting a culture of innovation and entrepreneurship. NM EPSCoR provides activities that engage and support learners at all educational levels, leading to a diverse future in STEM. Greater educational success in STEM enables New Mexicans to take advantage of well-paid employment opportunities and increase our research competitiveness.



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## ENERGIZE NEW MEXICO **STEM ADVANCEMENT PROGRAM**

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YEAR 3 ANNUAL REPORT: EDUCATION & OUTREACH



The STEM Advancement Program, or STEMAP, is a summer research opportunity created and run by NM EPSCoR. STEMAP takes students attending primarily undergraduate institutions around the state and matches them with NM EPSCoR faculty and students for an 8–10 week hands-on research experience. STEMAP participants work hand-in-hand with EPSCoR teams on cutting-edge research, and gain access to state-of-the-art equipment and materials directly related to *Energize New Mexico* projects at the state's three main research universities.

STEMAP for Year 3 took place in June and July 2015 with the largest cohort to date—

14 students! After spending a week together at NM Tech learning the basics of EPSCoR research, the ethics of research, presentation and poster skills, and more, the group went their separate ways with their NM EPSCoR mentors to NMSU in Las Cruces and UNM in Albuquerque, with some staying behind in Socorro at NM Tech. Mentors included faculty and graduate students from the Bio-algal, Solar, Uranium, Geothermal, and Social & Natural Science Nexus components.

On July 30, 2015, the STEMAP students congregated with family, friends, and NM EPSCoR participants to give presentations on their research. At the end of the program, students shared praise of their experience, and their testimonials can be seen on our [YouTube page](#).

**TOP:** The 2015 STEMAP Cohort; Brianne Willis, Sherwin Becenti, and NM Tech grad student Reid Brown in the field; Elan Glendening next to the NMSU outdoor algal raceway. **BOTTOM:** Roger Grano collects soil samples; Jennifer Thompson works with algal cells in the lab




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## ENERGIZE NEW MEXICO INFORMAL SCIENCE EDUCATION NETWORK

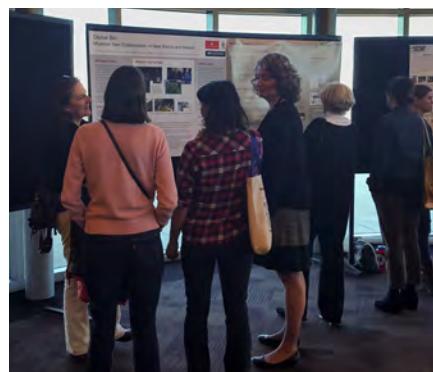
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YEAR 3 ANNUAL REPORT: EDUCATION & OUTREACH

Born from a need to connect informal educators with scientists and their research, NM EPSCoR is proud to sponsor the New Mexico Informal Science Education Network (NM ISE Net) to provide opportunities and resources for informal educators to work together to impact science teaching, science learning, and science awareness throughout the state. Given that we spend 95% of our lives outside the classroom, experiences provided by informal educators inspire and expose students and citizens to the wonder and possibility of science in everyday life.

In Year 3, NM ISE Net sponsored two major programs: ¡Explora! Children's Museum hosted a "Sharing Science" presentation to faculty from two universities and 9 NM ISE Net organizations; and "Citizen Science: The Power and Potential" by Cornell Lab of Ornithology's Rick Bonney attracted approximately 100 participants, including K-12 teachers, informal science educators, higher education teachers, research communities, and the general public.

NM ISE Net also funded 4 mini-grants to pair researchers with informal science educators to communicate NM EPSCoR research to a public audience. Awarded projects include a Teen STEM Café program at ¡Explora!, a Uranium-related outreach program at Laguna/Acoma Pueblo Schools, and a curriculum unit about energy in ecosystems.



*CLOCKWISE FROM TOP:* Explora, the NM Museum of Natural History & Science, and the National Museum of Nuclear Science and History; Rick Bonney addresses a packed room about citizen science; A citizen science poster session following Rick Bonney's talk

Science teachers and their students wrestle with energy concepts at nearly every grade level. What is energy? Where does New Mexico's energy come from? Is energy from the sun different from the energy that powers our daily lives, from our cars to our bodies? The Framework for K-12 Science Education provides a foundation for K-12 teaching and learning about energy as a crosscutting concept across the disciplines. Educators from the New Mexico Informal Science Education Network use the Framework to develop and present the annual Summer Teacher Professional Development Institute.

