2019

CAES ANNUAL REPORT

October 1, 2018 - September 30, 2019

CAES Center for Advanced Energy Studies

On the cover: A data set displayed in CAES' Applied Visualization Laboratory
Photo credit: Chris Morgan, INL

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Director's Letter

2019 was a momentous year here at CAES, one in which we commemorated the 10th anniversary of our Idaho Falls headquarters, welcomed our 15,000th visitor, and celebrated CAES Day in the State of Idaho.

CAES' first decade was loaded with milestones, and we intend to continue on that track as we harness the power of collaboration among our members to address complex global energy challenges and train the next generation of scientists, engineers, and researchers.

We began implementing the new CAES strategy this year in order to accomplish this. With its focus on collaborative research, education, and innovation, our reinvigorated approach has already begun bearing fruit.

In July, for example, a collaborative effort among Idaho State University and Idaho National Laboratory received an award of almost $1.1 million from the Idaho Global Entrepreneurial Mission (IGEM) grant program initiative. The project calls for the construction of a disaster response complex for first responders and is led by Dr. Mustafa Mashal, a CAES faculty member from Idaho State University who received seed funding to develop the project from CAES and first met his INL collaborators at a CAES workshop.

CAES will also be involved in INL's partnership with NuScale in building the world's first small modular reactor thanks to a grant from the Department of Energy's Nuclear Energy University Program that will support the installation of a NuScale reactor control room simulator at CAES. The grant to University of Idaho Professor Rich Christensen's team will allow CAES to train students on nuclear power plant behavior and expand CAES' research efforts, K-12 outreach, and public education regarding nuclear power and the technology behind small modular reactors.

Several CAES researchers garnered national recognition for their work in 2019, including Dakota Roberson, a CAES-affiliated Assistant Professor at University of Idaho who was selected for the prestigious White House Fellows program. Dave Estrada, the CAES Associate Director for Boise State University, and CAES-affiliated Boise State Professor Hoda Mehrpouyan received prestigious CAREER Awards from the National Science Foundation. Mehrpouyan's $454,000 award will support her work combatting cyber attacks on critical infrastructure such as water treatment plants. Estrada's award of more than $550,000 will enable research in the CAES focus area of advanced manufacturing and could revolutionize human tissue engineering.

In September, CAES made its presence known globally as the CAES Energy Policy Institute's annual Energy Policy Research Conference drew international attendees. And we made our mark in the nation's capital in March, when I had the honor of testifying before the US House Appropriations Subcommittee on Energy and Water Development concerning CAES' innovative efforts to develop the energy workforce of the future.

This year also saw the completion of the first full year of the CAES Summer Visiting Faculty program, which created 18 new partnerships between faculty at the CAES universities and INL researchers.

And just recently, we formed working groups in each of the CAES focus areas outlined in the strategy. These seven groups will catalyze researcher-driven deepdives into projects made possible through collaboration and serve as catalysts for sharing and leveraging the expertise, capabilities, and resources across the five CAES entities. These groups will ultimately serve as a force multiplier, allowing CAES to tackle complex global energy challenges and fulfill our vision of creating a better energy future through collaboration that inspires energy leadership, ignites technology innovation, and catalyzes global impact.

Finally, Idaho Governor Brad Little closed out the year by declaring October 1, 2019, as CAES Day in Idaho in commemoration of the facility's 10th anniversary. We are now looking forward to the next 10 years and a declaration of The Decade of CAES!

There is ample work to be done, and we are eager to get started. First, though, we hope you enjoy this annual report and the opportunity it provides to reflect on what we accomplished together in 2019 – from patents to proclamations, projects to partnerships.

There's much to do as we embark on our next decade, so let's get to it.

In collaboration,

Noël Bakhtian
CAES Director

CAES Center for Advanced Energy Studies

Executive Department
State of Idaho

The Office of the Governor
Proclamation

State Capital
Boise

WHEREAS, the Center for Advanced Energy Studies (CAES) is a research, education, and innovation consortium bringing the Idaho National Laboratory (INL) together with the public research universities of Idaho and Wyoming, including Boise State University, Idaho State University, University of Idaho, and University of Wyoming; and

WHEREAS, CAES' vision is to create a better energy future through collaboration that inspires energy leadership, ignites technology innovation, and catalyzes global impact; and

WHEREAS, CAES' mission is to inspire innovation and impact by leveraging collective capabilities to empower students, researchers, faculty, and industry to accelerate energy solutions; and

WHEREAS, CAES was conceived as a catalyst, activating world-class research assets at INL in combination with students and faculty at the universities to solve complex energy challenges while providing hands-on experience and mentorship that leads to valuable future career opportunities; and

WHEREAS, CAES is committed to conducting cutting-edge energy research, educating the next generation of scientists and engineers, and partnering with industry to advance competitiveness; and

WHEREAS, CAES focuses its efforts in the areas of nuclear energy, energy-water nexus, cybersecurity, advanced manufacturing, innovative energy systems, energy policy, and computing, data, and visualization; and

WHEREAS, CAES members have received more than $100 million in competitive grants and generated more than 1,700 publications, while inspiring the next generation by hosting more than 15,000 visitors; and

WHEREAS, CAES is a force multiplier created to spur collaboration for the greater good; and

WHEREAS, CAES over the last 10 years has served the State of Idaho and its residents with distinction;

NOW, THEREFORE, I, BRAD LITTLE, Governor of Idaho, do hereby proclaim October 1, 2019, to be

CENTER FOR ADVANCED ENERGY STUDIES (CAES) DAY

in Idaho.

IN WITNESS WHEREOF, I have hereunto set my hand and caused to be affixed the Great Seal of the State of Idaho at the Capitol in Boise on this 1st day of October, in the year of our Lord two thousand and nineteen and of the Independence of the United States of America the two hundred forty-fourth and of the Statehood of Idaho the one hundred thirtieth.

BRAD LITTLE
GOVERNOR

LAWERENCE DENNEY
SECRETARY OF STATE

BY THE NUMBERS

Through collaboration, CAES members leverage the following collective assets:

8,000 More than 8,000 scientists, engineers, faculty, and support staff

65,000+ More than 65,000 students

1,100 More than 1,100 degrees and certificates offered

100 Nearly 100 laboratories and engineering facilities

$1.8B Approximately $1.8 billion in annual research funding

Investments

$5Million Idaho National Laboratory investments in CAES

$3Million State of Idaho investments in CAES

Outreach

2,116
visitors to CAES and the CAVE 3D immersive research environment

68
working meetings, seminars, and speeches hosted or sponsored by CAES

197
CAES publications and proceedings

Research and Program Funding

~$1.086M
Funding to CAES member faculty through DOE's Nuclear Energy University Program (primary award)

~$1.3M
Funding to CAES member faculty through DOE's Nuclear Energy University Program (partner award)

$5M
FY2019 Laboratory Directed Research and Development (LDRD) Awards ($4M in FY18)

15K+
visitors, since the doors opened in 2009

University Impact at Idaho National Laboratory

111 Students from CAES universities interned at INL

17 Faculty members from CAES universities were awarded joint appointments at INL

14 Students from CAES universities received graduate fellowships at INL

18 Faculty members from CAES universities participated in the CAES Summer Visiting Faculty program.

2 Students from CAES universities were awarded postdoctoral appointments at INL

226 INL employees participated in Employee Education programs at CAES universities

CAES celebrates 10th anniversary

Feb. 20, 2019 marked the 10th anniversary of the dedication ceremony for the CAES headquarters in Idaho Falls. The milestone was commemorated with a celebratory event in Boise that drew approximately 100 people, including the Idaho governor and Battelle Executive Vice President of Laboratory Operations Ron Townsend, and featured presentations by INL Director Mark Peters, Former Idaho Gov. C.L. "Butch" Otter, Boise State University President Dr. Marlene Tromp, University of Idaho President C. Scott Green, and former DOE-Idaho official John Kotek, who is now Vice President of Policy Development and Public Affairs at Nuclear Energy Institute.

Change of address – 995 MK Simpson Blvd

In the spring, the city of Idaho Falls renamed the street on which CAES is located in honor of Congressman Mike Simpson and Kathy Simpson. The new name is MK Simpson Boulevard, and CAES' address is now 995 MK Simpson Blvd. In 2009, when the facility was dedicated, CAES was the anchor tenant, the first building with an address along the nearly half-mile stretch of road known as University Boulevard. In the decade since, fields have been replaced by buildings that comprise INL's research campus, "where the hard work of research, education and innovation intersect," as Idaho Falls Mayor Rebecca Casper wrote in a letter to the Simpsons in April 2019, adding, "The CAES facility illustrates this. Bringing together National Lab research with four universities and lots of brilliant students and scientists is a remarkable thing."

RESEARCHER, FACULTY, STAFF, AND STUDENT ACCOMPLISHMENTS


Dr. David Estrada

CAES Associate Director & Boise State faculty member receive NSF CAREER Awards

Dr. David Estrada, the CAES Associate Director for Boise State University, was awarded a National Science Foundation CAREER Award in April for his work utilizing graphene as a bio-scaffold for musculoskeletal tissue engineering, and CAES-affiliated Boise State Assistant Professor Hoda Mehrpouyan was awarded a CAREER Award to further her cybersecurity and network research. Mehrpouyan, who is also Associate Director of the Cyber Lab for Industrial Control Systems at Boise State, received a five-year award of $454,000 to support her work developing a complex security framework providing mechanisms that address the increasing risk of cybersecurity attacks on water treatment plants, reducing the risk to public health and safety, industry, and national security. Mehrpouyan has worked with Idaho Digital Learning, Suez Idaho, Women Innovators of Idaho, and INL, and the CAREER Award will allow her to advance research and expand opportunities for collaboration in cybersecurity, one of the seven focus areas outlined in the CAES Strategy. Estrada, who has served as Boise State Associate Director to CAES since June, was awarded more than $550,000 to support his collaborative research with fellow Boise State Professor Julie Oxford and faculty from the Italian Institute of Technology and Southern Demark University. The research is in the CAES focus area of advanced manufacturing and involves the use of graphene as a bio-scaffold, or engineering structure on which tissue may grow, for stem cell cultures. The work could revolutionize tissue engineering by enabling patient-specific organ growth, which would reduce patients' dependence on donors to treat organ failure. Estrada's five-year CAREER award also includes research activities to help develop a pathway for English language learners from a Boise-based language immersion program to participate in STEM programs at Boise State.

CAES AD for Boise State recognized with national award

In September, Estrada, was recognized by the Council for Opportunity in Education as one of six 2019 National TRIO Achievers. The name of the honor stems from the federal TRIO college access and support programs designed to help low-income, first-generation students and students with disabilities succeed in college. Estrada's parents immigrated from Mexico to Idaho in the early 1960s; neither had finished high school. Estrada and his five siblings all graduated from high school, and he was awarded a scholarship at University of Michigan through the Navy ROTC program. After struggling academically as a freshman, Estrada served six years in the Navy before returning to Idaho to pursue a degree in electrical engineering at Boise State. In 2007, Estrada became the first person in his family to earn a college degree, and he credits the McNair Scholars Program with providing the support and preparation he needed to succeed.

CAES hosts Hiring our Heroes Fellow

CAES hosted Paul Smith as a fellow in the Hiring Our Heroes Fellowship Program throughout fall 2019. Smith contributed to a number of communications projects for CAES, in addition to networking and sharing the story of the fellowship program, which provides military service members with professional training and hands-on experience as they transition from the military to the civilian workforce. A profile on Smith, an Idaho native who served more than 22 years in the US Army, ran on the INL web site and Boise State University web site.

Paul Smith


Dr. Dakota Roberson

CAESer lands White House Fellowship

CAES resident Dr. Dakota Roberson began serving in the 2019-2020 Class of White House Fellows over the summer. Roberson, an Assistant Professor of Electrical and Computer Engineering at University of Idaho, has been placed at the Department of Defense for the yearlong fellowship. At CAES, he leads an interdisciplinary research team studying electrical grid stability and security, and he is an appointed Nuclear Engineering Affiliate Faculty at University of Idaho. In addition to his professorial duties, Roberson promotes science, technology, engineering, and mathematics education through secondary school outreach and public speaking engagements; he also volunteers at a tech start up and serves as an unpaid advisor on regional energy infrastructure programs, according to a White House news release. Roberson was in the first cohort of the CAES Summer Visiting Faculty Program, in 2018, and he was integral to launching CAES' monthly Codebreaker seminar series, which provides a forum for students and researchers to address their work, communicate opportunities and challenges to a receptive audience, and increase dialogue among CAES affiliates leading to further interdisciplinary collaborations and ground-breaking new research.

A native of Shelley, Idaho, Roberson has collaborated with researchers, scientists, and engineers at several national laboratories, electric utilities, private stakeholders, and universities to mitigate 21st century energy-system threats. His engineering courses at UI are geared toward preparing students for careers in this area.

"Dakota is a valuable member of the CAES team and community," said CAES Director Noël Bakhtian, who encouraged Roberson to apply for the fellowship.

The White House Fellows Program was created in 1964 by President Lyndon B. Johnson. The non-partisan program provides professionals from diverse backgrounds an opportunity to engage in public service for one year by serving in various roles in the federal government. Fellows participate in education programs that expand their knowledge of leadership, policy-making and contemporary issues. Community service plays a prominent role in the program as fellows take part in numerous service projects throughout the year. The selection of the fellows is based on a record of professional accomplishment, evidence of leadership skills, the potential for further growth, and a commitment to service.


Dr. Mary Lou Dunzik-Gougar

CAES faculty member sworn in as American Nuclear Society VP at society's national meeting

Dr. Mary Lou Dunzik-Gougar, a CAES faculty member from Idaho State University, was named Vice President of the American Nuclear Society at its annual meeting in June, and is set to take over as the society's president in 2020, making her the first CAESer to serve as president in ANS history (we think!). In addition to serving as the ISU lead for the CAES joint certificate in nuclear security and co-lead of the CAES Nuclear Energy Working Group, Dunzik-Gougar is Associate Dean of the College of Science and Engineering, an Associate Professor of Nuclear Engineering, and Senior Reactor Operator at ISU.


