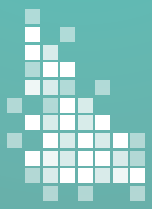
IDAHO GLOBAL ENTREPRENEURIAL MISSION

FY2019 ANNUAL REPORT



IGEM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The Idaho Global Entrepreneurial Mission (IGEM) is a unique program that invests public funds in advanced university research and capacity building to further economic development initiatives for the state.

The IGEM grant program uses a three-pronged approach to support a statewide entrepreneurial and commercialization pipeline to bring to market advances in agribusiness, computer science, medical and veterinary research, advanced energy initiatives, and other areas that are equally vital to the state's economy.

In the first seven years of operation, IGEM has been successful in advancing important research projects, funding strategic research capacity investments, and propelling innovations that position Idaho industries in new and profitable markets.

This annual report provides a succinct update on the IGEM program, its funded projects, and successes over the past seven years.

IGEM PROVIDES THREE DISTINCT FUNDING OPPORTUNITIES:

IGEM – COMMERCE
$1 MILLION

Managed by Idaho Commerce under the direction of the IGEM Council.

Funds research where industry and university partnerships work together to bring innovative products and technologies to market.

IGEM – HERC
$2 MILLION

Managed by the State Board of Education (SBOE) and administered by the Higher Education Research Council (HERC).

Invests funds to support infrastructure and advance key capacities at Idaho's research universities.

IGEM – CAES
$2 MILLION

Managed by the SBOE and administered by the Center for Advanced Energy Studies (CAES).

Leverages the partnerships between Idaho's three public research universities, Boise State University, Idaho State University and University of Idaho, the University of Wyoming, and the Idaho National Laboratory to fund advanced energy projects and initiatives.

The IGEM-Commerce grant program funds research initiatives where university investigators and private sector business experts partner together to bring viable technologies to market. IGEM commercialization grants are a powerful economic resource by funding university research that can advance private sector products and services produced in Idaho. Through its support of commercialization partnerships, IGEM makes an investment in developing new business ventures, creating new products and high-value jobs, while supporting the research capacity of Idaho's universities.

At the helm of the IGEM-Commerce program is the IGEM Council, a twelve-member body appointed by the Governor as prescribed in Idaho Code section 67-4726. The IGEM Council's diverse and experiential make-up consists of the brightest business, research, policy, strategy, and financial minds in the state.

The Council thoroughly vets IGEM grant proposals to mitigate risk and maximize the return on investment. The IGEM Council's fiscal stewardship and strategic direction advances IGEM's overall intended goal of economic prosperity through investments in technological advancements and innovation.

IGEM-Commerce, having completed its 7th year is proud to provide a succinct update on past and current projects.

IGEM COUNCIL

The IGEM Council is a twelve-member council appointed by the Governor as prescribed in Idaho Code section 67-4726.

Membership of the IGEM Council includes:

- Four (4) representatives from the private sector;
- One (1) representative from the State Board of Education;
- One (1) representative from the Idaho National Laboratory (INL) or the Center for Advanced Energy Studies (CAES);
- One (1) representative each from Boise State University, Idaho State University, and the University of Idaho;
- One (1) representative from the Idaho Senate
- One (1) representative from the Idaho House of Representatives; and the
- Director of Idaho Commerce.

This twelve-member Council thoroughly vets IGEM grant proposals to mitigate risk and maximize the return on investment. The IGEM Council's fiscal stewardship and strategic direction advance IGEM's overall intended goal of economic prosperity through investments in technological advancements and innovation.

