

2017

ANNUAL REPORT

OCTOBER 1, 2016
THROUGH
SEPTEMBER 30, 2017



Message from the Director:

When I came to the Center for Advanced Energy Studies (CAES) in May 2017, I was immediately impressed by the collaborative nature that exists here. From its founding, CAES was established to strengthen relationships between academia, industry, and national laboratories so the world's increasingly complex energy challenges can be identified and solved, in partnership.

The CAES model is effective because our affiliated institutions are committed to a collaborative approach that recognizes and utilizes the distinctive capabilities of each organization. CAES is a classic example of an organization that is stronger together than each of its individual parts. Backed by our five affiliated institutions — Idaho National Laboratory, Boise State University, Idaho State University, the University of Idaho, and the University of Wyoming — CAES has become a place where world-renowned researchers interact daily with university faculty, and where high-achieving students receive hands-on experience, increasing our collective impact, igniting innovation, strengthening the regional workforce, and creating a new generation of energy professionals.

After more than a decade of performing collaborative energy research, CAES will spend 2018 reviewing and refreshing our strategic direction to make sure it continues to align with university, laboratory, and regional needs. This fall, I made visits to all four CAES universities, meeting with their leadership, professors, and students. It was rewarding to hear that such diverse institutions are united by a common desire to be part of CAES' success. The collaboration, cohesion, and shared vision that are essential to our mission remain strong.

A significant development this last year was a reorganization within Idaho National Laboratory (INL) that made CAES a full INL directorate, on the same level as the laboratory's Nuclear Science & Technology (NS&T), National & Homeland Security (N&HS), Energy and Environment Science & Technology (EES&T), Materials & Fuels Complex (MFC), and the Advanced Test Reactor (ATR) research organizations. This realignment gives further prominence and accountability to our work, while also broadening our network of CAES collaborators, specialized equipment, and unique facilities.

Each day, we make progress fulfilling CAES' foundational vision, but our full potential is still ahead of us. The CAES team continues to put in place the capabilities to enable "win-wins" and set a foundation for a new period of innovation and growth. This is a place to think big, but it all comes down to our people, and the pride they take in what they're doing. I am delighted to be associated with so many remarkable researchers, both seasoned and newly minted, but all game-changing. What we do every day makes a difference, and I'm convinced it will all add up to something extraordinary.

Sincerely,

Noël Bakhtian, Director of CAES

.....
ON THE COVER: VISIBLE SCRATCHES ARE
SEEN ON A STEEL AND ZIRCONIUM METAL
SAMPLE PRIOR TO POLISHING INSIDE THE
CAES ADVANCED MATERIALS LABORATORY.
.....

FY 2017 | By the Numbers

INVESTMENTS

\$3M

STATE OF IDAHO INVESTMENT IN CAES

\$7.7M

IDAHO NATIONAL LABORATORY'S INVESTMENTS IN CAES OPERATIONS AND INFRASTRUCTURE

\$788,308

LABORATORY DIRECTED
RESEARCH
AND DEVELOPMENT

\$493,009

CAVE EQUIPMENT
UPGRADES

OUTREACH

130

CAES PUBLICATIONS AND PROCEEDINGS

9

COLLABORATIVE PLANNING
MEETINGS HOSTED BY CAES

1,119

VISITORS TO THE CAES CAVE 3-D IMMERSION RESEARCH ENVIRONMENT

STUDENT IMPACT

76

STUDENTS FROM CAES UNIVERSITIES INTERNEED AT INL IN AREAS INCLUDING NUCLEAR ENGINEERING, BIOLOGICAL SCIENCES, COMPUTER SCIENCE AND MECHANICAL ENGINEERING, PLUS:

12

JOINT APPOINTMENTS
FROM CAES
UNIVERSITIES

5

INL GRADUATE
FELLOWS FROM CAES
UNIVERSITIES

3

POSTDOCTORAL
RESEARCHERS FROM
CAES UNIVERSITIES

Regional Leadership

Wastewater Treatment, Recycling and Energy Research

CAES and the Northwest Food Processors Association (NWFPA) co-hosted a meeting in February 2017 to address challenges with wastewater treatment and energy consumption in food processing, one of the Northwest's biggest industries. The Boise meeting convened more than 30 researchers from government, national laboratories, industry and academic institutions to discuss challenges in wastewater management and energy efficiency. Attendees and speakers included representatives from the Idaho Department of Commerce, 12 companies and researchers from all CAES member institutions.

DID YOU KNOW?