Dr. R.A. Borrelli

University of Idaho ANS Student Section recognized at annual meeting

The CAES-affiliated University of Idaho American Nuclear Society (ANS) Student Section was awarded second place for the 2019 Samuel Glasstone Award at the ANS Annual Meeting in June. Established in 1969, the annual Glasstone Award recognizes ANS student sections that have made notable achievements in public service and the advancement of nuclear science and engineering. The UI ANS Student Section is comprised of about 20 students, combined, on the Idaho Falls and Moscow campuses. Professor R.A. Borrelli, a CAES/UI faculty member, is the section's faculty advisor; CAES/UI graduate student Robin Roper is the current president; and James Richard, also a CAES/UI graduate student, was president last year.

CAES Collaboration Fund winners announced

Recipients of the 2019 CAES Collaboration Fund were announced over the summer. The fund is designed to advance selected proposals by INL researchers that would enhance collaborative relationships with CAES universities, in line with the CAES strategic plan. Here is a look at the recipients, their CAES-affiliated collaborators, and their proposals:

- INL's Brittany Hodges, from the Energy and Environment Science and Technology Directorate, and University of Wyoming faculty members Dean M. Roddick and Katie Li-Oakey, collaborated on a proposal that encompasses two CAES focus areas, Energy-Water Nexus and Innovative Energy Systems, and calls for a visit to the University of

Wyoming, presentation of a seminar, and meetings with potential partners to advance solutions in the two focus areas.

- INL researchers Mary Case and Robert Fox, with the Energy and Environment Science and Technology Directorate, Idaho State University Professor Rene Rodriguez, and Boise State University Professor Kris Campbell developed a proposal that calls for collaboration among the recipients and a possible industry partner to advance solutions in the Advanced Manufacturing focus area, leading to a report on potential collaboration and approaches, a summary of literature searches performed by students, and a summary of discussions at a series of meetings.
- INL's Josh Peterson-Droogh, in the Nuclear Science and Technology Directorate, and ISU Associate Professor Leslie Kerby developed a proposal in the Cybersecurity focus area that calls for developing material to teach advanced machine learning applications for nuclear energy, and hosting several working meetings to hone the material and determine the potential for collaboration in the cross-cutting effort of utilizing data science with nuclear energy.
- INL's Bin Li, with the Energy and Environment Science and Technology Directorate, and BSU Associate Professor Claire Xiong developed a proposal in the Advanced Manufacturing focus area that calls for student mentoring and the development of new concepts or proposals in the field of stationary energy storage.
- INL's Kevin Gering, with the Energy and Environment Science and Technology Directorate, and BSU collaborators Claire Xiong, Eric Jankowski, Will Hughes, and Amy Moll developed a proposal in the Cybersecurity focus area that calls for developing a roadmap of proposal opportunities and possible connections with INL's Collaborative Computing Center and industrial engagement.


Dr. Mustafa Mashal

Idaho State University faculty member named Engineer of the Year

CAES-affiliated Idaho State University Assistant Professor Dr. Mustafa Mashal was named the Southern Idaho Section Engineer of the Year by the American Society of Civil Engineers in March. Mashal participated in the CAES Summer Visiting Faculty program this year, collaborating with INL's Matthew Watrous on a project that addressed two CAES focus areas: Innovative Energy Systems and Cybersecurity. Mashal also received a $1.1 million award from the state of Idaho's Idaho Global Entrepreneurial Mission (IGEM) initiative this year. More information on the IGEM grant is among the Research Highlights included in this report.

CAES researcher lauded

John Peterson, a University of Idaho graduate student who is conducting research at CAES, was recently awarded first place in the Department of Energy-sponsored Innovations in Nuclear Technology R&D Awards. Peterson's award in the program's Energy Policy category was for his research paper "An Overview of Methodologies for Cybersecurity Vulnerability Assessments Conducted in Nuclear Power Plants." The paper was published in the journal Nuclear Engineering and Design in May. The Innovations in Nuclear Technology R&D Awards program is designed to: award graduate and undergraduate students for innovative research publications relevant to nuclear technology, demonstrate the DOE's commitment to higher education in nuclear energy-relevant disciplines, and support communication among university students and DOE representatives.

CAES director selected for STEP board

CAES Director Noël Bakhtian was selected by the National Academies of Sciences, Engineering, and Medicine to serve on its 11-member Board on Science, Technology, and Economic Policy (STEP). She joins 10 other members, selected from industry, academia, and government. The mandate of the STEP board is to advise federal, state, and local governments and inform the public about economic and related public policies to promote the creation, diffusion, and application of new scientific and technical knowledge to enhance the productivity and competitiveness of the U.S. economy and foster economic prosperity for all Americans. The board and its committees draw from the expertise of scholars, industrial managers, investors, and former public officials to help craft policies intended to guide and accelerate scientific and technological change. Members include Board Chair Adam B. Jaffe, Research Professor at Brandeis University; former US Senator Jeff Bingaman (D-New Mexico); Brenda Dietrich, Geoffrion Family Professor of Practice of Operations Research and Information Engineering at Cornell University; Arati Prabhakar, former Director of the Defense Advanced Research Projects Agency; Kathryn Shaw, Ernest C. Arbuckle Professor of Economics at Stanford University; and Scott Sterm, David Sarnoff Professor of Management of Technology and Professor of Technological Innovation, Entrepreneurship, and Strategic Management at MIT Sloan School of Management.

CAES reaches milestone of 15,000 visitors

Among the visitors this year:

LISA BERTHELOT
Stakeholder Involvement Officer at International Atomic Energy Agency

DWAYNE BOLTON
DOE Office of Congressional and Intergovernmental Affairs

MIKE CRAPO
US Senator

THOMAS DAVIS
with Oxford University

RUSS FULCHER
US Representative

C. SCOTT GREEN
University of Idaho President

DR. CHRISTIAN KÄHLER
Professor at Universitat der Bundeswehr Munchen

JANICE MCGEACHIN
Idaho Lieutenant Governor

DR. KEVIN NILSEN
senior software engineer at IBM

LARA PEIRPOINT
Technology Strategy Director at Exelon

DR. ARATI PRABHAKAR
former DARPA director

DR. MARLENE TROMP
Boise State University President

MARK YALE
from Department of Energy's Office of Nuclear Energy

A DELEGATION FROM TOKAI-MURA, JAPAN, and IDAHO FALLS' SISTER CITIES PROGRAM

Dozens of HIGH SCHOOL STUDENTS *from across the region*

Members of the IDAHO PERMANENT BUILDING FUND ADVISORY COUNCIL

SENIOR STAFF
from the Naval Nuclear Laboratory

CAES initiates CAES Excellence Certificate award

Throughout the year, students, researchers, and faculty from the CAES entities can nominate their colleagues for their work promoting collaboration, safety, and technical excellence in research, education, and innovation (the CAES strategic pillars). In May, we started drawing a name from the list of nominees each month, with the winner receiving a preferred parking spot for the month. Here's a list of the winners:

May:
Yaqiao Wu, Safety

June:
Kim Jeffery, Collaboration

July:
Kelly Cunningham, Safety

August:
Jana Pfeiffer, Safety

September:
Matt Evans, Collaboration

Research Highlights

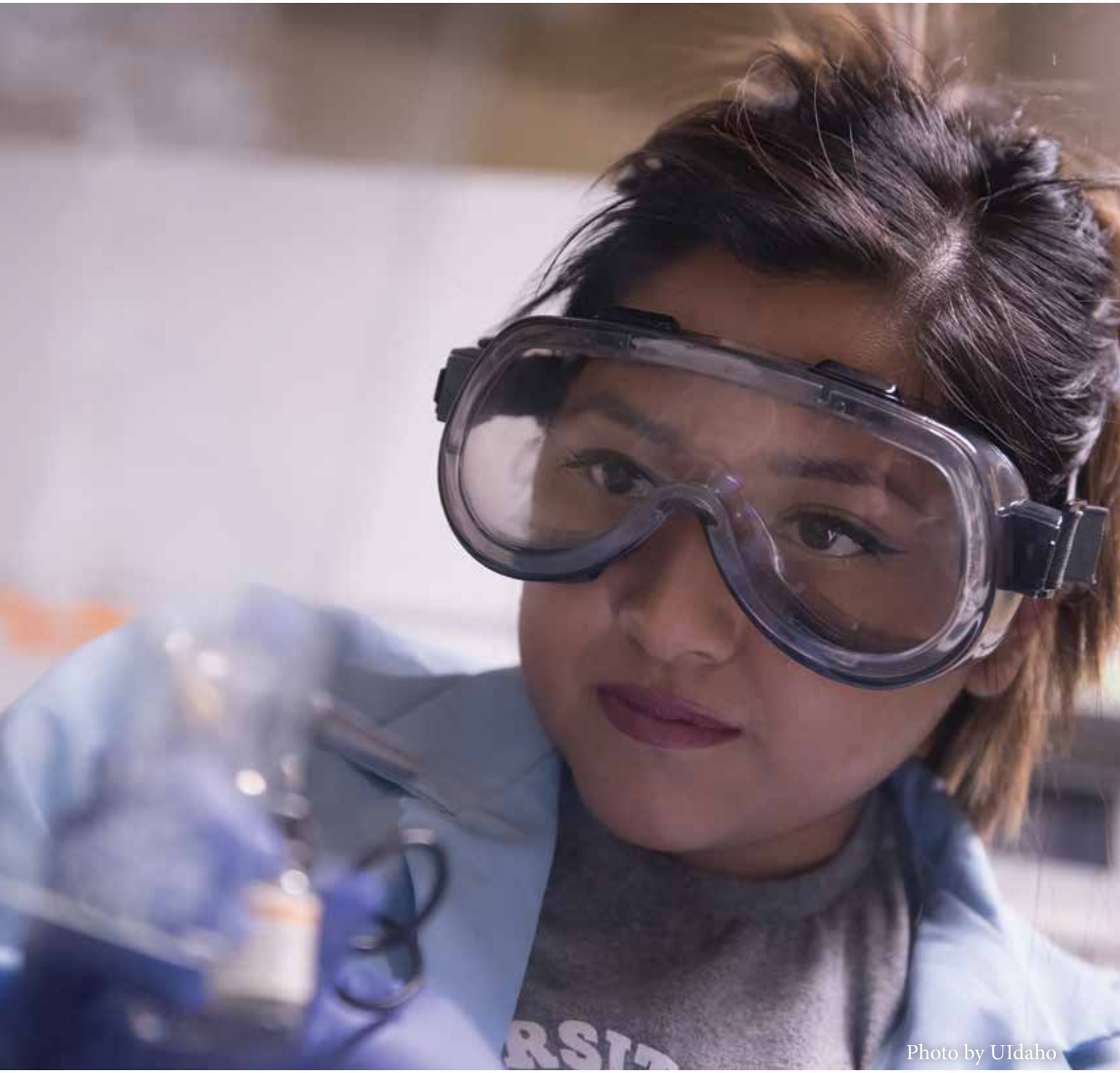


Photo by UIdaho

NuScale simulator bound for CAES

The Department of Energy awarded a grant to CAES-affiliated University of Idaho Professor Richard Christensen to support the installation of a NuScale reactor plant simulator at CAES. The simulator is a virtual nuclear power plant control room that will enhance CAES' ability to inspire, train, and educate the future energy workforce, expand opportunities for collaborative research, and provide a valuable tool for educating the public about nuclear energy and reactor technology. Christensen is the Principal Investigator of the project, *Multi Universities Small Modular Reactor Simulators: NuScale*, which received a Research and Development award from the DOE's Nuclear Energy University Program (NEUP) that is estimated at $285,763. The project calls for collaboration with fellow UI professors Robert Borrelli, Michael Haney, and Michael McKellar, and NuScale's Derrick Both. NuScale is developing a small modular reactor that is under certification review by the Nuclear Regulatory Commission. The reactors are expected to be operational by the mid-2020s as the Carbon Free Power Project, which calls for a small modular reactor power (SMR) plant consisting of 12, 60-megawatt modules located on INL's 890-square-mile desert site. Most of the power generated will go to Utah Associated Municipal Power Systems, which consists of 46 public power utilities in six western states. INL has been involved with NuScale's SMRs for years, assisting with several technical aspects of the project, including modeling and simulation of small modular reactor components and systems. The NuScale project will help INL and DOE research and demonstrate safe, secure, and resilient microgrid systems, and will be part of DOE's INL-led Gateway for Accelerated Innovation in Nuclear (GAIN) program, which makes DOE national laboratory assets available to assist industry in bringing nuclear energy technology to market.

CAESers lead, collaborate on projects recognized by NEUP

CAES-affiliated Professor Mary Lou Dunzik-Gougar from Idaho State University is the Principal Investigator on a project that received a Research and Development award from the Department of Energy's Nuclear Energy University Program (NEUP), while Haiyan Zhao, CAES-affiliated Professor at University of Idaho, is a collaborator on a project that received a NEUP Reactor Concepts Research and Development and Demonstration award.

Dunzik-Gougar's project, *Measuring Mechanical Properties of Select Layers and Layer Interfaces of TRISO Particles via Micromachining and In-Microscope Tensile Testing*, calls for the development of improved modeling of fuel behavior, which would positively impact ongoing efforts in DOE's Advanced Gas Reactor Program to qualify and license TRI-structural ISOtropic (TRISO-coated) particle fuel. Collaborators include Isabella van Rooyen from INL's Nuclear Science & Technology Directorate. NEUP funding for the project is estimated at $799,815.

Zhao is a collaborator on *Ni-based ODS alloys for Molten Salt Reactors*, which will examine the concept of developing new nickel alloy material for molten salt reactors. The project's goal is to resolve problems related to corrosion and irradiation damage that limit the currently available nickel alloys for use in molten salt reactors, while improving the mechanical properties of the material. The project's estimated funding is $800,000. The Principal Investigator is Djamel Kaoumi from North Carolina State University, and Zhao's fellow collaborators are Peter Hosemann of the University of California, Berkeley; David Armstrong and Michael Moody from Oxford University; and INL's Michael V. Glazoff, who is in the INL's Energy and Environment Science and Technology Directorate. The corrosion testing work may be performed by Zhao's research group in the Radiochemistry Laboratory at CAES.