Educators from seven different New Mexico Informal Science Education Network (NM ISE Net) institutions supported the 2015 *Energize New Mexico* Teacher Professional Development Institute in Farmington at the beginning of June. The goals of the teacher professional development component of NM ISE Net are two-fold: 1) to provide access to excellent teacher professional development; and 2) to increase the capacity of New Mexico's science museums to provide teacher professional development.

Twenty-two elementary and middle school teachers representing three school districts gathered at the Farmington Museum for a five-day workshop to learn about energy and connections to literacy and assessment. The course was based on WestEd's Making Sense of Science Energy course with some additional material about New Mexico's energy resources. The Farmington Museum is located on the banks of the Animas River which gave participants front row seats to amazing flows during the week.

Four of the Institute's instructors facilitated additional weeks of Making Sense of Science in Albuquerque, Santa Fe, and Las Cruces in collaboration with NM Public Education Department. This small investment by NM EPSCoR will have huge impacts on teachers around the state, and on the 4,560+ students they will reach over three years.



FROM TOP: The 2015 Energize New Mexico Professional Teacher Development Institute cohort; NM ISE Net member Tish Morris walks the participants through a collaborative activity

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## ENERGIZE NEW MEXICO SUMMER TEACHER INSTITUTE

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# ENERGIZE NEW MEXICO CREATIVE STARTUPS

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## YEAR 3 ANNUAL REPORT: EDUCATION & OUTREACH

The Creative Startups Accelerator is catalyzing growth in New Mexico's creative and cultural industries and bringing lasting economic benefits to the state through investment and jobs. Creative Startups' activities that launched in New Mexico have been so successful, communities around the country and world are seeking out the skill-set and curriculum the accelerator brings. Companies that span the nexus of technology, engineering, and arts are now recognized as one of the most promising economic growth sectors in New Mexico.

In 2015, the Global Center for Creative Entrepreneurship, which runs the Creative Startups Accelerator, received a Kauffman Foundation grant to further evaluate and expand the program. The Accelerator engages 50 mentors who have built highly successful businesses in the creative industries and provide ongoing assistance to startup participants in the program. The Accelerator offers 12 training modules, and culminates in a week-long "Deep Dive" during which mentors and community leaders join the startup cohort to provide advice, deliver technical assistance, and network with the entrepreneurs.

## Creativity + Technology = Economic Growth

According to the Bureau of Economic Analysis and United Nations, growth in the creative economy is outpacing growth in any other sector, globally. Artistic and cultural entrepreneurs are increasingly recognized as a key component to economic innovation, with education initiatives supporting "STEAM," or STEM education with an added component of arts. The Creative Startups Accelerator, founded by the Global Center for Cultural Entrepreneurship and supported by NM EPSCoR, is the first startup accelerator in the nation designed by and for creative entrepreneurs, and it capitalizes on STEAM-based entrepreneurial activity to support business development at the intersection of design, technology, and creative expression.

To date, startup companies that were part of the first two Creative Startups Accelerator cohorts have raised nearly \$3 million in private investment and created over 140 jobs in New Mexico. Nearly 90% of these startups are women- or minority-owned. Companies that straddle the creative and technology spheres have been leading success stories. Meow Wolf—a collaborative working to revolutionize interactive gaming, art, technology, and entertainment—participated in the Creative Startups Accelerator and then attracted over \$1,500,000 from private investors; it now employs 45 full-time artists and 35 part-time employees and

is planning to file a number of patents. Another Creative Startups education technology company, Bright Bot, doubled its revenues in one year to reach \$120,000 in sales for its interactive apps that are designed to help with child literacy and reading comprehension. Bright Bot's My Story app, available on iTunes, has been downloaded over 800,000 times and was featured as a top three education app on the iPad App Store rankings. Bright Bot has collaborated with Synapse Apps, another Creative Startups company, to develop a version of My Story for children with speech and language challenges.



*Meow Wolf's House of Eternal Return in Santa Fe, NM.*



GUTC teachers provide hands-on computer science education to elementary and middle school students, both in afterschool programs and through daytime curricular units created to promote computer science literacy



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## ENERGIZE NEW MEXICO **GROWING UP THINKING COMPUTATIONALLY**

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### YEAR 3 ANNUAL REPORT: EDUCATION & OUTREACH

Growing Up Thinking Computationally (GUTC) has a very specific strategic priority: to increase student access to and engagement in computer science, STEM education, and research in K–12. This year, GUTC developed two new curricular units: one to introduce students to computer science and simulations, and a second that focused on climate change and agriculture. Within each 12-week unit, students investigate a local problem, gather data, build a computer model, and run experiments using the model as a virtual testbed. Over 385 students in grades 4–9 participated in GUTC activities, 37% in afterschool clubs and 63% through classes integrated with GUTC curricular units. A Fall Roundtable brought 65 GUTC club members together to demonstrate their projects and share ideas before an audience of STEM professionals, community members, and friends and family.