NWFPA IS A TRADE ASSOCIATION OF MORE THAN 140 PROCESSOR COMPANIES AND 350 SUPPLIERS INCLUDING CHOBANI, CLIF BAR, AND THE J.R. SIMPLOT COMPANY.

Intermountain Energy Summit

CAES was a presenting sponsor for the 2017 Intermountain Energy Summit Aug. 8-9 in Idaho Falls. CAES Director Noël Bakhtian was given the honor of introducing featured speaker Laura Holgate of the Belfer Center for Science and International Affairs. Her talk was entitled "Virtuous circles: Linking business and nuclear security." Mike Hagood, INL Regional Initiatives director and former acting CAES director, moderated the panel discussion "Nuclear Energy Re-imagined: Innovation in Applications," which featured panelists Simon Irish, CEO of Terrestrial Energy; Mark Peres, Fluor's executive project director; Dr. Ashley Finan, Nuclear Innovation Alliance; and Dr. Richard Boardman, Idaho National Laboratory.



INL DIRECTOR MARK PETERS INTRODUCES A SPEAKER AT THE INTERMOUNTAIN ENERGY SUMMIT.

The breakout discussion, "Re-imagining Regional Coal Development," was moderated by Mark A. Northam, founding director University of Wyoming's School of Energy Resources. Richard A. Horner, who has headed UW's Special Projects and Technology Directorate since 2015, was a panelist. The University of Wyoming has been a member of CAES since 2014.

Produced Water and Rare- Earth Elements

Representatives from all CAES institutions participated in a working group on June 26 at University of Wyoming. The event focused on identifying methods for optimizing the secondary value in produced water and rare-earth elements associated with oil and gas production, including hydraulic fracturing. Forthcoming white papers could be further developed into research proposals. Coordinators included Kipp Coddington (UW director, Carbon Management Institute), Jon Brandt (UW professor, director, Center of Excellence for Produced Water Management), Bill Bellamy (VP CH2MHill & UW professor of Practice), Travis McLing and Rob Podgorney (both INL). Forthcoming white papers will outline key objectives to optimize produced water utilization and rare earth production as a base for regional economic development.

25

THE NUMBER OF FACULTY,
STAFF, AND GRADUATE STUDENTS WHO
ATTENDED THE PRODUCED WATER/RARE-
EARTH ELEMENT MANAGEMENT
WORKING GROUP

Collaborative Meetings and Seminars

In FY 2017, CAES hosted, sponsored or participated in dozens of meetings that attracted researchers from the region and beyond. Here is a partial list of events that took place at CAES.

- Acid Transport Modeling Using the Finite Element Method (FEM)
- Advancing Energy Innovation Through Proper Data Management
- Advancing Marine and Hydrokinetic Energy Technology Through Materials
- Brown-bag Session: Gates, Guards and Geeks: The Changing Face of Nuclear Security
- Social-Ecological and Technological Systems Science and the New Energy Landscape
- CAES Energy Policy Institute 2017 Research Conference
- Carbon Engineering
- CyberSecurity Energy Connected
- DOE Nuclear Energy University Program call for proposals collaborative meeting
- Geothermal Energy: Here and Now: Sustainable, Clean, Flexible
- Heat, fluid flow and mechanics in MOOSE: The Porous Flow module
- International Conference on Probabilistic Methods Applied to Power Systems (PMAPS)
- Connecting research with DOE Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) opportunities
- Microstructure and in-pile sensors
- Northwest Energy Coalition NW Clean & Affordable Energy Conference
- Produced Water and Rare Earth Elements Planning Meeting
- Public Water Supply: How Much Energy Does It Take?
- INL LDRD Annual Poster Session
- My Amazing Future
- Engineering Your Future
- Lab-Bridge seminar on technology commercialization
- Lab-Bridge Pitch Competition
- Report on the Western Idaho Nuclear Complex
- Scintillator Neutron Detectors for Nuclear Science and Security
- The I-Ching: Ancient Chinese Philosophy Interconnected to Modern Science and Technology
- Thoughts on Developing Fuels & Materials for Advanced Nuclear Reactors
- Transient Kinetic Approach to Catalytic Materials for Energy-Efficient Routes to Ammonia, Ethylene and Related Chemicals
- Development of a Novel Rectenna-Based Waste Heat Harvesting Device: A DOE-ARPAe Approach
- University of Idaho Engineering Design EXPO
- Waste Water Treatment/Recycling and Energy Research for the Food Processing Industry
- Web Applications for Identifying Inefficiencies in City Water Systems

New Leadership

2017 saw some new faces added to the CAES leadership team.