2019 MEMBERS:

- **Dr. David Hill**
  Chair, State Board of Education
- **Bill Gilbert**
  Vice Chair, The CAPROCK Group
- **Von Hansen**
  AlertSense
- **Rick Stott**
  Superior Farms
- **Mike Wilson**
  Consultant
- **Dr. Noël Bakhtian**
  Center for Advanced Energy Studies (CAES)
- **Dr. Janet Nelson**
  University of Idaho
- **Dr. Harold Blackman**
  Boise State University
- **Dr. Scott Snyder**
  Idaho State University
- **Senator Kelly Anthon**
  Idaho Senate
- **Representative Paul Amador**
  Idaho House of Representatives
- **Tom Kealey**
  Director, Idaho Commerce

IGEM-COMMERCE GRANT PROGRAM

The chart below provides an overview of the IGEM-Commerce grant program. With $1 million in annual funding, Idaho Commerce utilizes $50,000 for program administrative costs, leaving $950,000 for grant awards. To date, IGEM-Commerce has funded 32 projects, resulting in over $6.8 million invested in university and industry research partnerships.


Photo by ISU Photography Services


Photo by ISU Photography Services

Fiscal Year	Applications	Applications Funded	Funds Requested	Funds Awarded
FY2013	18	7	$3,088,169	$844,093
FY2014	20	4	$3,506,145	$972,371*
FY2015	14	3	$3,044,732	$950,000
FY2016	18	6	$4,149,029	$1,104,830*
FY2017	14	4	$3,628,640	$979,569*
FY2018	14	3	$5,375,198	$950,000
FY2019	13	5	$3,626,955	$1,016,728*
Total	**111**	**32**	**$26,418,686**	**$6,817,591**

*Supplemental funding provided by Idaho Commerce

To date, the program's largest grant award was $427,173, with the smallest being $46,146. Over the past seven years, the average grant request has reached nearly a quarter of a million dollars.

Fiscal Year	Average Application Request	Applications
FY2013	$171,565	18
FY2014	$175,307	20
FY2015	$234,210	14
FY2016	$230,502	18
FY2017	$259,189	14
FY2018	$383,943	14
FY2019	$278,997	13
Avg. Request	**$240,172**	**16**
Avg. Award	**$213,050**	

FY2019 GRANT AWARDS


Photo by ISU Photography Services

DESIGN AND DEVELOPMENT OF AN AUGMENTED REALITY PLATFORM FOR ROBOTIC SYSTEMS DESIGN AND INTERACTION

Idaho State University

Grant Amount: $162,606

Idaho State University partnered with House of Design to develop an Augmented Reality (AR) robotics physics and communication engine to be used for industrial robot design, operation, and interaction. House of Design is a rapidly growing company whose main functionality is to integrate robots into industrial production lines.

TEST THE FUNCTIONALITY AND EFFICACY OF A PATENTED SANITIZING TOILET SEAT

Idaho State University

Grant Amount: $82,792

The Departments of Mechanical Engineering and Chemistry at Idaho State University have partnered with Fufuloo Products LLC. which has a patented toilet seat called the Washie. This seat is the solution to dirty toilet seats in public restrooms. Washie allows the user to clean the seat with an all-natural cleaning solution before use. After activating a sensor, located on the right side of the seat, cleaning solution rises from the seat and is wiped down with toilet tissue to clean the seat. Having the user clean the seat is the major difference between Washie and other self-cleaning toilet seats on the market and is more affordable to businesses. Research will test the functionality of internal and external mechanisms, battery versus cartridge life, durability of parts, and study the effects of cleaning chemicals on the seat after prolonged repetitive use. Lastly, work on a new formulation of the cleaning chemical is being conducted which will satisfy EPA regulations.