*With NM EPSCoR funding, GUTC engaged over 385 students between grade 4 and grade 9 during the 2015–2016 school year. 59% of students were underrepresented minorities, and 45% of the students were female.*

Also in Year 3, GUTC held a Career Connections Conference, which engaged 70 middle school students and 10 teachers with STEM professionals involved in algal biofuels research, aquaponics, energy efficiency, and composting.



FROM TOP: Adam Martinez in the lab at Trevi Systems in California; John Roesgen working on gel encapsulation at NMSU; Xu Wang enjoying the campus of NM Tech

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## ENERGIZE NEW MEXICO GRADUATE EXTERNSHIPS

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YEAR 3 ANNUAL REPORT: EDUCATION & OUTREACH

The EPSCoR Externship Program is a research exchange program that allows New Mexico graduate students (with an existing assistantship) to spend a semester or summer doing research at a partnering New Mexico university or research facility. Externships provide opportunities to conduct research in a host lab, take courses at the host institution, and interact within the host's laboratory and institution.

Year 3 was the first year in the program, and three students participated—two in summer 2015 and one in fall 2015. These students presented their work at the fall New Mexico Academy of Science Research Symposium and wrote blog posts for the NM EPSCoR website.

John Roesgen, a UNM PhD student, learned techniques to analyze metabolomics at Dr. Omar Holgin's NMSU lab. Metabolomics is the study of unique chemical fingerprints that cells can leave behind, and John measured the metabolic response of algae grown in silica gels. Of the experience, John said, “I doubt that I would have been able to expand my knowledge to include metabolomic assays or incorporated them

into my research without the assistance provided through this externship.”

Xu Wang, a Masters student at NMHU, worked at Dr. Frank Huang's NM Tech osmotic power lab. Xu worked closely with Dr. Huang's team, and helped develop a thin, water-stable membrane that can be used to produce clean water from wastewater. “Here at NM Tech people enjoy sharing their ideas on every aspects with you,” Xu said. “I am really grateful for this opportunity.”

Adam Martinez, a NM Tech Masters student under Dr. Huang, worked at Trevi Systems in Petaluma, CA, during the fall 2015 semester. Under the direction of Osmotic co-lead Qiang Wei from NMHU, Adam developed hollow fiber membranes that can be used in removing salt from sea water. He says Trevi employees treated him as if he were part of their team. “Working at Trevi was an incredible experience. I genuinely felt as though I were part of a team working towards a common goal.”

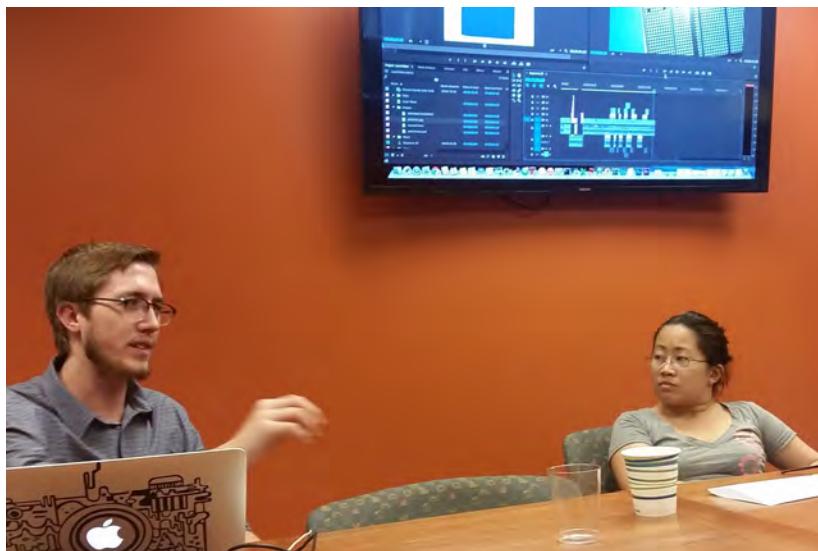
*“I was given responsibilities as though I were legitimately part of the team, not just an intern... I found every aspect of this experience worthwhile.” –Adam Martinez, Externship Alumnus*

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## ENERGIZE NEW MEXICO INNOVATION WORKING GROUPS

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YEAR 3 ANNUAL REPORT: EDUCATION & OUTREACH



Interdisciplinary Innovation Working Groups (I-IWG) provide a venue for researchers, educators, and nationally recognized experts to address grand challenges that require an interdisciplinary approach to transform science. I-IWG support is aimed at groups that emphasize the collaborative development and testing of important ideas and theories, cutting-edge analysis of recent or existing data and information, the use of sound science policy and management decisions, and investigation of social issues that pertain to energy development that minimizes impacts on water and the environment.