Noël Bakhtian

Noël Bakhtian was hired as CAES director in May, replacing interim director Mike Hagood. Bakhtian most recently served as a senior policy adviser for environment and energy in the White House Office of Science and Technology Policy. She has also held technical positions with the U.S. Department of Energy. She earned her engineering doctorate at Stanford University's Department of Aeronautics and Astronautics; holds masters' degrees from Stanford University and the University of Cambridge, where she was a Churchill Scholar; and completed her bachelor's degree in mechanical engineering and physics at Duke University.



Anita Gianotto

Anita Gianotto was hired as CAES chief operating officer in October, replacing interim COO Gary Gresham. Previously, she served as INL's Energy and Environment Science & Technology (EES&T) manager for Research Operations. Anita actively managed the EES&T Laboratory Directed Research and Development (LDRD) portfolio and coordination of two EES&T strategic documents (INL Lab Agenda and Lab Plan). Prior to her role in EES&T, she served as the INL LDRD program manager and INL Research Management System lead gaining extensive experience in management of research operations. She has over 25 years of hands-on research experience in analytical chemistry focusing on mass spectrometric analyses and other analytical instrumentation. Anita earned her Bachelor and Master of Science in microbiology from Idaho State University.



Ethan Huffman

Ethan Huffman was hired as CAES lead for Communications and Legislative Affairs in October. Huffman previously worked for U.S. Congressman Mike Simpson working closely with state and federal agencies, county commissioners, non-profit organizations, and business leaders across eastern Idaho. He also worked for the Idaho National Laboratory from 2004 to 2012. Huffman holds a bachelor's degree in mass communication from Idaho State University and a master's degree in communication and leadership studies from Gonzaga University.

Amy Moll came on as Boise State University's associate CAES director, replacing David Solan. Moll has been with Boise State since 2000, most recently serving as dean of the College of Engineering. She holds a bachelor's degree in ceramic engineering from the University of Illinois, and earned her master's and doctorate in materials science and engineering from the University of California at Berkeley. In 2015, she was honored with a "100 Inspiring Women in STEM" Award from Insight Into Diversity magazine.



Amy Moll

Richard Christensen was appointed interim associate director for the University of Idaho when former Associate Director Tom Wood retired. A faculty member and director of UI's Nuclear Engineering program in Idaho Falls, Christensen joined the UI and CAES family in 2015, bringing in 17 new full-time graduate students. He was awarded two Department of Energy Nuclear Energy University Program grants, collaborating with the University of Michigan and the University of Wisconsin, and is working with two nuclear startup companies on novel nuclear facilities. Christensen will serve as associate director until a national search for a permanent replacement is complete.



Richard Christensen

Ed Synakowski, the new vice president of Research at the University of Wyoming, was appointed to the CAES Steering Committee following the retirement of former Wyoming VPR Bill Gern. Synakowski is the former DOE associate director of Science for Fusion Energy Sciences. A Fellow of the American Physical Society and the Institute of Physics, he has authored over 150 refereed publications. Synakowski received his Ph.D. in physics at the University of Texas at Austin and a Bachelor of Arts degree from the Johns Hopkins University.



Ed Synakowski

At the CAES Energy Policy Institute, **Harold Blackman**, the associate vice president of Research at Boise State University, took the helm as interim director. Former EPI Director David Solan accepted a senior advisory role at the U.S. Department of Energy. When CAES headquarters opened in early 2009, Blackman was the institution's second director, building meaningful relationships among leadership, faculty, staff, and students across all the affiliated institutions.



Harold Blackman

New Research Staff

University Idaho

Amin Mirkouei and **Alex Vakanski** joined CAES in industrial technology tenure track positions. **David Arcilesi** joined CAES in a mechanical engineering tenure track position, and **Dakota Roberson** is involved in an electrical and computer engineering effort with the Idaho Global Entrepreneurial Mission (IGEM).

Idaho State University

Leslie Kerby and **Haiming Wen** joined CAES as ISU/INL joint appointments for nuclear science and engineering. They each bring new capabilities to our Nuclear Science and Engineering research program. Kerby is engaged in modeling and simulation activities for nuclear and other energy systems, including neutronics, while Wen studies the behavior of irradiated nuclear fuel materials and related areas. Wen left ISU in August. **Mason Jaussi** (right) also joined CAES supporting safety efforts.

ISU'S MASON JAUSSI JOINED CAES TO SUPPORT SAFETY EFFORTS.





Boise State University

Cassandra Koerner joined EPI in January 2017 as project coordinator, providing key research support and coordinating work among affiliated collaborators. In the public and private sectors, Koerner has worked on several regional environmental impact projects as a researcher, technical writer and budget manager.