CAES faculty member leads project that receives IGEM grant

Idaho State University's Civil and Environmental Engineering department is leading a CAES-initiated project at the forefront of earthquake and structural engineering research

Dr. Mustafa Mashal and Dr. Bruce Savage

that will enhance collaboration between INL and ISU. ISU was awarded nearly $1.1 million this year from the Idaho State Board of Education's Idaho Global Entrepreneurial Mission (IGEM) initiative to build the Disaster Response Complex (DRC) in Pocatello. The concept and collaboration for the DRC resulted from a 2018 CAES-coordinated collaborative research planning meeting with INL's National & Homeland Security Directorate. CAES-affiliated ISU Professor Dr. Mustafa Mashal is the Principal Investigator on the project, which calls for the construction of a facility that will replicate the features of a structure collapsed by an earthquake, hurricane, or other natural disaster. Mashal and his Co-PI, Dr. Bruce Savage, an associate professor and Chair of ISU's Department of Civil and Environmental Engineering, teamed on the project with INL's Bryon Marsh, establishing a partnership that provides expertise in chemical, biological, radiological, and nuclear (CBRN) research. The DRC will be the first of its kind in the Intermountain West, serving as a training site for first responders to learn search-and-rescue operations in disaster scenarios, enabling research into new disaster response techniques and technology, and supporting future collaborative training and exercises planned for INL's Radiological Response Training Range. Potential clients include Idaho National Guard and the Office of Emergency Management. Seed funding for the project came via a 2018 CAES program development award and a 2018 CAES Collaboration Fund award.

University of Idaho awarded IGEM grant

University of Idaho Professor Indrajit Charit is the Principal Investigator on a collaborative project involving INL and CAES-affiliated Boise State University Assistant Professor Brian Jaques that received a $247,167 grant from the Idaho Global Entrepreneurial Mission (IGEM) initiative. The project calls for using laser beams to manufacture complex and unique metallic parts, with potential applications in nuclear reactors and food processing plants. Jaques is one of five Co-PIs on the project, which also involves Blackfoot-based Premier Technology Inc. INL will serve in an advisory role, and the researchers plan to conduct characterization work at CAES. The project could enable Premier Technology to quickly manufacture complex and unique machine parts on-site – parts such as smart filters for food processing equipment – potentially reducing down-time for equipment and personnel. Another potential application is for US Navy fleets – crews would be able to rapidly manufacture needed materials at sea, without returning to port.

Did you know: The IGEM grant program initiative began in 2012, with the goal of boosting Idaho's economic growth through commercialized research at the state's three public research universities.

CAESers on teams that receive VTR funding

Several CAES-affiliated faculty members at Idaho State University and University of Idaho are members of teams that received funding through the Versatile Test Reactor Program, which DOE created in 2018 to support the development of new nuclear energy technologies in the U.S. The program is led by INL and is charged with developing a conceptual design and cost estimate for a proposed, one-of-a-kind research reactor capable of producing neutrons at higher speeds to support new nuclear technology development.

Richard Christensen and David Arcilesi from CAES/University of Idaho are co-PIs on a team led by the University of Michigan that received $375,000 in funding for its Versatile Test Reactor (VTR) project, Development of a Multi-functional Experimental Vehicle for GFR Irradiation Testing in VTR, in June. Christensen serves as director of UI's Nuclear Engineering program at CAES, and Arcilesi is an Assistant Professor in UI's College of Engineering in Idaho Falls who participated in the CAES Summer Visiting Faculty program in 2018.

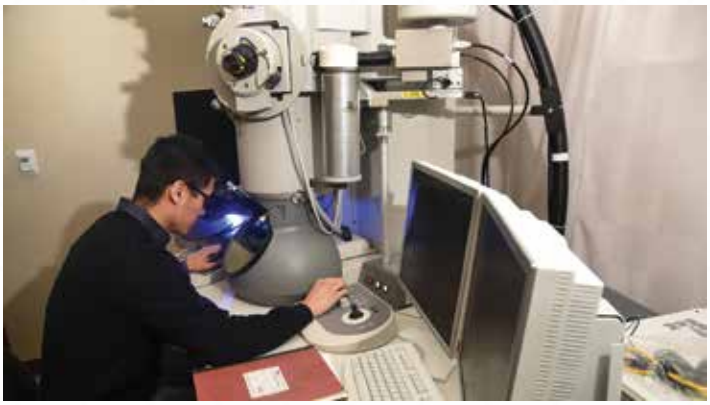
ISU Professors Goerge Imel and Chad Pope also serve as co-PIs on teams that were recognized in June. Imel, a CAES-based Nuclear Engineering professor at ISU, is a co-PI on a project led by Purdue University called In-Situ Irradiation Creep Testing Vehicle Instrumented with Novel Sensors that was awarded $350,400. Pope, director of ISU's Nuclear Engineering program who has taken part in several successful projects at CAES, including a 2015 project that received a $200,000 grant from INL to study the performance of nuclear power plant components under flooding conditions, serves as co-PI on an Oregon State University-led project, Accelerating the Experimental Mission of VTR Through an Ex-Pile Operational Program, that received $250,000 in funding through the VTR program.

In all, the VTR program awarded $1.7 million in funding to six university-led projects in June. The funding is intended to allow the universities to develop instrumentation and tools for a proposed research reactor that would generate high-speed – or "fast" – neutrons for experimentation and testing purposes.

While INL leads the VTR program, its team consists of Argonne National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, Savannah River National Laboratory, and industry and university partners.

2019 Laboratory Directed Research and Development Awards (LDRD)

Award	Recipient	Research/Development
$786,434	Colby Jensen (INL), Richard Christensen (UI), Alberto Cardenas Melgar (UI)	In-Pile Investigation of Transient Boiling in TREAT
$518,140	Bjorn Vaagensmith (INL), Curtis Cantley (BSU)	Robust Insulation for Resilient Transformers Against a Electromagnetic Pulse or Geomagnetic Disturbance
$485,511	Eric Dufek (INL) Lan Li (BSU), Caire Xiong (BSU), Haoyu Zhu (BSU)	Carbon: Interfaces, Structure and the Impacts on Performance
$475,000	Danuel Schwen (INL)	Mitigating Irradiation Assisted Stress Corrosion Cracking by Rapid Alloy Design
$430,000	Adrian Wagner (INL), Brian Jaques (BSU)	Advanced Manufacturing of Uranium Dioxide Fuel Pellets with Radially and Axially Zones Burnable Poisons and Hour-glassing Control Features
$384,750	Junhua Jiang (INL), Haiyan Zhao (UI)	Three-Dimensional Electrochemical Manufacturing and Sensing (3DEMS)
$377,300	David Hurley (INL), Christy Allison (BSU), Jon Huff (BSU), William Kowlton (BSU), Ryan Pensack (BSU), Paul Simmonds (BSU), Kevin Daniel Vallejo (BSU), Bernard Yurke (BSU)	Investigation of Exciton Delocalization and Exciton Coherence in Chromophores and Acoustic Nanostructures
$282,500	Ronald Boring (INL), Harold Blackman (BSU)	Human Reliability Analysis for Advance Reactor Technologies and Systems
$275,000	Craig Rieger (INL), Michael Haney (UI), Brian Johnson (UI), Philip Richardson (UI)	Resilient, Scalable Cyber State Awareness of Industrial Control System Networks to Threat
$266,860	Edna Cardenas (INL), Jon Stoner (ISU)	Novel Methods to Produce an Argon-37 Standard
$251,396	Kevin Gering (INL), Bryton Anderson (BSU), Mike Henry (BSU), Eric Jankowski (BSU), Matthew Jones (BSU)	Surface Morphological Patterning, Structure-activity Modeling, and Aging Analysis of Catalyst Materials to Enhance Oxidative Dehydrogenation of Ethane Reaction Coversion Efficiency
$208,846	Cheng Sun (INL), Ryan Carnahan (ISU)	Advanced Manufacturing of Fuel Cladding Materials by Equal-channel Angular Pressing
$205,333	Kevin Lyon (INL), Jarod Perko (UI), Vivek Utgikar (UI)	Modeling and Simulation for Nuclear Fuel Cycle Separations Using Modular Coupling
$96,000	Gary Groenewold (INL), Yaqiao Wu (BSU)	Separation of Fragile Chemical; Species Using Carbon Nanotube Emitters at Very Low Electrical Potential



NEUP Nuclear Energy University Program
U.S. Department of Energy

2019 Nuclear Energy University Program Awards (NEUP)

Award	Recipient	Research/Development
$285,763	NEUP Infrastructure (Prime award) Rich Christensen (UI)	NuScale Simulator
$799,815	NEUP CINR (Prime award) Mary Lou Dunzik-Gougar (ISU), Isabella van Rooyen (INL)	Measuring Mechanical Properties of Select Layers and Layer Interfaces of TRISO Particles via Micromachining and In-microscope Tensile Testing
$800,000	NEUP CINR (Partner award) Djamel Kaoumi (NC State), Haiyan Zhao (UI), Michael Moody and David Armstrong (Oxford), Peter Hosemann (UC-Berkeley), Michael Glazoff (INL)	Ni-based ODS Allows for Molten Salt Reactors
$499,997	NEUP CINR (Partner award) Zhao Ji-Cheng (Ohio State), Yaqiao Wu (BSU), Ed Lahoda (Westinghouse)	Neutron Radiation Effect on Diffusion Between Zr (and Zircaloy) and Cr for Accurate Lifetime Prediction of ATF

Team with CAES connections receives NSF award

CAES Associate Director for University of Wyoming Katie Li-Oakey is a Co-PI on a project that received a National Science Foundation (NSF) Major Research Instrumentation award. The proposal, which is led by University of Colorado Assistant Professor Adam Holewinski and INL's Rebecca Fushimi, is called *NSF MRI: Acquisition of a High-Sensitivity Low-Energy Ion Scattering (HS-LEIS) Spectrometer with Multiple Reactive Environment Transfer for Interrogating Surfaces and Interfaces*. The project has been awarded more than $880,000 for a HS-LIES spectrometer that will be publicly available and will enable collaboration in studying catalysis, atomic layer deposition and coatings, photovoltaics, and solid state structure and interfaces, among other areas. The spectrometer will be the second comparable instrument in North America today.

Dr. Katie Li-Oakey

CAESer receives DOE award for geothermal project

The DOE's Geothermal Technologies Office awarded funding to an INL-CAES geothermal energy storage project focused on determining whether reservoirs deep within the earth could be used to store energy. The collaborative project, *Dynamic Earth Energy Storage: Terawatt-Year, Grid-Scale Energy Storage using Planet Earth as a Thermal Battery*, is led by Principal Investigator Travis McLing of INL/CAES and includes researchers from University of Idaho, University of Wyoming, Rocky Mountain Power, and Lawrence Berkeley National Laboratory. It was one of eight projects selected to receive up to $2.4 million in funding via the Beyond Batteries Lab Call: Geothermal Energy Applications for Storage Alternatives and support the objectives of the DOE Grid Modernization Initiative. The projects are exploring opportunities for integrating geothermal energy into various functions in support of the Beyond Batteries objectives. These include dispatchability, co-production, and hybrid operations to improve grid reliability, resilience, and security.

CAES Collaboration Fund recipient gets published

Ahmad Al Rashdan, a Senior Research and Development Scientist in INL's Nuclear Science and Technology Directorate, wrote a research paper published in *IEEE Transactions on Nuclear Science*. The project behind the paper, *A Frequency Domain Control Perspective on Xenon Resistance for Load Following of Thermal Nuclear Reactors*, was funded through the CAES Collaboration Fund, a program designed to provide funding to selected proposals by INL researchers that would enhance collaborative relationships with CAES universities, in line with the CAES strategic plan. Rashdan teamed with CAES-affiliated University of Idaho Assistant Professor Dakota Roberson on the project.

Working groups assembled to implement strategic plan

Researcher-led working groups have been developed in each of the CAES focus areas, with recruitment underway at the end of the fiscal year. The goal is to help implement the CAES strategic plan, with the groups serving as catalysts for a community of researchers in each of the strategic focus areas, leading to new collaborations, external funding, and maximum impact in research, education, and innovation. The working groups will have access to funds to accelerate these outcomes. There are seven groups focusing on Nuclear Energy; Energy-Water Nexus; Cybersecurity; Advanced Manufacturing; Innovative Energy Systems; Energy Policy; and Computing, Data, and Visualization.

Working Group	Working Group Leads
Nuclear Energy	Rich Christensen, UI; Mary Lou Dunzik-Gougar, ISU; Don Wood, INL
Energy-Water Nexus	Jon Brant, UW; Karen Humes, UI
Cybersecurity	Jim Alves-Foss, UI; Wayne Austad, INL; Corey Schou, ISU
Advanced Manufacturing	David Estrada, BSU; Rob O'Brien, INL
Innovative Energy Systems	John Gardner, BSU; Scott Quillinan, UW
Energy Policy	Kathleen Araujo, BSU; Kipp Coddington, UW
Computing, Data, and Visualization	Leslie Kerby, ISU; John Koudelka, INL

Education Highlights

Photo by UIdaho

CAES Summer Visiting Faculty program

The CAES Summer Visiting Faculty program completed its first full year in 2019 with 18 participants, each partnered with an INL researcher. The program fosters collaboration among INL researchers and university professors in order to develop a joint-funded research proposal. The ultimate goal is to build a sustainable ecosystem of research collaboration as is outlined in the CAES strategic plan. The program ran from June 3 to August 8, giving participants a glimpse at the inner workings of a national laboratory (including opportunities at the new Cybercore Integration Center and Collaborative Computing Center [C3]) while allowing them to learn about the capabilities and expertise afforded by collaboration with researchers at a national laboratory. It also provides the faculty and INL researcher an opportunity to create lasting networks and gain access to diversified funding options. This year, proposals were solicited from faculty in all seven focus areas outlined in the CAES Strategy.