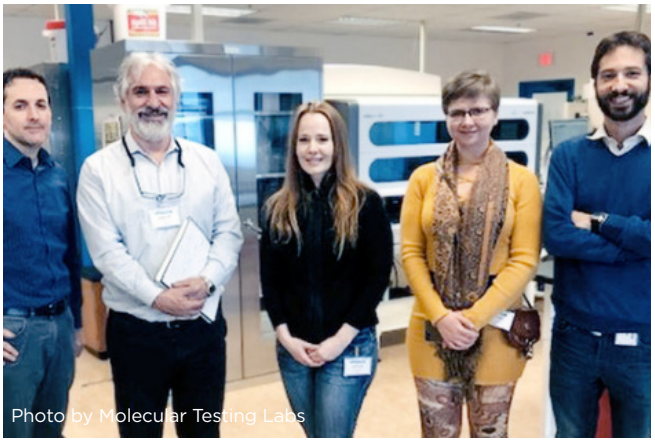
Photo by Molecular Testing Labs

DEVELOPMENT OF A RIBONUCLEIC ACID (RNA) HOME TEST FOR EARLY HIV DETECTION

Boise State University

Grant Amount: $255,496

Boise State University and its industry partner, Molecular Testing Labs, are collaborating research efforts to commercialize a ribonucleic acid (RNA) home test for early HIV detection. RNA can also reveal a patient's response to drug treatment, diet, and other regimes. The research conducted in this project will advance efforts in bringing to market a home test where RNA can now be extracted from blood spots and provide HIV results in 7 to 10 days after infection, instead of 3 to 9 weeks.

CONVERT AGRICULTURAL WASTE INTO AN EFFECTIVE NEMATODE SUPPRESSING FOOD AND FERTILIZER

University of Idaho

Grant Amount: $241,667

Plant-feeding roundworms, or nematodes, are responsible for about 14%, or $100 billion, in overall annual agricultural yield loss per year. Using IGEM funding, the University of Idaho and industry partner, California Safe Soils, are combining mustard seed meal with a food hydrolysate product to develop an affordable new biopesticide that can combat these roundworms while increasing yield and avoiding the negative environmental consequences of chemical pesticide use. Experiments are underway to optimize the amounts and methods of pesticide application in the laboratory and greenhouse. Preliminary results show a synergy between the two materials and an impact on nematode populations and plant growth. Further refinement of application methods will continue through the winter months, followed by field verification during the 2020 growing season.

DEVELOPMENT IN OPTIMIZING LASER METAL DEPOSITION ADDITIVE MANUFACTURING TECHNIQUES

University of Idaho

Grant Amount: $274,167

Through a collaboration with industry partner Premier Technology, Inc. (PTI) and Boise State University, University of Idaho is optimizing a laser deposition-based additive manufacturing (3-D printing) technique to produce innovative products for the energy and food processing industries. This unique technique will allow users to quickly make large metallic parts with complex geometry and design flexibility under controlled atmospheric conditions. The project will not only create key technical knowhow in this area but will also provide hands-on research experience to several students, supporting the development of the next generation technical workforce in the rapidly expanding area of additive manufacturing. The project will help position PTI as a leader by expanding their presence in the marketplace across Idaho and beyond, while the universities gain valuable research expertise to attract further funding in this area.

IGEM - COMMERCE IN PROGRESS PROJECTS

GENERAL-PURPOSE GONIOMETER

Boise State University

FY2018 Grant Amount: $368,772

Research on this project supports the design and development of a market ready general-purpose portable infrasound goniometer. The goniometer will be able to detect natural phenomena sounds as well as differentiating man-made sounds and their sources. Multiple systems have been built and are currently running successful tests in Boise and Utah.

ALUMINUM CASK FOR USED FUEL COOLING

Boise State University & University of Idaho

FY2018 Grant Amount: $237,898

Researchers from the University of Idaho in Idaho Falls, the Center for Advanced Energy Studies research consortium, and Japan-based Sakae Casting, LLC, used IGEM funding to perform criticality assessments of potential casks, develop mechanical and chemical means to dissolve boron compounds in molten aluminum, cast a prototype used fuel cask, and conduct experimental tests on that prototype used fuel cask to determine the maximum heat loading permitted. These tasks were conducted to develop and bring to market a borated aluminum cask for cooling used nuclear fuel. The cask will strengthen used fuel management at nuclear power plant sites around the world, as many reactor sites have limited space to store used fuel, which is often stored in large, deep water-cooled pools. The cask presents an intermediate, space saving storage option.

DEVELOPMENT OF A MAGNETIC SHAPE MEMORY (MSM) MICROPUMP

Boise State University

FY2018 Grant Amount: $343,330

This project further supports the development of a working Magnetic Shape Memory (MSM) Micro-pump prototype for volume production. The industry partner, Shaw Mountain Technology, LLC, (SMT) is a Boise State University startup company founded in 2015 by Distinguished Professor and former Chair of the Materials Science and Engineering Department, Dr. Peter Müllner. The research and development of this project are focused on replacing the driving mechanism, currently an electromotor and permanent magnet assembly, with a more compact and energy efficient electromagnetic system. The project team is in the process of filing a patent application on intellectual property arising from this project.