Idaho National Laboratory

James Pittman (above) joined the CAES Catalysis and Transient Kinetics Laboratory. This lab houses two Temporal Analysis of Products systems to design advanced catalytic materials that consume far less energy while minimizing byproduct and waste streams. Pittman is a leading expert in the design and fabrication of TAP systems. He will use his skills to ensure both the CAES reactor systems operate at peak performance. Pittman has been a professional welder since high school and has done specialty work on TAP systems

since their invention in the late 1980s. Pittman's experience building hardware around scientific concepts will be essential to developing better techniques for catalyst design.

Research Highlights

CAES collaborative developing new sensors

A collaborative between Idaho National Laboratory, Boise State University, and the University of Notre Dame was awarded funding through the Department of Energy's Nuclear Energy Enabling Technology (NEET) and Nuclear Science User Facilities (NSUF) programs to develop and demonstrate an additive manufacturing approach to fabricating spatially resolved sensors for in-pile thermal conductivity measurement. The team will print three omega thermal conductivity sensors onto fuel components using an aerosol jet printing approach, and study in-pile performance of the printed sensors through irradiation and post-irradiation testing. This research has the potential to establish a new sensor-manufacturing paradigm for the nuclear industry.

ISU leads teams for NEET, NSUF

Dr. Haiming Wen, a CAES joint appointment from ISU, led a team of doctoral students, master's students and visiting doctoral students in two projects. "Enhancing irradiation tolerance of steels via nanostructuring by innovative manufacturing" includes three INL collaborators – Dr. James I. Cole, Dr. Isabella van Rooyen, and Dr. Yongfeng Zhang. The second project was a Laboratory Directed Research and Development (LDRD) project: "Advanced manufacturing of metallic fuels and cladding by equal-channel angular pressing."

Partnering with French nuclear scientists

Dr. George Imel of ISU participated in an OECD Nuclear Energy Agency (NEA) meeting of the Expert Group on Improvement of Integral Experiments Data for Minor Actinide Management in Paris, France, May 31-June 1, 2017. The French agreed to financially support a Ph.D. student to further study oscillator techniques for use in French experiments. This agreement offers a unique opportunity for a CAES student to perform their dissertation at one of the most active nuclear research centers in the world.



DR. HAIMING WEN LED
SEVERAL ISU RESEARCH
COLLABORATIONS AT CAES.

Performing innovative nuclear energy research

DOE'S Office of Nuclear Energy strives to promote integrated and collaborative research conducted by partners at national laboratories, universities, industry and international entities. CAES partners pursued three Consolidated Innovative Nuclear Research (CINR) projects in 2016-17.

1

ELUCIDATION OF ELECTROCHEMICAL BEHAVIOR OF TECHNETIUM, TELLURIUM, AND IODINE IN MOLTEN SALT SOLUTIONS; DR. KRISHNAN RAJA, UNIVERSITY OF IDAHO

2

INTEGRATED SILICON/ CHALCOGENIDE GLASS HYBRID PLASMONIC SENSOR FOR MONITORING OF TEMPERATURE IN NUCLEAR FACILITIES; DR. MARIA MITKOVA, BOISE STATE UNIVERSITY

3

ADDITIVE MANUFACTURING OF THERMAL SENSORS FOR IN-PILE THERMAL CONDUCTIVITY MEASUREMENT; DR. YANLIANG ZHANG, BOISE STATE UNIVERSITY



Informing global clean energy investment decisions

CAES will be the integrator for a new effort to provide timely, quantified and unbiased data. The Energy Systems Strategies, Assessment and Integration (ESSAI) model aims to help inform global clean energy investment and policy decisions through comprehensive interdisciplinary research, with a focus on the role of nuclear energy. Already ESSAI has spawned new collaborations, discussions and ultimately innovative ideas in interdisciplinary energy systems studies within CAES.

CAES is currently executing a study, coordinated with the LINE Commission with the intent to inform state leadership, to evaluate the potential value chain of advanced reactors, particularly as it pertains to opportunities for Idaho and the Northwest region. Specifically, tasks include evaluating potential markets, both traditional and emerging; enumerating barriers and incentives to attract industry; and, evaluating the existing public-private partnership framework to drive advanced nuclear reactor economic development.



Modeling enhanced geothermal site

A CAES team led by INL's Rob Podgorney is aiding the University of Utah FORGE team, building the "earth model" and subsequent "reservoir models" for the enhanced geothermal pilot site near Milford, Utah. FORGE (Frontier Observatory for Research in Geothermal Energy) is a DOE project aimed at developing sites where hot subsurface rock can be fractured and water introduced to create steam to drive turbines and generate electricity. CAES interns Andy Lau (Boise State University) and Michael Janis (University of Oklahoma) are assembling the earth model and writing the code to transfer it into INL's FALCON modeling and simulation program.