Here's a list of the participants in the 2019 CAES Summer Visiting Faculty Program:

University Faculty	Institution	INL Researcher	Focus Area(s)
Liljana Babinkostova	BSU	Robert Erbes	Cybersecurity
Zhangxian (Dan) Deng	BSU	Michael Shaltry	Advanced manufacturing
David Estrada	BSU	Rebecca Fushimi	Energy-water nexus
Tony Forest	ISU	Daniel Schwen	Nuclear energy; computing, data, and visualization
Michael Hurley	BSU	Donna Guillen	Advanced manufacturing
Brian Jaques	BSU	Subhashish Meher	Nuclear energy
Nirmala Kandadai	BSU	Joshua Daw	Energy-water nexus
Leslie Kerby	ISU	Leah Guzowski	Computing, data, and visualization
Constantinos Kolias	UI	Craig Rieger	Cybersecurity
Michal Kopera	BSU	Cody Permann	Computing, data, and visualization
Min Long	BSU	Larry Aagesen	Advanced manufacturing; computing, data, and visualization
Mustafa Mashal	ISU	Matthew Watrous	Innovative energy systems; cybersecurity
Mike McKellar	UI	Donna Guillen	Nuclear energy; advanced manufacturing; innovative energy sysems
Thomas Ptak	UI	Noël Bakhtian	Energy policy
Zouheir Rezki	UI	Arup Bhuyan	Cybersecurity
Edoardo Serra	BSU	Shane Stailey	Cybersecurity; computing, data, and visualization
Min Zian	UI	Su-Jong Yoon	Computing, data, and visualization
Yaqi You	ISU	Chenlin Li	Nuclear energy; energy-water nexus; cybersecurity

5 students from CAES-affiliated universities among 12 selected for INL Graduate Fellows program

Three graduate students from the University of Idaho and two from Boise State University were among the 12 students selected into the third cohort of INL graduate fellowship program from universities throughout the US. The program is a collaboration between INL and the universities that is designed to identify exceptional talent in research areas aligned with INL's strategic agenda. Fellows receive mentoring from a technical advisor at INL and the university thesis advisor, as well as nationally competitive financial support – tuition and a stipend – throughout the program. The goal is to train the next generation of engineers, researchers, scientists, and leaders in order to enable the current and future mission of INL and DOE.

Graduate Fellow	University	Major	INL Mentor	INL Directorate
Robert Ivans	Boise State University	Electrical and Computer Engineering	Craig Rieger	National and Homeland Security
Tyler Phillips	Boise State University	Computing-Computer Science	Craig Rieger	National and Homeland Security
James Richards	University of Idaho	Nuclear Engineering	Cristian Rabiti	Nuclear Science and Technology
Amey Shigrekar	University of Idaho	Nuclear Engineering	Richard Boardman	Nuclear Science and Technology
Kevin Terrill	University of Idaho	Mechanical Engineering	Colby Jensen	Nuclear Science and Technology

Idaho universities collaborate on fellowship program

Idaho's three public research universities are collaborating on a yearlong fellowship aimed at providing the state's scientists and engineers the opportunity to learn firsthand about policymaking.

The Idaho Science and Technology Policy Fellowship (ISTPF) is a nonpartisan professional development program led by the James A. and Louise McClure Center for Public Policy Research at University of Idaho. The first cohort is set to begin in August 2020. The intent is to connect doctoral-level scientists and engineers to the development of relevant state policies, with a focus on challenges such as water, energy, public health, and economic development and provide technical expertise to Idaho policy makers. Initial funding for the ISTPF is from the California Council on Science and Technology in partnership with the Gordon and Betty Moore Foundation and the Simons Foundation. CAES Director Noël Bakhtian serves as chair of the ISTPF advisory board. Other advisory board members include CAES EPI Director Kathleen Araújo, and representatives from the Micron Foundation, Idaho Technology Council, Idaho STEM Action Center, St. Luke's Health System, and several Idaho state agencies, among others.

Boise State-Idaho State Wind Tunnel Transfer

Two CAES entities, Boise State University and Idaho State University, collaborated on a project that resulted in ISU receiving what may be the largest wind tunnel in Idaho. The tunnel belonged to the Boise State's Mechanical and Biomedical Engineering Department but had been in storage due to a shortage of space on campus. Dr. Mustafa Mashal, a CAES-affiliated Assistant Professor of Structural and Earthquake Engineering at Idaho State, having heard about the status of the wind tunnel, approached CAES Energy Policy Institute Director Kathleen Araújo about moving the structure to the Idaho State campus, noting that it would be a valuable research tool for his department. It can be used for structural testing of wind turbines and small modular reactors, for example. After negotiations involving department chairs Bruce Savage and Katy D'Amico, the transfer of $100k in equipment was carried out successfully weeks later, a testament to CAES' ability to leverage resources for the gain of its members.

Rajiv Khadka in CAES' Applied Visualization Laboratory

CAES intern pens book chapter

CAES intern Rajiv Khadka, a PhD candidate in Computer Science at University of Wyoming, became a published author in late June. Khadka co-wrote a chapter in VR Developer Gems, a book that serves as a reference guide for computer programmers of all skill levels, novice to expert. Each chapter was written by "veteran virtual reality researchers and developers," and offers tips to help the reader find solutions to programming problems. The title of Khadka's chapter, which he wrote with UW Professor Amy Banic and research colleague Elliot Hunt, is Bi-Manual Interaction for Manipulation, Volume Selection, and Travel: Using the leap Motion, Game Controllers and Mobile Devices. It is based on Khadka's work at CAES' Applied Visualization Laboratory and the 3D Interaction and Agents Research Lab at University of Wyoming.

Innovation Highlights

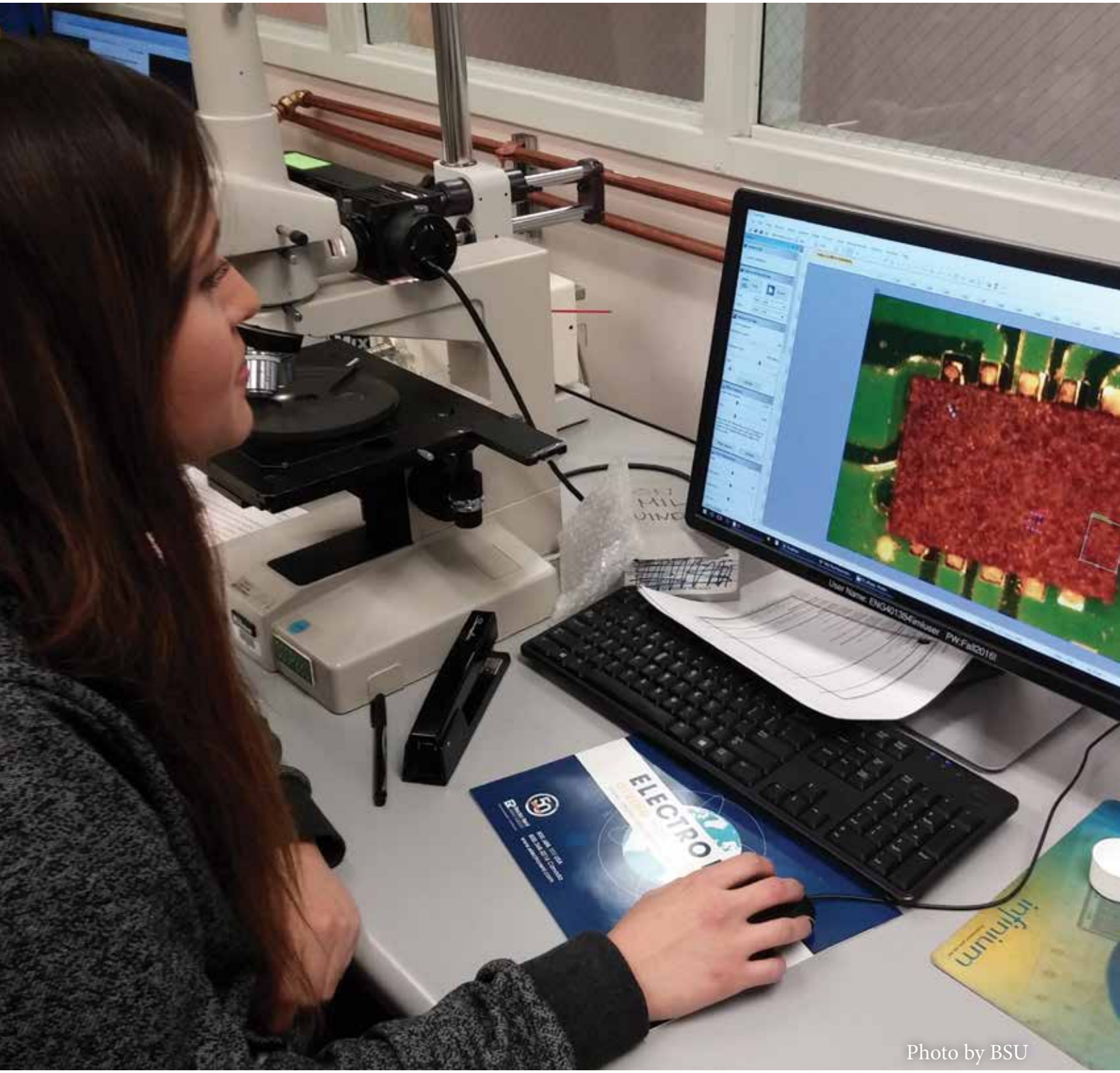
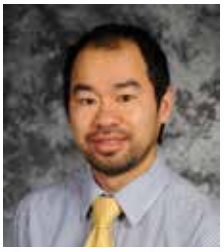


Photo by BSU

CAES hosts CO*STAR training

INL's Technology Deployment group held a CO*STAR training session in the CAES Auditorium in August, with a total of 52 INL researchers and CAES university personnel registering to learn practices proven to help develop new ideas, create winning proposals, and ensure research being conducted at the CAES entities has a tangible, positive impact in alignment with the innovation pillar outlined in the CAES strategic plan. The CO*STAR method imparts best practices for researchers to find opportunities for innovation, come up with creative solutions, communicate in a clear and compelling manner, and create cost-effective prototypes. It also teaches how collaboration can lead to rapid improvement of ideas and provides tips for developing a value proposition. The training aligns with the Innovation pillar outlined in the CAES Strategy, which calls for collaborative innovation that supports entrepreneurial opportunities, industry partnerships, and tech-to-market impact. CAES not only helps pair key regional industries with INL researchers and CAES faculty and students, but also helps them leverage the intellectual property they created – through training such as CO*STAR - to bring research and development to market and, in turn, benefit our communities and businesses.



Roger Lew

Team with CAES connections to participate in Energy I-Corps Cohort 9

An INL team with CAES connections was selected to participate in Energy I-Corps, a DOE/INL program that pairs research teams with industry mentors for intensive training. The training allows researchers to gain insight into industry engagement that will help guide future research and create a culture of market awareness in the Department of Energy's national laboratories. The goal is to ensure the nation's investment in the national labs is maintaining and strengthening long-term US competitiveness. Over the two-month training, researchers define technology value propositions, conduct customer discovery interviews, and develop viable market pathways for their technologies. Team Rotoro, one of two INL teams selected to participate, consists of INL Researchers Ronald Boring and Thomas Ulrich of the Nuclear Science and Technology Directorate, University of Idaho Professor Roger Lew, and industry mentor Eric Harvey. The team developed a nuclear power plant simulator that has been streamlined and simplified to allow rapid demonstration of control room concepts for new reactors. The simulator is touted as being easy to customize, portable, and flexible. It is also capable of facilitating classroom training and can be used in areas where it is not feasible to build a full-scale simulator, such as a university laboratory.

CAESer awarded patent

Dakota Roberson, a CAES-affiliated Assistant Professor at University of Idaho, and John F. O'Brien from University of Wyoming, were awarded US Patent No. 10,355,485 B2 on July 16 for their invention, Variable Loop Gain Using Excessive Regeneration for a Delayed Wide-Area Control System, which could improve the safety and stability of the electric grid. The patent was officially awarded to the University of Wyoming and was made possible by a DOE grant.

INL chemist awarded Technology Commercialization funding for 2 projects with Boise State University

Prabhat Tripathy

INL Chemist Prabhat Tripathy was recognized by Department of Energy's Office of Technology Transitions Technology Commercialization Fund (TCF) for two projects on which he is collaborating with Boise State University and industry partner Inflex Labs, LLC.

Each of the projects, *Advanced Manufacturing of Electrochemical Sensors for Molten Salt Applications* and *Fabrication of Near-net-shape Metallic Components from Oxides*, received $150,000, with half of the funding coming from DOE along with matching funds from Inflex Labs. TCF was created in 2005 to promote projects with the potential to advance promising commercial energy technologies and bolster collaboration between DOE's national labs and industry.

NEW LEADERSHIP

Dr. Marianne Walck (Steering Committee)

Dr. Marianne Walck joined the steering committee in January 2019, when she took over as INL's Deputy Laboratory Director for Science and Technology and Chief Research Officer. Dr. Walck came to INL from Sandia National Laboratories' California laboratory, where she served as Vice President in charge of its Energy and Climate Program and was responsible for principal programs including stewardship or nuclear weapons, homeland security with a focus on defending against weapons of mass destruction, hydrogen energy research, biology, and advanced computational and information systems. Walck serves on several advisory board for universities and technical institutes, including the Texas A&M Energy Institute, and is a Senior Fellow on the California Council on Science and Technology. She earned PhD and Master's degrees in Geophysics from the California Institute of Technology and a Bachelor's degree in Geology/Physics from Hope College.

Dr. Scott Snyder (Steering Committee)

Dr. Scott Snyder was named Interim Vice President of Research at Idaho State University in December 2018. Dr. Snyder also serves as Dean of ISU's College of Science and Engineering. He joined ISU in June 2018 after serving nearly eight years as Chief Research Officer and Associate Vice Chancellor at the University of Nebraska Omha (UNO). In 2013, Dr. Snyder was appointed Interim Executive Director of the Peter Kiewit Institute, a teaching and research institute comprised of UNO's College of Information Science and Technology and the University of Nebraska Lincoln's College of Engineering in Omaha. Snyder initially joined UNO in 2001 as a faculty member in Biology and became a full Professor in 2008. From 2008-2010, he served as Program Director in the Division of Environmental Biology at the National Science Foundation. Snyder has also held a faculty position at the University of Wisconsin Oshkosh and was an NSF/Alfred P. Sloan Postdoctoral Fellow in Molecular Evolution at the University of New Mexico. Snyder earned his PhD in Parasitology at the University of Nebraska-Lincoln, where he also earned his Bachelor's in Biology. He earned his Master's in Parasitology at Wake Forest University.

Dr. David Estrada (Executive Board)

Boise State University Associate Professor Dr. David Estrada was named as CAES Associate Director for BSU in June. Estrada has been a CAES-affiliated faculty member at BSU's Micron School of Materials Science and Engineering since 2013, when he earned his PhD in Electrical Engineering at University of Illinois at Urbana-Champaign. Estrada is the Boise State lead for the Advanced Manufacturing efforts of the DOE's In-Pile Instrumentation Program, and he runs a NASA EPSCoR program to develop technology's for in-space manufacturing of flexible electronics and sensors. Estrada also serves as co-lead of the Advanced Manufacturing Working Group at CAES. A US Navy veteran, Estrada is a past-recipient of NSF and National Defense Science and Engineering Graduate Fellowships. He took over as Associate Director for Dr. Amy Moll.