In Year 3, we awarded three I-IWGs: *Linking Desalination Technologies to Geothermal Greenhouse Operations*; *In-situ Leaching of Uranium: Methodology and Environmental Aspects*; and *Developing Effective Communication Techniques to Relate Graduate-Level Research toward Informal Educational Audiences*.

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The intent of the Infrastructure Seed Awards (ISA) program is to increase the access of undergraduate students, especially women and members of underrepresented groups, to research experiences by increasing non-PhD granting institutions' capacity to provide research experiences for students. Faculty members at any public 2 or 4-year New Mexico institution of higher education that does not offer STEM PhD degree programs are eligible to apply for these awards.

In Year 3, NM EPSCoR funded three ISAs: *A Storage Area Network to Enhance the Capacity of Northern's Undergraduate STEM Research and Training Experiences* at NNMC under Jorge Crichingo; *Growth of Heat/Salinity-Tolerant Microalgal Strains from Cheese Whey Wastewater in Photobioreactors* at ENMU under Juchao Yan; and *Optimization of Algal Culture and Lipid Extraction Techniques for Use in Biodiesel Production* at WNMU under Shawn White.



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## ENERGIZE NEW MEXICO INFRASTRUCTURE SEED AWARDS

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YEAR 3 ANNUAL REPORT: EDUCATION & OUTREACH

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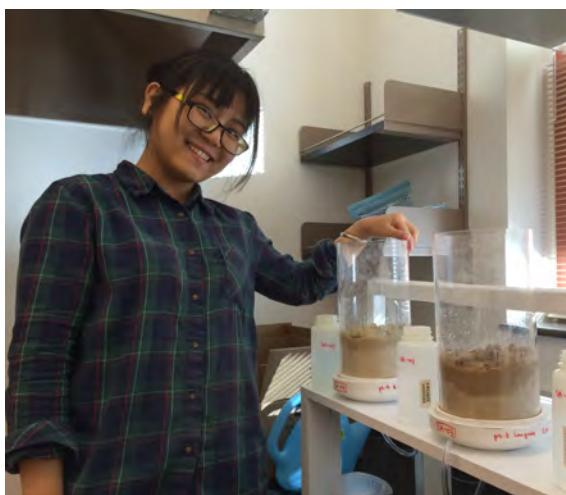
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YEAR 4  
**A LOOK AHEAD**

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With only two years left in the *Energize New Mexico* project, component teams are making great strides in their research and ramping up efforts to communicate results. Education and outreach activities will include new museum exhibits on *Energize New Mexico*-related topics, a statewide Town Hall on energy workforce development, and additional cohorts of successful programs like STEMAP and GUTC.



## CREDITS & ACKNOWLEDGMENTS

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## ACRONYMS

AISES	American Indian Science and Engineering Society
CI	Cyberinfrastructure
CO <sub>2</sub>	Carbon dioxide
DS	Dissolved solids
DSWB	Dynamic Statewide Water Budget
ENMU	Eastern New Mexico University
EPA	Environmental Protection Agency
GUTC	Growing Up Thinking Computationally
I-IWG	Interdisciplinary Innovation Working Group
ISA	Infrastructure Seed Award
MT	Magnetotelluric
NM EPSCoR	New Mexico Experimental Program to Stimulate Competitive Research
NMHU	New Mexico Highlands University
NM ISE Net	New Mexico Informal Science Education Network
NMSU	New Mexico State University
NM Tech	New Mexico Tech
NNMC	Northern New Mexico College
NSF	National Science Foundation
PI	Project Investigator
PRO	Pressure-retarded osmosis
PDVF	Polyvinylidene fluoride
SEED Facility	Small-scale Experimental Ecological Design facility
SFCC	Santa Fe Community College
STEM	Science, Technology, Engineering & Math
STEMAP	Science, Technology, Engineering & Math Advancement Program
UNM	University of New Mexico
WNMU	Western New Mexico University





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