KIYO FUJIMOTO IS A DOE INTEGRATED UNIVERSITY PROGRAM FELLOW WORKING ON A PROJECT FUNDED BY A NUCLEAR ENERGY UNIVERSITY PROGRAM GRANT. SHE IS ALSO ONE OF FIVE RECIPIENTS OF A 2017 INL GRADUATE FELLOWSHIP.

Earning annual nuclear energy research funding

CAES consortium members won more than \$5 million in nuclear energy research and infrastructure funding from the U.S. Department of Energy. DOE awarded more than \$66 million in nuclear energy research, facility access, crosscutting technology development and infrastructure awards in 27 states. In total, 86 projects were selected to receive funding; 25 projects include collaborators from CAES member institutions. These awards provide funding for nuclear energy-related research through the Nuclear Energy University Program (NEUP), Nuclear Science User Facilities (NSUF), Nuclear Energy Enabling Technology (NEET) and Infrastructure Award programs.

25

DOE NUCLEAR ENERGY-FUNDED PROJECTS INCLUDE CAES MEMBER INSTITUTIONS

25

RAPID TURNAROUND PROJECTS AWARDED TO CAES THROUGH DOE'S NUCLEAR SCIENCE USER FACILITIES PROGRAM

\$5.3
MILLION

AMOUNT OF DOE MONEY CAES MEMBERS WON FOR NUCLEAR ENERGY R&D AND INFRASTRUCTURE

Awards and Recognition



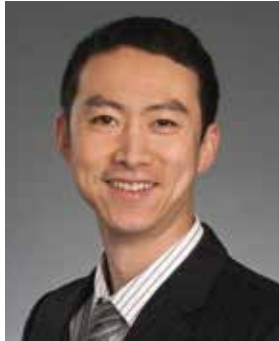
Dr. Donald McEligot

UI's McEligot honored

At the 2017 TURBO EXPO, Dr. Donald M. McEligot, visiting professor of nuclear engineering at CAES/University of Idaho and a nuclear science directorate fellow at INL, was awarded the American Society of Mechanical Engineers (ASME) Gas Turbine Heat Transfer Committee Outstanding Service Award. The award is an acknowledgment by the ASME International Gas Turbine Institute committees to their members who have made significant contributions in terms of personal service to the committee and its operations.

DID YOU KNOW?

THE TURBO EXPO WAS FORMERLY THE INTERNATIONAL GAS TURBINE CONFERENCE.



Yanliang Zhang

BSU's Zhang earns NSF CAREER Award

CAES/Boise State University engineering professor Yanliang Zhang earned a prestigious National Science Foundation Faculty Early Career Development (CAREER) Award.

The CAREER award is the NSF's most prestigious award supporting junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations. It is intended to give promising researchers an early career boost by providing stable research funding over an extended period. His project was selected to receive about \$500,000 over five years.

169

TEAMS ENTERING THE GEORGE BARLEY CLEAN WATER SCIENCE PRIZE OPENING PHASE WORKING GROUP

3

ENTRIES ADVANCING TO THE CONTEST'S STAGE 1, INCLUDING UI'S TEAM BLUEXGREEN

DOE Nuclear Energy research funding

CAES Affiliates Were Prime Awardees

2017 NEUP R&D AWARD	\$796,741	K. RAJA (UI), G. FREDRICKSON (INL), AND S. FRANK (INL)	ELUCIDATION OF ELECTROCHEMICAL BEHAVIOR OF TECHNETIUM, TELLURIUM, AND IODINE IN MOLTEN SALT SOLUTIONS
2017 NEET AWARD	\$890,000	M. MITKOVA (BSU), I. VAN ROOYEN (INL)	INTEGRATED SILICON/ CHALCOGENIDE GLASS HYBRID PLASMONIC SENSOR FOR MONITORING OF TEMPERATURE IN NUCLEAR FACILITIES
2017 NSUF R&D AWARD	\$500,000	Y. ZHANG (BSU), C. JENSEN (INL)	ADDITIVE MANUFACTURING OF THERMAL SENSORS FOR IN-PILE THERMAL CONDUCTIVITY MEASUREMENT
2017 INFRASTRUCTURE AWARD	\$295,392	D. ESTRADA (BSU)	SYNTHESIS AND CHARACTERIZATION EQUIPMENT TO SUPPORT ADVANCED MANUFACTURING FOR NUCLEAR SENSORS
2017 INFRASTRUCTURE AWARD	\$247,471	V. UTGIKAR (UI)	DYNAMIC MATERIALS TESTING LOOP AND THERMAL ANALYSIS SYSTEM