Dr. Katie Li-Oakey (Executive Board)

Dr. Katie Li-Oakey succeeded Don Roth as CAES Associate Director representing University of Wyoming in July. Li-Oakey received her PhD and postdoctoral training from the University of Colorado. She joined the faculty at UW's Department of Chemical Engineering in 2011, after working at several companies, including Intel Corporation and startups such as Mesoscopic Devices, Metafluidics, and DRC Metrigraphics. Her research focuses on surface and interface chemistry, engineering, and bottom-up nanomaterial design and synthesis such as covalent organic frameworks to address challenges in the areas related to energy, water, and healthcare. In addition to high-impact journal publications, Li-Oakey and her research group developed a patent portfolio upon which she founded TLS Materials, LLC in 2016.

Dr. David Rodgers (Executive Board)

Dr. David Rodgers was named CAES Associate Director for Idaho State University in July. An ISU faculty member since 1985, Rodgers also serves as ISU's Associate Vice-President for Research. He recently returned from sabbatical in Tajikistan, where he spent the 2018-2019 academic year as a Fullbright Scholar at the University of Central Asia. From 2010-2018, Rodgers was Associate Dean in the ISU College of Science & Engineering, and from 2013 to 2018, Rodgers was ISU Site Leader for MILES (Managing Idaho's Landscapes for Ecosystem Services), a research program that involved 100-plus participants at Idaho's three research universities. In that position, he managed more than $4 million in grants from the National Science Foundation. Rodgers earned his PhD in Geology from Stanford University and his Bachelor's from Carleton College. He succeeds Dr. Richard "Jake" Jacobsen.

Dr. John Russell (Executive Board)

Dr. John Russell was named CAES Associate Director for University of Idaho in late 2018. Russell is a recognized expert in chemistry and materials science who also is a joint-faculty appointment with INL. Prior to his arrival at CAES, Russell spent three years in policy advisor roles, most recently as a congressional nuclear security fellow for the office of U.S. Sen. Steve Daines, (R-Mont.). Russell advised Daines' staff on a variety of topics, including quantum information science, advanced computing, 5G wireless, and coal-fired power plants. He was also a Science and Technology Fellow at the American Association for the Advancement of Science, serving as a Cybersecurity Research and Development Policy Advisor for the National Science Foundation and as an Energy and Advanced Computing Research and Development Policy Advisor for Department of Energy. Russell earned his doctoral degree from the University of Illinois at Chicago. He replaced Rich Christensen.

Additional Hires

Amy Woodard

Amy Woodard is Business Operations Specialist for CAES, having replaced Jeff Benson in September. She is responsible for coordination of business outcomes, project management, and CAES process improvement. Prior to joining CAES, Woodard worked for Zions Bank as the Regional Commercial Real Estate Portfolio Manager and Vice President. As Portfolio Manager, she handled the commercial construction and real estate loan portfolio for the region, with individual projects ranging from $1 million to $80 million. Woodard specializes in underwriting, construction contracts, and financial analysis. She holds a Bachelor of Business Administration Degree in Finance from Idaho State University.

Matt Evans

Matt Evans became the CAES Communications Lead in May, replacing Ethan Huffman. He handles marketing materials and branding, social media content, interesting developments and feature stories, press releases, presentations, facility tours, and more. Evans' background is in journalism, having worked for more than a decade as a newspaper reporter and editor. He has been involved in the energy industry since 2010, most recently as Policy Advisor/Public Information Officer for the Idaho Public Utilities Commission. Prior to that, he spent seven years as Communications Lead at Idaho Falls Power.

CAES HOSTED OR PARTNERED ON 68 WORKING MEETINGS, SEMINARS, AND SPEECHES

Here's a glimpse:

My Amazing Future at CAES

CAES hosted nearly 150 eighth-grade young women for the annual My Amazing Future day in February. In its 12th year, the INL event allows students from throughout the region to interact with researchers, engineers, and scientists at INL, giving the young scholars a chance to explore more than a dozen topics including DNA extraction from a strawberry, cybersecurity, radioisotope thermoelectric generators, and hands-on chemistry. The program is designed to show the young women that scientific and technical fields can provide rewarding professional opportunities. A number of CAESers volunteered to help with this effort: CAES Administrator Donna Wuthrich took the lead and was assisted by CAES Director Noël Bakhtian, Leslie Kerby from Idaho State University, INL's Thomas Szewczyk, and Meng Shi and Haiyan Zhao from University of Idaho.

CAES hosts 2019 Center for Space Nuclear Research Fellowship

The Center for Space Nuclear Research Fellowship program kicked off at CAES in June with 16 students from across the country, including two from CAES universities – Spencer Charles Ercanbrack from Idaho State University and Joseph Hafen from University of Idaho. In its 14th year and led by

Dr. Stephen Herring, the program follows the CAES model of fostering collaboration among the students and INL scientists as they team up to complete research projects of interest to NASA. This year's program focused on three projects, one involving the optimal configuration of INL's Advanced Test Reactor for the production of Pu-238 to provide power and heat for spacecraft bound for the outer solar system and beyond, modeling the impact of changes in the oxygen content of heat sources uses in space missions, and studying potential new heat sources for missions to the moon and Mars. The students were divided into teams based on the fields of expertise needed to tackle each project, but the program also provides the fellows an opportunity to explore fields beyond their majors, in order to expose them to cross-disciplinary approaches to challenging, real-world problems.

CAES hosts CINR and LDRD workshops

CAES, in collaboration with the National University Consortium (NUC), hosted a two-day CINR Workshop in August. The event featured more than two dozen breakout sessions timed to coincide with the DOE's Office of Nuclear Energy's (DOE-NE) FY20 Consolidated Innovative Nuclear Research (CINR) funding opportunity announcement. The CINR funding announcement is managed by the Nuclear Energy University Program (NEUP), which aligns DOE-NE's mission with academic nuclear energy research. The workshop served as an opportunity for INL researchers to foster ideas for joint proposals with university researchers within CINR work scope areas. Breakout sessions focused on an array of topics, including Electromechanical Separations; Used Nuclear Fuel Disposition; Thermal Fluid Applications; Big Data, Machine Learning, and Artificial Intelligence; a funding overview; Advanced Methods for Manufacturing; and Multiscale Nuclear Performance. More than 100 researchers attended.

CAES and NUC also teamed up in February to hold a joint workshop focused on partnering for INL's Laboratory Directed Research and Development (LDRD) call. The two-day event featured breakout sessions led by INL subject-matter experts on INL's LDRD topics, including nuclear energy competitiveness and leadership, integrated fuel cycle solutions, advanced integrated energy systems, and advanced design and manufacturing.

CAES hosts Idaho chapter of Women in Nuclear kickoff

Idaho Women in Nuclear, a state-wide professional organization with core initiatives focused on professional development, nuclear energy and technology advocacy, and networking, held its kickoff meeting in the CAES Auditorium in June. Dr. Marsha Bala, Nuclear Energy Innovative Capabilities National Strategic Director at INL, led the public meeting.

CAES hosts data science training meetings

Dr. Leslie Kerby, a CAES-affiliated faculty member at Idaho State University, and Dr. Joshua Peterson-Droogh from INL held a series of data science training sessions throughout the spring and summer that were aligned with the CAES focus area of Computing, Data, and Visualization. Funding for the meetings was made possible through CAES Collaboration Funds. Kerby, an Assistant Professor at ISU, was a member of the team that won the Institute of Electrical and Electronics Engineers (IEEE) Big Data, IEEE Big Brain Hackathon competition at COMPSAC 2018 in Tokyo.

CAES collaborates on cybersecurity seminar

CAES started a series of monthly cybersecurity talks from late summer through the end of the fiscal year. The cybersecurity series is sponsored by CAES and Cybercore, in collaboration with University of Idaho-Idaho Falls and Idaho State University-Idaho Falls, and is intended to further the collaborative objectives outlined in the CAES Strategy while bolstering Cybercore's mission of protecting critical infrastructure systems from an always-evolving threat landscape.

CYBERCORE integration center

CAES hosts CIOs for IT overhaul

CAES hosted Chief Information Officers of the CAES entities to outline upgrades to the facility's information-technology infrastructure. The collaborative meeting marked the first time the CIOs had met together and was intended to accelerate the development of a plan that will best enable collaborative research and development at CAES.

CAES leads Artificial Intelligence Meeting

About 30 participants, including the Deputy Director of National Center for Atmospheric Research and representatives from INL, attended a CAES Artificial Intelligence meeting held at University of Wyoming in Laramie. Participants established a foundation for collaborations and a way forward to position the group for success in upcoming Funding Opportunity Announcements. Additionally, participants pledged to recruit pipeline companies as industry collaborators with CAES.

Cyber Fallout 5 training co-sponsored by CAES

Twenty participants from the CAES entities took part in a one-week workshop provided by CAES Leadership and the INL Cybercore Integration Center team. Cybercore and CAES collaborated to pilot the program for students, faculty, and professionals from all over the world. Attendees earned academic credit from Idaho State University upon completion of the course, which focused on the key technologies found in a nuclear facility and identified the skills needed to assess cyber risks and vulnerabilities. The original Cyber Fallout course is taught by the INL Cybercore team worldwide through the International Atomic Energy Agency (IAEA) at INL.

SEMINAR SERIES

CAES Director's Colloquium debuts

Dr. Arati Prabhakar

Former DARPA Director Dr. Arati Prabhakar spoke at the inaugural CAES Director's Colloquium in September in the INL Meeting Center. The event was open to the public and drew more than 100 people, including students and faculty who watched a live stream from event spaces at Idaho State University and University of Wyoming. Prabhakar served as Director of the Defense Advanced Research Projects Agency (DARPA) from 2012 until 2017, and as the first female Director of the National Institute of Standards and Technology (NIST) from 1993 to 1997. DARPA is a branch of the US Department of Defense charged with advancing innovative, often revolutionary, military technology for use in the public sector, while NIST promotes US innovation and industrial competitiveness by advancing measurement science, standards, and technology. Prabhakar is currently CEO of Actuate Innovation. Her presentation, *Changing What's Possible: The Power of Breakthrough Technologies*, focused on the potential for innovation to help society overcome challenges associated with the energy-water-food nexus, digital infrastructure, and health outcomes. The annual CAES Director's Colloquium is designed to promote open dialogue between world-class speakers and the public in a community setting that provides insight into research activities, current events, best practices, and career and life journeys.

Codebreaker

The CAES Codebreaker seminar series brought in internal and external talent for general education and collaborative matchmaking to fill the auditorium throughout the year.

Speakers included:

October: Brian Jaques, Boise State University, *Advanced Materials Research for Nuclear Applications*

November: Amy Banic, University of Wyoming, *Importance of 3D UI/UX for Immersive Visualizations and Virtual Reality Applications*

December: Mustafa Mashal, Idaho State University, *The Importance of Structural and Earthquake Engineering*

January: Glen Tait, Idaho National Laboratory, *A View from Washington: Representing INL in the Nation's Capital*

February: Sean McBride, Idaho State University, *Cybersecurity and Critical Infrastructure Protection*

March: Monica Regalbuto, Idaho National Laboratory, *The High Assay Low Enriched Uranium (HALEU) Program at INL*

April: Roger Plothow, Adams Publishing Group, *Science is Not Finished Until It Is Communicated*

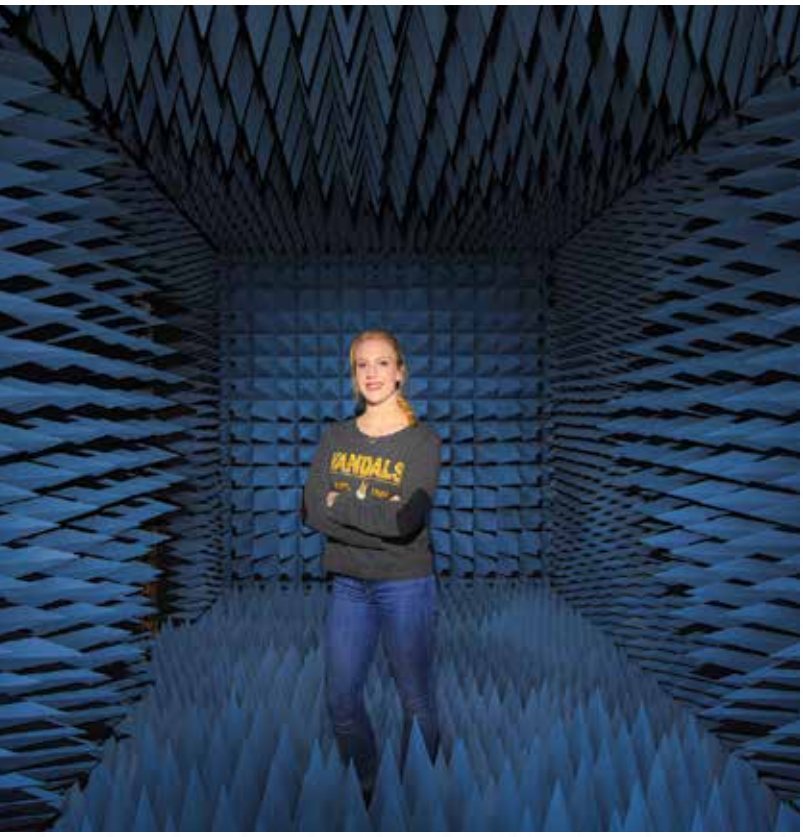
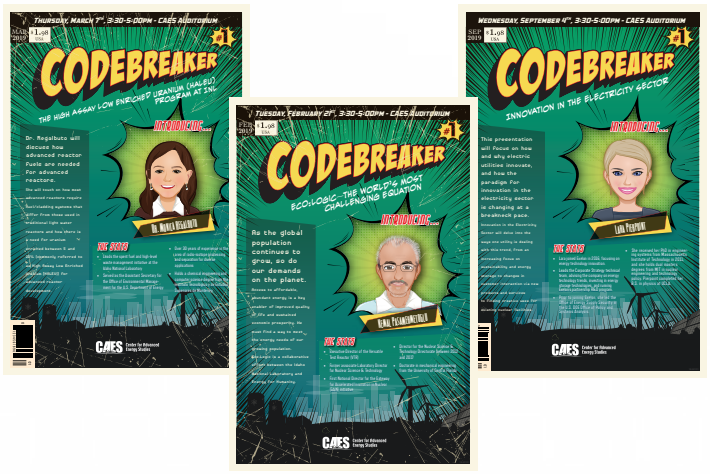


Photo by University of Idaho



May: Kipp Coddington, University of Wyoming, *The Low-Carbon Energy Transition: Some Observations Regarding Possible Impacts for the Rocky Mountain Region*

June: Lan Li, Boise State University, *Combining Computational Modeling and Artificial Intelligence to Accelerate Nuclear Materials Development*

July: Steve Herring, Center for Space Nuclear Research, *Exploring the Connection Between Nuclear Energy and Space Research*

August: Keith Weber, Idaho State University, *Getting a Handle on Wildfires with GIS*

September: Lara Pierpoint, Exelon, *Innovation in the Electricity Sector*

CAES pilots CAES Currents, a public forum focused on current events

CAES hosted a public forum on the recent fires in the Amazon rainforest in mid-September. The event was moderated by CAES Associate Director for Idaho State University Dave Rodgers and featured experts from several CAES entities, including Idaho National Laboratory, Idaho State, and University of Wyoming. The discussion focused on the potential long-term impacts of the fires and what can be done to mitigate those impacts. CAES leadership intends to regularly hold these public forums - called CAES Currents - focusing on current events when representatives from the CAES entities have relevant expertise. The goal is to provide a forum for the CAES community - students and faculty at the CAES universities, INL researchers and the public - to gain insight into the topic, discover opportunities and solution-based outcomes, and increase dialogue among the CAES affiliates in the hopes of generating or furthering collaboration and education among them.