DOE Nuclear Energy research funding

CAES Affiliates Were Partner Awardees

2017 NEET AWARD	\$300,000	V. AGARWAL (INL), Y. ZHANG (BSU)	3-D CHEMO-MECHANICAL DEGRADATION STATE MONITORING, DIAGNOSTICS AND PROGNOSTICS OF CORROSION PROCESSES IN NUCLEAR POWER PLANT SECONDARY PIPING STRUCTURES
2017 NEUP AWARD	\$325,000	R. CHRISTENSEN (UI), P. SABHARWALL (INL)	EXPERIMENTAL DETERMINATION OF HELIUM/AIR MIXING IN HELIUM COOLED REACTOR
2017 INFRASTRUCTURE AWARD	\$150,000	G. PASTORE (INL), 20 ADDITIONAL PARTNERS	DEVELOPMENT OF A MECHANISTIC HYDRIDE BEHAVIOR MODEL FOR SPENT FUEL CLADDING STORAGE AND TRANSPORTATION
2017 INFRASTRUCTURE AWARD	\$299,337	R. CHRISTENSEN (UI) 10 ADDITIONAL PARTNERS	ADVANCEMENTS TOWARDS ASME NUCLEAR CODE CASE FOR COMPACT HEAT EXCHANGERS

UNIVERSITY OF IDAHO AND CAES
GRADUATE RESEARCHER AMEY
SHIGREKAR SPEAKS TO A YOUNG STUDENT
AT INL'S FAMILY NUCLEAR SCIENCE NIGHT.

Education and Outreach

Family Nuclear Science Night

To inspire a new generation of scientists, engineers and technicians, INL sponsored its first Family Nuclear Science Night at CAES on Nov. 3, 2016. Families had the opportunity to meet nuclear scientists and engineers and engage in hands-on activities focused on nuclear science. The event, presented in conjunction with Nuclear Science Week, was co-sponsored by CAES and the University of Idaho American Nuclear Society Student Chapter (UI-ANS).



Big Ideas Grant

An interdisciplinary team of graduate students and faculty from the University of Idaho won a grant from UI's Vandal Ideas Project to fund, "Increasing the Go-on Rate in Southeast Idaho through the Nexus of Food, Energy, and Water." The project aims to increase the percentage of southeast Idaho high school seniors going to college by providing mentorship for senior projects. Seniors will be connected with mentors from INL and local industries to assist in senior projects relating to the Water-Energy-Food Nexus.

TRIO student day

UI-ANS students partnered with the CAES, INL, Eastern Idaho Technical College and ISU on Dec. 2, 2016, to present STEM day for ISU-TRIO students. Federal TRIO Programs prepare disadvantaged individuals for successful entry into, retention in, and completion of post-secondary education.

>100

STUDENTS HOSTED DURING TRIO STUDENT DAY

Engineering Your Future

High school students from eastern Idaho schools converged on CAES Feb. 22, 2017, to participate in "Engineering Your Future," an event featuring workshops on mechanical engineering basics, wind energy, data visualization and drone flight simulation. Activities included GridGame, a computer program devised by INL engineer Tim McJunkin to simulate electrical power grid management, as well as hands-on STEM from INL's Energy and Environment Science & Technology directorate.

Cyber Physical Security Laboratory

With support from INL and the National Science Foundation, the Energy Systems Technology and Education Center (ESTEC) at ISU began building the Cyber Physical Security Laboratory using input from the program's Technical Advisory Committee and instructors. The lab provides hardware and software that cyber students need to complete their coursework. An associated 4-tank process control station is designed with physical system security. This station will be connected in a network that has various levels of cybersecurity, allowing cybersecurity training on real industrial control systems.



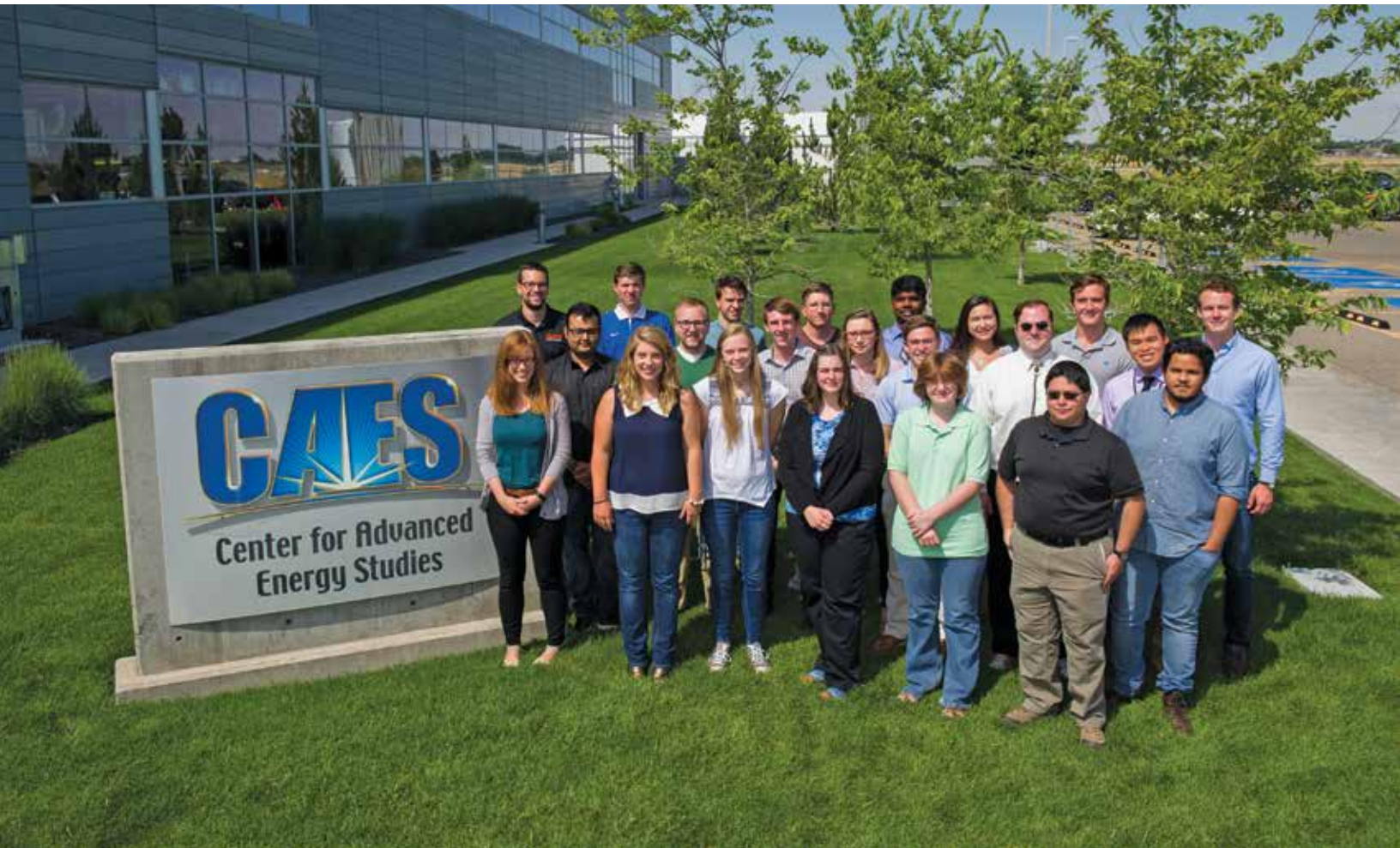
STUDENTS PLAY THE GRIDGAME DURING THE ENGINEERING YOUR FUTURE EVENT.

Internships and Assistantships

Each year, internships and assistantships provide opportunities for the best and brightest students to further their educations by working with CAES scientists and engineers. Internships and assistantships are an opportunity for universities and INL to showcase capabilities and get new perspectives on research. Students learn how to solve real-world problems under the guidance of distinguished scientific and technical experts.

This year, 76 students had a CAES internship or assistantship or came from CAES partner universities and worked on INL projects. An additional 15 worked at CAES as Center for Space Nuclear Research (CSNR) fellows or Nuclear Science User Facilities interns.

IN FISCAL YEAR 2017, 76 STUDENTS
FROM CAES AFFILIATED SCHOOLS
INTERNEED AT INL.





Thomas Blackham



Kiyo Fujimoto



Stephen Hancock



Rahul Reddy Kancharla



Emma Redfoot

New INL graduate program

INL has collaborated with several universities to develop the new INL Graduate Fellowship Program. The first call for the program closed earlier this year and 11 fellows were selected in August. During this pilot call, INL targeted candidates from Center for Advanced Energy Studies (CAES) and National University Consortium (NUC) schools.