OUTREACH

Director Testifies on Capitol Hill

In March, CAES Director Noël Bakhtian testified before the US House Appropriations Subcommittee on energy workforce opportunities and challenges. In her testimony, Bakhtian highlighted the unique role that CAES plays in conducting cutting-edge energy research, educating the next generation of scientists and engineers, and partnering with industry to advance competitiveness. She also highlighted how CAES can meet the needs of a shifting energy workforce and the importance of robust federal support for CAES' efforts.

Idaho Board of Education briefed on CAES

The Idaho State Board of Education received a briefing on the work under way at CAES and the growing research/education/innovation campus consisting of CAES and new buildings housing the Collaborative Computing Center and Cybercore Integration Center, both of which opened in October 2019.

City of Boise Partners with the Energy Policy Institute andIdaho Policy Institute:

The City of Boise recently adopted a target to derive 100 percent of its electricity from clean energy by 2035, a decision informed by research completed by the CAES Energy Policy Institute and Idaho Policy Institute, both based at Boise State University. The two institutes surveyed Boise residents' priorities and practices in areas such as energy savings and fuel sourcing. Among the findings, results showed that 57.5% of respondents strongly agreed with the city's goals to reduce energy use and transition to clean/renewable energy.

Dr. Kathleen Araújo

CAES Energy Policy Institute staff conducts energy training for Mandela Washington Fellowship

CAES Energy Policy Institute (EPI) instructors at Boise State University supported training over the summer for fellows in its Mandela Washington Fellowship for Young African Leaders Program. Dr. Kathleen Araújo, EPI Director, and EPI Senior Research Associate Stephanie Lenhart trained approximately 25 young leaders from the public- and private sector in Sub-Saharan Africa on energy decision-making as part of a six-week training program managed in part by the U.S. Department of Education.

CAES Energy Policy Institute hosts 9th annual conference

The CAES Energy Policy Institute at Boise State University held the 9th annual Energy Policy Research Conference. The theme of the three-day event was "Energy Decision-Making in Times of Disruptive Change," and it focused on the ways in which energy policy is framed, influenced, and evaluated in an era of disruptive change. More than 150 people registered for the event, which included keynote speaker Carol Battershell, the Principal Deputy Director in the Department of Energy's Office of Policy; Mitch Colburn, Resource Planning and Operations Director for Idaho Power; Barbara Lockwood, Vice President of Regulation for Arizona Public Service Company; Boise State University President Dr. Marlene Tromp; and CAES Director Noël Bakhtian. EPI's annual conference examines the drivers and impacts of policy in energy-related systems, allowing attendees to explore issues and opportunities while fostering in-depth cross-cutting exchanges of ideas. It brings together leading researchers, policymakers, industry practitioners, students, and members of the private sector. The conference drew international attendees, including John Kotek, Vice President of Policy Development and Public Affairs with the Nuclear Energy Institute; Zachary Tudor, Associate Laboratory Director at Idaho National Laboratory;

Desmarie Waterhouse, Vice President of Government Relations and Counsel for American Public Power Association; Martin Young, Director of Policy and Risk at World Energy Council; Fouad Khan, Associate Editor for Nature Energy journal; and Steve Hammer, Advisor for World Bank.

CAES represented at climate conference

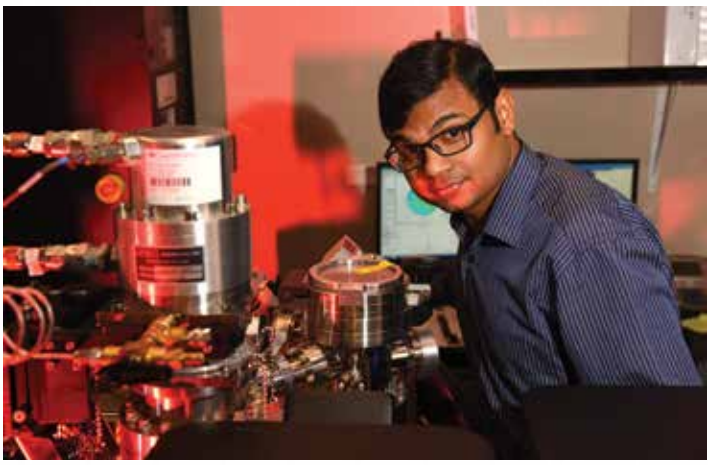
Two CAES-affiliated researchers spoke at a climate conference in New York City in June: Kipp Coddington, Director of Energy Policy & Economics at University of Wyoming's School of Energy Resources, participated in a panel discussion on carbon-dioxide removal at the conference, *Beyond Electricity: Climate Change and the 75% Problem*, and Anne Gaffney, Chief Science Officer for INL's Energy and Environment Science and Technology Directorate, took part in a panel discussion focused on industrial production. Held at AAAS Headquarters in New York City, the conference examined the challenges and potential solutions available in areas in which decarbonization is less obvious than in the electricity sector, where technology and policy options abound, and it featured several high-profile speakers, including former Department of Energy Chief Financial Officer Joe Hezir, now with Energy Futures Initiative; Jacqui Patterson, the Environmental and Climate Justice Program Director at the NAACP; and Kathleen Hogan, former Deputy Assistant Secretary for Energy Efficiency in the DOE Office of Energy Efficiency and Renewable Energy.

CAES represented at energy conference

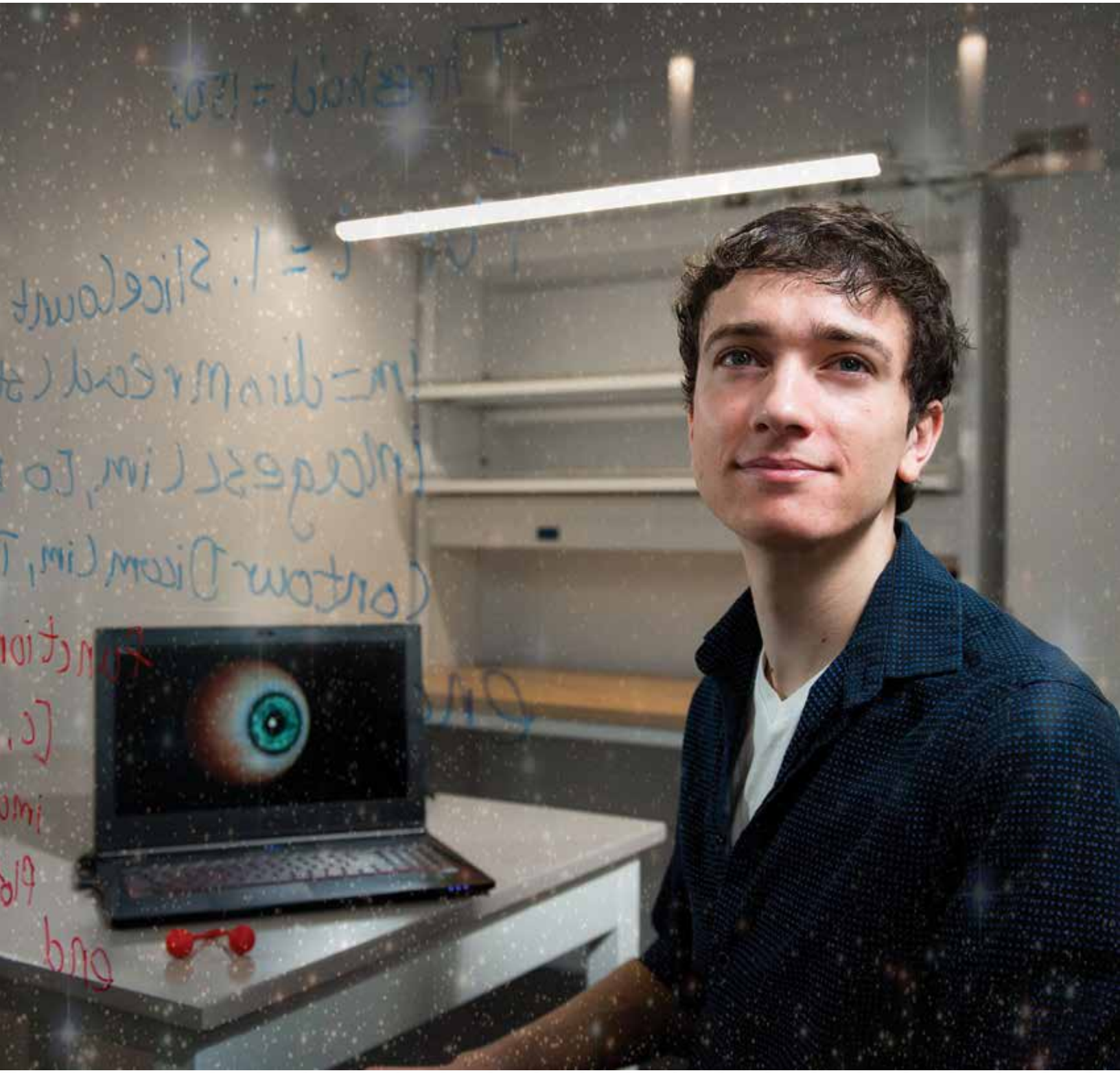
CAES was an exhibitor at the Powering the Future: Energy in the West conference in Boise in late August. The event featured more than 30 presenters from eight states, including CAES Energy Policy Institute Director Dr. Kathleen Araújo, who led a panel discussion at the conference titled The Role of the Science Enterprise and Innovation in Energy Transitions. Among the panelists were Dr. JoAnn Lighty, Dean of Boise State University's College of Engineering, and Dr. John Russell, CAES Associate Director for University of Idaho. Araújo's presentation was called Energy Jobs and Innovation Hubs in Energy Transitions.

CAES invited to inaugural energy summit

CAES was invited to participate in the inaugural University Energy Institute Leadership Summit in Pittsburgh in late September. The summit was sponsored by the Advanced Research Projects Agency-Energy and the Alfred P. Sloan Foundation and focused on the importance of creating and maintaining open channels of communication in order to tout the knowledge and innovation in the energy and environment fields at the nation's universities.



Publications and Proceedings



PUBLICATIONS AND PROCEEDINGS

In fiscal year 2019, CAES-affiliated students, researchers, and faculty from the CAES member organizations published 197 papers, journal articles, reports, and conference proceedings. The following pages include an alphabetized list of the CAES publications and proceedings as reported by each organization's CAES associate director.

Boise State University

1. Araujo, K., Boucher, J., Aphale, O. *A Clean Energy Assessment of Early Adopters in Electric Vehicles and Solar Photovoltaic Technology,* Journal of Cleaner Production.
2. Araujo, K. Distributed generation panel at Association of Public Policy and Management, Fall Conference, Washington DC, November 10, 2018.
3. Araujo, K. Hybrid systems meetings at IAEA, October 22, 2018.
4. Araujo, K. Geothermal Resources Council Annual Meeting, Reno, NV, October 14-17.
5. Araujo, K. Scientific Advisory Board Member for International Energy and Society Conference.
6. Aruajo, K., Boucher, J., Aphale, O. *A Clean Energy Assessment of Early Adopters in Electric Vehicle and Solar Photovoltaic Technology*, Journal of Cleaner Production, 216, 99-116.
7. Araujo, K., Larson, B., Fry, V., Osterhout, G. *Urban Energy Planning: Policy through Consultative Surveys*, Energy Policy Research Conference paper.
8. Araujo, K. Geothermal Resources Council Annual Meeting: Moderated panel on opportunities and challenges for the geothermal industry.
9. Araujo, K. Energy in the West conference: Keynote speaker on regional innovation systems and energy jobs; moderated panel on the role of the science enterprise in energy transitions.
10. Araujo, K. Sun Valley Forum: Speaker on international energy transitions; panelist on energy.
11. Araujo, K., Larsen, B., Osterhout, G., Crossgrove-Fry, V. *Boise's Energy Future: Survey and Technical Report*, to inform Boise City Council's decision to adopt 100% clean electricity targets by 2035.
12. Babinkostova, L., Pansera, B.A. *Selective versions of theta-density*, Topology and its Applications 258 (2019), 268 – 281.
13. Bahr, C., Kim, Y.H., Neyman, E., Taylor, G.K. *Anomalous Primes and the Elliptic Korselt Criterion*, Journal of Number Theory (2019), in press.
14. Estrada, D., Pandhi, T., Kreit, E., Aga, R., Fujimoto, K., Mohammad, S., Khademi, S., Chang, A.N., Xiong, F., Koehne, J., Heckman, E.M. *Emerging 2D Nanomaterials for Additive Manufacturing of Space-Grade Flexible Electronics*, 69th International Aeronautics Congress (IAC), (Bremen, Germany; Oct. 2018)
15. Estrada, D. *Emerging Materials for Additive Manufacturing of Flexible Hybrid Sensors*, Americas International Meeting on Electrochemistry and Solid State Science (Cancun, Mexico)
16. Estrada, D. *Graphene as Biomaterial for Defense Applications*, International Society for Optics and Photonics (SPIE) Security and Defence Conference (Berlin, Germany)
17. Estrada, D., Hollar, C., Fleming, A., Davis, K., Budwig, R., Jensen, C. *A Parametric Study of a Transient, Multilayer Analytical Model of In-Pile Thermal Conductivity Measurements using the Needle Probe*, International Journal of Thermal Sciences, 145, 106028 (2019).