Congratulations to:

Thomas Blackham (ISU)

INL adviser: Tammie Borders

University thesis adviser: Leslie Kerby

Kiyo Fujimoto (BSU)

INL adviser: Troy Unruh

University thesis adviser: David Estrada

Stephen Hancock (UI)

INL adviser: Richard Boardman

University thesis adviser: Richard Christensen

Rahul Reddy Kancharla (BSU)

INL adviser: Josh Kane and William Smith

University thesis adviser: Elisa Barney Smith

Emma Redfoot (UI)

INL adviser: Shannon Bragg-Sitton

University thesis adviser: Bob Borrelli

The recipients of these nationally competitive fellowships have their tuition and fees covered by their university during their first years of graduate school (years one to three) and their tuition and fees plus a \$60,000 annual salary paid by INL during the last two years of their doctoral research performed at the lab.

FOR MORE INFORMATION ABOUT THE PROGRAM,

CONTACT ALI JOSEPHSON (208-526-0940) OR

MICHELLE THIEL BINGHAM (208-526-7830).

Industry Engagement

Characterizing irradiated stainless steel welds

Customers from Japan's Nippon Nuclear Fuel Development Co., Ltd. visited CAES in June to view researchers' work with atom probe tomography. Their goal was to characterize how irradiation-induced material changes such as precipitation (solids coming out of solution) and spinodal decomposition (rapid unmixing of liquids or solids). The specimens were irradiated in Norway's Halden reactor and prepared in Japan before being shipped to CAES. The team successfully demonstrated that atom probe tomography can be used to quantify the amount of spinodal decomposition experienced by delta ferrite, a component of certain stainless steel welds.

12

MAXIMUM NUMBER OF MODULES IN
NUSCALE POWER'S SMR POWER PLANT

50

MWE
POWER LEVEL OF EACH MODULE

Analyzing small modular reactor economics

The CAES Energy Policy Institute at BSU completed a techno-economic analysis of NuScale Power's small modular reactor plant design. The "Economies of Small" report compares costs of the systems and functions of NuScale's advanced design with those of existing large nuclear power plants. A proprietary final report was delivered in November 2016 to NuScale executives, who then contracted a second report from EPI. A regional Levelized Cost of Electricity study will compare NuScale's electricity to other generation options in specific regions of the U.S. and one region abroad.

Finding savings in food processing plants

CAES researchers at UI and INL are working together to help Idaho food processing companies reduce their energy and water use, with support from Avista Corp. A \$93,600 grant from Avista funds a one-year project to evaluate north Idaho food processing plants. With mentoring from INL researchers, the UI team will create in-depth models of a plant's energy and water use. Beyond tapping into expertise across UI's colleges and locations, the project connects to CAES' Energy-Water Initiative and helps Avista meet the Idaho Public Utilities Commission's directive for utility companies to support reduced energy consumption by funding research and technology development.



Publications and Proceedings

Boise State University

1. Barnes, P., Lewis, J., Smith, K., Dufek, E., Dumias, J. & Xiong, H. (2017). *Sodium Electrolyte Degradation: Evaluating Pure Electrolyte Degradation through a Safe and Convenient NMR Technique*. Paper presented at the PacRim 12 ACS.
2. Black, G., Aydogan, F., Labor, L. & Solan, D. *Economies of Small*. Proprietary Final Report to NuScale.
3. Deng, C., Lau, M.L., Barkholtz, H.M., Xu, H., Parrish, R., Xu, M.O., . . . Xiong, H. (2017). Amorphous boron nanorod as an anode material for lithium-ion batteries at room temperature. *Nanoscale*, 9(30), 10757-10763. doi:10.1039/c7nr03017g
4. Jaques, B.J. (2016a). *CARAT (Collaboration for Advanced Research on Accident-Tolerant Fuel: Fuels subgroup)*. Paper presented at the Research Activities in the Synthesis and Corrosion behavior of Uranium Mononitride, Stockholm, Sweden.
5. Jaques, B.J. (2016b). *Characterization of Kerogen Morphology in Oil Shales*. Student poster presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.
6. Jaques, B.J. (2016c). *Cluster Evolution in F/M Alloys upon Neutron, Proton, and Self-Irradiation*. Student paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.
7. Jaques, B.J. (2016d). *High Temperature Behavior of Zirconium Alloys*. Student poster presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.
8. Jaques, B.J. (2016e). *High Temperature Investigation of Zirconium Alloys in Air*. Student paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.
9. Jaques, B.J. (2016f). *In-situ Monitoring of Mechanochemically-stimulated Self-propagating Reactions in the Lanthanide*. Student paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.
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