18. Estrada, D., Hollar, C. Fleming, A., Davis, K., Budwig, R., Jensen, C. *A Parametric Study of a Transient, Multilayer Analytical Model of In-Pile Thermal Conductivity Measurements using the Needle Probe*, International Journal of Thermal Sciences, in revision.
19. Estrada, D., Hollar, C., et al. *High-Performance Flexible Bismuth Telluride Thin Film from Solution Processed Colloidal Nanoplates*, ACS Applied Energy Materials, in review.
20. Estrada, D., Varghese, T., Dun, C., Kempf, N., Saeidi-Javash, M., Richardson, J., Zhang, Y. *Bulk Like Thermoelectric Performances of Flexible Devices by Scalable Printing and Liquid-Phase Sintering*, ACS Energy Letters, in review.
21. Estrada, D., Fujimoto, K., Unruh, T., Fujimoto, A., Cornwell, C., McMurtrey, M., Subbaraman, H. *Aerosol Jet Printing o In-Pile Passive Temperature Sensors*, International Conference on Advancements in Nuclear Instrumentation Measurement Methods and Applications (ANIMMA), (Portoroz, Slovenia; Jun. 2019).
22. Estrada, D., Fujimoto, K., Pandhi, T., Mansoor, N-e, Muramutsa, F., Subbaraman, H. *Emerging Nanomaterial Inks for Additive Manufacturing of Wearable Sensors*, 235th Electrochemical Society Meeting, (Dallas, TX)
23. Estrada, D., Mansoor, N-e, Muramutsa, F., Schuck, C., Subbaraman, H., Pandhi, T., Gogotsi, Y. *Aerosol Jet Printing of Ti3C2 MXene Aqueous Ink*, 235th Electrochemical Society Meeting, (Dallas, TX)
24. Estrada, D., Hollar, C., Fleming, A., Davis, K.L., Budwig, R., C. Jensen, C. *Analytical Modeling of In-Pile Thermal Conductivity Measurements Using a Line Heat Source*, International Conference on Advancements in Nuclear Instrumentation Measurement Methods and Applications (ANIMMA), (Portoroz, Slovenia).
25. Flores, A.N., Pandit, K., Dashti, H., Glenn, N. F., Maguire, K. C., Shinneman, D. J., Flerchinger, G. N., and Fellows, A. W. (2019), *Optimizing shrub parameters to estimate gross primary production of the sagebrush ecosystem using the Ecosystem Demography* (EDv2.2) model, Geosci. Model Dev.
26. Flores, A.N., Dashti, H., Poley, A., Glenn, N. F., Ilangakoon, N. T., Spaete, L., Roberts, D., Enterkine, J., Ustin, S. L., Mitchell, J. J. (2019), *A multi-method, multi-sensor approach for regional scale vegetation classification in drylands*, Remote Sensing, 11(18), 2141.
27. Flores, A.N., Sadegh, M., AghaKouchak, A., Mallakpour, I., Nikoo, M.R. *A Multi-Model Nonstationary Rainfall-Runoff Modeling Framework: Analysis and Toolbox*, Water Resources Management,
28. Flores, A.N., Dashti, H., Glenn, N.F., Ustin, S., Mitchell, J.J., Ilangakoon, N.T., Silvan-Cardenas, J., Zhao, K., Spaete, L.P., and de Graaff, M.A. *Empirical Methods for Remote Sensing of Nitrogen in Drylands May Lead to Unreliable Interpretation of Ecosystem Function, IEEE Transactions on Geoscience and Remote Sensing*, accepted.
29. Flores, A.N.,et al,. *Yamazaki, Structures and Functions of Hillslope Hydrology with Relevance to Earth System Modeling: Syntheses and Testable Hypotheses, Water Resources Research*, accepted.
30. Flores, A.N., Steimke, A.L., B. Han, B., and Brandt, J.S, *Climate Change and Curtailment: Evaluating Water Management Practices in the Context of Changing Runoff Regimes in a Snowmelt-Dominated Basin*, Water, 10, 1490.
31. Flores, A.N. Global Change Assessment Model annual science meeting, College Park, MD. Hosted by Joint Global Change Research Institute (JGCRI) of Pacific Northwest National Laboratory.
32. Flores, A. Nelsen Lecture, Syracuse University Department of Earth Sciences, *Modeling Integrated Hydro-terrestrial Environments at Human-relevant Scales*.
33. Gardner, J., Schwartz, R., Kuwada, J. *Mesh Network Communications for Robust Aggregation of Distributed Resources*, presented at the 9th Energy Policy Research Conference, Boise ID, 2019.
34. Gardner, J.F., Sukjoon, O. *Large scale energy signature analysis: Tools for utility energy efficiency programs*, Electric Power Systems Research, in review.
35. Gardner, J. CEERI Director participated in the 2019 TEDxBoise conference. *What if Fossil Fuels had Never Existed*.
36. Jankowski, E., et al. *Perspective on Coarse-Graining, Cognitive Load, and Materials Simulation. Comp. Mater*. Sci. 169, 109129 (2019).
37. Jankowski, E., Miller, E. D., Jones, M.L., Henry, M. M., Stanfill, B. *Machine learning predictions of electronic couplings for charge transport calculations of P3HT*. (2019).
38. Jaques, B., Bateman, A., Rodriguez, Y., Schoensee, L., Phero, T., Han, K.B., Nachlas, J., Steppan, J., Nair, B. *Seal ring method for high-temperature, high-pressure metal to ceramic transitions*.

39. Jaques, B., Charit, I., Kundu, A., Jiang, C. *Effect of rare earth oxides on the microstructure and mechanical behavior of Fe-Cr based alloys processed via spark plasma sintering*.

40. Jaques, B., Kundu, A., Jiang, C., Sittiho, A., Charit, I. *Development of Fe-9Cr Alloy via High Energy Ball Milling and Spark Plasma Sintering for Fast Reactor Fuel Cladding Material*. Submitted to the Journal of Nuclear Materials. 18 December 2018.

41. Jaques, B., Kundu, A., Instasi, S., I. Charit, I., and Jiang C. *A Preliminary Study on the Development of a Fe-9Cr Model Alloy via High Energy Ball Milling and Spark Plasma Sintering*. Submitted to the Journal of Alloys and Compounds (06 November 2018).

42. Jaques, B. 2018 University Turbine Systems Research Project Review Meeting. Daytona, FL. October 31, 2018. B.J. Jaques co-presented *Development of a Novel Ceramic-to-Metal Seal for High-Temperature, High-Pressure Applications*.

43. Jaques, B., et al. Materials Science and Technology 2018 Conference. Columbus, OH. October 14-18, 2018. B.J. Jaques authored or co-authored 3 presentations: Oxidation behavior of Zr-alloy cladding candidates for the TREAT reactor LEU fuel core.

44. Jaques, B., Rodriguez, Y., Phwero, T.L., Schoensee, L., Bateman, A., Han, K.B., Steppan, J., Nachlas, J. Poster presentation: *Diffusion Studies for Ceramic-to-Metal Joining for Heat Exchanger Applications*. Materials Science and Technology 2018 Conference. Columbus, OH. October 14-18, 2018.

45. Jaques, B., Lupercio, A.E., Watkins, J.K., Foster, J.G. Poster presentation: *Transverse Rupture Strength of Ceria as a Surrogate Nuclear Fuel*. Materials Science and Technology 2018 Conference. Columbus, OH. October 14-18, 2018.

46. Jaques, B., Butt, D.P., Watkins, J.K. *Hydrothermal Corrosion of UN and UN-UO2 Nuclear Fuels*. Journal of Nuclear Materials. Vol. 518, pp. 30-40, 2019.

47. Jaques, B. 11th annual Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies (NPIC-HMIT 2019) Conference. Orlando, FL. February 9-14, 2019. Jaques was a panelist for the In-Pile Instrumentation Development for Test Reactor Experiments Panel.

48. Jaques, B., Riley, S., Perrine, B., Sikorski, E., Skifton, R., Li, L. *Development and performance of high temperature irradiation resistant thermocouples*. Presented at the Materials Science and Technology 2019 Conference. Portland, OR. September 29-October 3, 2019.

49. Jaques, B., Rodriguez, Y., Phero, T., Bateman, A., Han, K., Steppan, J., Nair, B. *Study of solid-state reactions in diffusion bonded Inconel 600 to SiC with metallic interlayers*. Presented at the Materials Science and Technology 2019 Conference. Portland, OR. September 29-October 3, 2019.

50. Jaques, B., Bateman, A., Monpara. G., Fertig, R., Wu, Y. *Linking microscale experiments and modeling to predict macroscale mechanical properties in iron*. Presented at the Materials Science and Technology 2019 Conference. Portland, OR. September 29-October 3, 2019.

51. Jaques, B., Winters, R., Lupercio, A., Doyle, C., Kiggans, J., Nelson, A.T. *Synthesis and Mechanical Testing of CeO2 as a Surrogate Nuclear Fuel*. Presented at the Materials Science and Technology 2019 Conference. Portland, OR. September 29-October 3, 2019.

52. Jaques, B., Watkins, J.K., Sikorski. E., Li, L. *Improved hydrothermal corrosion resistance of UN fuel forms via addition of metallic constituents*. Presented at the American Nuclear Society (ANS) supported Top Fuel 2019: Light Water Reactor Fuel Performance Conference. Seattle, WA. September 22-26, 2019.

53. Jaques, B., et al. *Oxidation behavior of Zr-alloy cladding candidates for the TREAT reactor*. Presented at the American Nuclear Society (ANS) supported Top Fuel 2019: Light Water Reactor Fuel Performance Conference. Seattle, WA. September 22-26, 2019.

54. Jaques, B., Efaw, C.M., Reynolds, M., Vandegrift, J., Smith, K., Wu, Y., Hu, H., Xiong, H., Hurley, M.F. *Determination of Zircaloy oxide chemistry through complimentary characterization techniques*. Presented at the American Nuclear Society (ANS) supported Top Fuel 2019: Light Water Reactor Fuel Performance Conference. Seattle, WA. September 22-26, 2019.

55. Jaques, B., Lupercio, A., Doyle, C., Winters, R.C., Nelson, A.T. *Transverse rupture strength of cerium dioxide as a surrogate nuclear fuel*. Presented at the American Nuclear Society (ANS) supported Top Fuel 2019: Light Water Reactor Fuel Performance Conference. Seattle, WA. September 22-26, 2019.

56. Jaques, B.J., Li, L., Sikorski, E., Watkins, J.K. *Improved Hydrothermal Corrosion Resistance of UN Fuel Forms via Addition of Metallic Constituents*. Proceedings of the American Nuclear Society (ANS) supported Top Fuel 2019: Light Water Reactor Fuel Performance Conference, Seattle, WA, September 22-26, 2019.

57. Jaques, B.J., Vandegrift, J.L., Efaw, C., Price, P.M., Parga, C., Butt, D.P., Coryell, B., Hurley, M.F. *Oxidation Behavior of Zr-Alloy Cladding Candidates for the TREAT Reactor*. Proceedings of the American Nuclear Society (ANS) supported Top Fuel 2019: Light Water Reactor

Fuel Performance Conference, Seattle, WA, September 22-26, 2019.

58. Jaques, B., Wu, Y., Efaw, C.M., Reynolds, M., Vandegrift, J., Smith, K., Hu, H., Xiong, H., Hurley, M.F. *Determination of Zircaloy Oxide Chemistry Through Complimentary Characterization Techniques*. Proceedings of the American Nuclear Society (ANS) supported Top Fuel 2019: Light Water Reactor Fuel Performance Conference, Seattle, WA, September 22-26, 2019.
59. Jaques, B., Sikorski, E.L., DaSilca, T.H., Aegesen, L. Li, L. *First-principles Comparative Study of UN and Zr Corrosion*, Journal of Nuclear Materials, Accepted in June 2019.
60. Jaques, B., Vandergrift, J.L., Price, P.M., Van Rooyen, I.J., Morrell, S., Butt, D.P. *Oxidation Behavior of Zirconium, Zircaloy-3, Zircaloy-4, Zr-1Nb, and Zr-2.65Nb in Air and Oxygen*. Nuclear Materials and Energy. 2019.
61. Jaques, B., Charit, I., Jiang, C., Kundu, A., Sittiho, A. *Development of Fe-9Cr Alloy via High Energy Ball Milling and Spark Plasma Sintering*. The Journal of The Minerals, Metals, and Materials Society. 2019.
62. Jaques, B., Li, L., Sikorski, E., Aafesen, L. *First-principles Comparative Study of UN and Zr Corrosion*. Journal of Nuclear Materials. Sent to production June 6t, 2019.
63. Jaques, B. International conference on Advancements in Nuclear Instrumentation Measurement Methods and their Applications (ANIMMA). Protoroz, Slovenia. June 17-21, 2019.
64. Kuwada, J. and Gardner, J. *Swarm Behavior to Mitigate Demand Rebound with AC Demand Response Events*. 9-219 ASHRAE Technical Conference, Boise Idaho, 5 April 2019.
65. Lawson, M., Horn, J., Wong-Ng, W., Espinal, L., Lapidus, S.H., Nguyen, H.G., Meng, Y., Suib, S.L., Kaduk, J.A., Li, L. Invited cover paper, *First-principles study of carbon capture and storage properties of porous MnO2 octahedral molecular sieve OMS-5, Powder Diffraction*, 34, 13-20, 2019.
66. Larsen, B., Osterhout, G., Crossgrove-Fry, V. and Araujo, K., (2019). *Boise's Energy Future*, Technical Report.
67. Lawson, M., Williamson, I., Ong, Z-Y, Li, L. *First-Principles Analysis of Structural Stability, Electronic and Phonon Transport Properties of Lateral MoS2-WX2 Heterostructures*, Computational Condensed Matter, 19, e00389 (9pp), 2019.
68. Lenhart, S. presented on community-level solar in public power and rural cooperatives, Association of Public Policy and Management, Fall Conference, Washington DC, November 10, 2018.
69. Lenhart, S. *Driving Innovation for a secure and Prosperous Idaho*, sponsored by the Sun Valley Institute for Resilience; Boise, ID, October 10, 2018.
70. Lenhart, S. Joint Committee on Regional Electric Power Cooperation (CREPC)-Western Interconnection Regional Advisory Body (WIRAB) Meeting, Phoenix, AZ, October 24-26, 2018.
71. Lenhart, S., Chan, G., Forsberg, L., Grimley, M., and Wilson, E. (February 2019). *Barriers and Opportunities for Distributed Energy Resources in Minnesota's Municipal Utilities and Electric Cooperatives*, Final Research Report.
72. Lenhart, S., Nelson-Marsh, N. *An eye toward the future: Adaptive and transformative resilience in interorganizational collaborations*, submitted for special edition for the Journal of Applied Communication Research.
73. Lenhart, S., Chan, G., Grimely, M., Wilson, E. Submitted- Draft Chapter: *Comparing and contrasting the Institutional Relationships, Regulatory Frameworks, and Energy System Governance of European and U.S. Electric Cooperatives*, Routledge Handbook of Energy Democracy.
74. Lenhart, S., presented *Innovation in Community Electric Power: Constraining and Enabling Distributed Energy Resource*, International Sustainability Transitions Conference, June 2019, Carleton University.
75. Li, L. *Materials Design for Energy and Sustainability*, 2019 TMS (The Minerals, Metals & Materials Science), San Antonio, TX, Mar 2019.
76. Li, L. *Computational Discovery and Design of 2D Transition Metal Dichalcogenide Heterostructures*, 2019 TMS, San Antonio, TX, Mar 2019.
77. Li, L. *Tuning Transition Metal Dichalcogenide Heterostructure Transport Properties*, 2019 TMS, San Antonio, TX, Mar 2019.
78. Li,L., Fothergill, J. W., Hernandez, A. C., Knowlton, W., Yurke, B. *Ab-Initio Studies of Exciton Interactions of Cyanogen Dye Aggregates*, Journal of Physical Chemistry A, 122, 8989-8997, 2018.
79. Li, L., Sikorski, E.L., da Silva, T.H., Aagesen, Larry, Jaques, B. *First-principles Comparative Study of UN and Zr Corrosion*, Journal of Nuclear Materials, Resubmitted in Nov, 2018, now under revision.
80. Li, L., da Silva, T. H., Butler D., Biaggne A., Kandadai N., Subbaraman H., Daw J. *First-Principles Studies of Dopant and Radiation Defect Effects on Optical Fiber Sensors*, submitted to the peer-reviewed proceedings for 11th Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies (NPIC&HMIT) conference, now under review.

81. Li, L., Lawson, M., Horn, J., Wong-Ng, W., Espinal, L., Lapidus, S.H., Nguyen, H.G., Meng, Y., Suib, S. L., JKaduk, J.A. *First-Principles Studies of Octahedral Molecular Sieves OMS-2 and OMS-5 for Carbon Dioxide Capture and Storage Applications*, invited paper by a special issue of the journal Power Diffraction on "Crystallography and Properties of Metal Organic Framework (MOF) Compounds," now under review.

82. Li, L. *Materials-by-Design for Electronic and Energy Applications*, seminar at University of Tennessee, Knoxville, TN, Nov 2018.

83. Li, L. *Porous Manganese Dioxide Octahedral Molecular Sieve (OMS)*, 2018 MS&T (Materials Science and Technology), Columbus, OH, Oct 2018.

84. Li, L. *Strain Effect on Electrical and Thermal Transport Properties of 2D Transition Metal Dichalcogenide Heterostructures*, 2018 MS&T, Columbus, OH, Oct 2018.

85. Li, L. *Uranium Nitride Corrosion and High-Temperature Irradiation Resistant Thermocouples*, 2018 MS&T, Columbus, OH, Oct 2018.

86. Li. L. Lawson, M. Horn, J., Espinal, L., Meng, Y, Nguyen, H.G., Wong-Ng, W., Lapidus, S.H., Suib, S.L., Kaduk, J.A. Invited paper *Carbon Capture and Storage Properties of Octahedral Molecular Sieve OMS-5*, a special issue of the journal Power *Diffraction* on "Crystallography and Properties of Metal Organic Framework (MOF) Compounds," Accepted, 2019.

87. Li, L., Efaw, C.M., Da Silva, T., Davis, P.H., Graugnard, E., Hurley, M.F. *Toward Improving Ambient Volta Potential Measurements with SKPFM for Corrosion Studies*, Journal of The Electrochemical Society, 166, C1-C10, 2019.

88. Mikova, M. Presented plenary talk *Amorphous and Nanostructured Chalcogendies (ANC9)* - Chisinau Moldova June 30-July 4, 2019.

89. Scheepers, M., Pansera, B.A. *Selective versions of theta-density, Topology and its Applications 258* (2019), 268-281.

90. Sikorski, E., Da Silva, T.H., Aagesen, L., Jaques, B., Li, L. *First-principles Comparative Study of UN and Zr Corrosion*, Journal of Nuclear Materials, 523, 402-412, 2019.

91. Subbaraman, H, S. Rana, S., Kandadai, N. *Role of Metal Coating Parameters on the Reflective Long Period Grating Spectrum*, OSA Conference on Optics and Photonics for Sensing the Environment, ETH1A.5 (2019)

92. Subbaraman, H., Simon, A., Ullah, S.M.R., Badamchi, B., Mitkova, M. *Materials Characterization of Thin Films Printed with Ge20Se80 Ink*, Microscopy and Microanalysis, 25(S2), 2606-2607 (2019)

93. Williamson, M. Lawson, S. Li, Y. Chen, and L. Li, *Metal-Site Dopants in Two-Dimensional Transition Metal Dichalcogenides*, 2019 IEEE-WMED Conference Proceedings, Apr 2019, DOI: 10.1109/WMED.2019.8714147.

94. Wu, Y., Jaques, B.J., Bateman, W.A., Burns, J. *Push to Pull Method for Quantitative In-Situ TEM Tensile Testing*, in preparation. Wu, Y.

95. Wu, Y., Mao, Keyou, Sun, Perez, Emmanuel, Wharry, Janelle, P. *Laser weld-induced formation of amorphous Mn-Si precipitate in 304 stainless steel*, Materialia, 3, 174-177, November 2018.

96. Wu, Y., Burns, J., et al. *Microstructure and mechanical properties of neutron-irradiated alloy D9 and NF709 stainless steels*, submitted to The 10th International Conference on Advanced Materials and Processing, August 18-22, 2019, Xi'an, China. Wu, Y.

97. Wu, Y. et al. *Microstructure and mechanical properties of ATR-irradiated Alloy D9 and NF709*, The Nuclear Materials Conference 2018, Seattle, WA.

98. Wu, Y., Burns, J., Jaques, B. Bateman. *Push to Pull Method for Quantitative In-Situ TEM Tensile Testing*, submitted to Microscopy and Microanalysis.

99. Wu, Y., Estrada D., et al. *High-Performance Flexible Bismuth Telluride Thin Film from Solution Processed Colloidal Nanoplates*, submitted to Nano Letters. Wu, Y

100. Wu, Y., Yano, K.H., Wharry, J.P. *Size Effects in TEM in situ Cantilever Flow Stress Measurements in Irradiated Fe-9%Cr ODS*, in preparation.

101. Wu, Y., Burns, J., Chen, T., He, L., Knight, C., Sridharan, K., Xu, H. Tan, L. *Correlation between the nanoindentation mechanical properties and neutron-damaged microstructures of austenitic alloys*, TMS 2019, San Antonio, TX, USA, March 10-14, 2019.

102. Wu, Y., Patki, P., Wharry, J. *Qualitative Analysis and Modelling of Deformation in Proton Irradiated Nanocrystalline Copper Tantalum Alloy*, TMS 2019, San Antonio, TX, USA, March 10-14, 2019.

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104. Wu, Y., Jaques, B., Bateman, A., Monpara, G. Fertig, R. *Linking microscale experiments and modeling to predict macroscale mechanical properties in iron*, submitted to MS&T 2019.

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161. Mashal, M., Shokrgozar, A. *The Mw 5.3 Sulphur Peak Earthquake in Soda Springs, Idaho*: Perspectives from Earthquake Engineering

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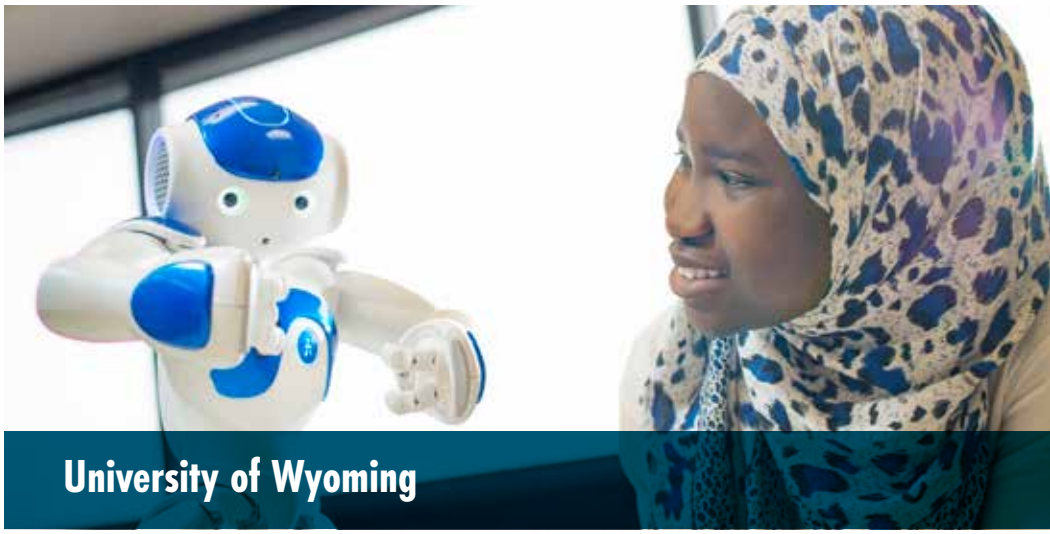

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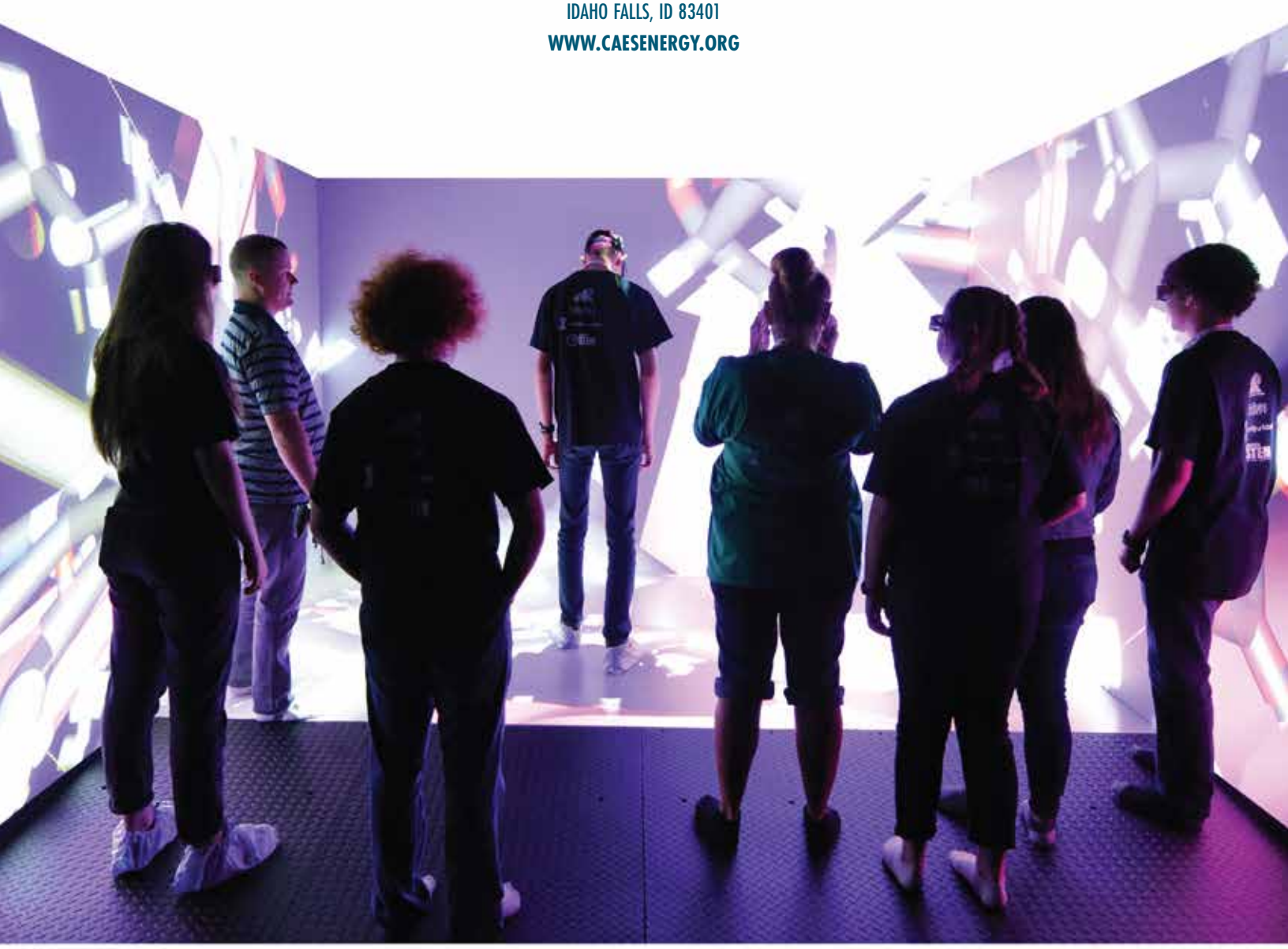

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