REMOTE SENSING OF ALFALFA CROP BLOOM

Boise State University

FY2017 Grant Amount: $194,000

This project allows Boise State University's Department of Geosciences to apply its experience and expertise in remote sensing data collection and analysis to provide protocols and prediction models to the industry partner, Kairosys, Inc., that will form an important part of the suite of solutions it is developing for managed pollination. Boise State is using imaging technology based on spectroscopy science for monitoring alfalfa as it progresses through its flowering cycle. Based on the success of the project, S&W Seed Company has joined as a new industry partner. In partnership with S&W, sensors were deployed in several alfalfa fields and a predictive model is under development. S&W has provided additional data to the project and, along with the founders of Kairosys, are actively engaged on the product development of the predictive model.

IGEM - COMMERCE COMPLETED PROJECTS

FLEXIBLE SENSORS ASSISTED MINIATURIZED AIR SCRUBBER FOR PROTECTING STORED POTATOES

Boise State University & Idaho State University

FY2017 Grant Amount: $413,681

This IGEM grant has led to a multi-institution effort to develop an integrated miniaturized air scrubber and cloud-enabled wireless distributed sensor network to monitor and control the storage environment for potatoes. This integrated solution should enable IHT, the industry partner, to increase their share of the potato storage market. While each component of the integrated system has unique capabilities, their integration marks an important advance in agricultural technologies.

EVALUATION OF THE ANKLE ROLL GUARD'S EFFECTIVENESS TO IMPROVE CLINICAL BENEFIT

Boise State University

FY2016 Grant Amount: $148,927

A new, innovative orthopedic product (Armor1) that prevents injury by limiting excessive inversion of the ankle has been developed by Ankle Roll Guard™. Boise State University quantified Armor1's effectiveness and compared its ability to prevent excessive ankle inversion with existing orthopedic products. The preliminary quantitative data demonstrated that Armor1 provides similar prevention of excessive inversion as existing orthopedic products but may allow the wearer more natural ankle motions and better physical performance. Using this data, Ankle Roll Guard™ has initiated negotiations with several medical device distributors.

TECHNOLOGY DEVELOPMENT FOR EFFICIENT PROVISION OF UAS PRODUCTS

University of Idaho

FY2016 Grant Amount: $161,524

The University of Idaho, along with assistance from Z Data Inc. has developed software tools to assist Empire Unmanned in handling enormous amounts of data acquired during unmanned aerial system (UAS) flights. The ability to process, visualize and disseminate large volumes of gathered data enables Empire Unmanned to expand its product offering.

TIME-OF-FLIGHT SPECTROSCOPIC REFLECTOMETER

Boise State University

FY2017 Grant Amount: $260,435

Boise State University has developed a spectroscopic time-of-flight reflectometer (STOFR) to assist the manufacturing and quality control process of a new revolutionary process which reduces and eliminates reflections from the end of an optical fiber (RARe Motheye Fiber™ process), developed by Fiberguide Industries, Inc. An instrument with such a broadband capability and high sensitivity does not exist on the current commercial market. STOFR has been in field operation since July 2018. The revenue generated by RARe Motheye Fiber™ is expected to exceed $1 million in 2020.

HOPLITE SKATE ARMOR™ COMPARATIVE ANALYSIS

Idaho State University

FY2017 Grant Amount: $111,453

This project tested a safety device called HOPlite Skate Armor™, a patented two-piece composite plastic foot protector designed be worn over a standard hockey skate and intended to reduce foot related injuries for hockey players, developed by Fi-Ber Sports. The Idaho State University research team was charged with the development of a consistent delivery system capable of accelerating a hockey puck to 100 mph, record the velocity of the puck prior to its impact with the protective device, and record impact data and video from the puck collisions with the HOPlite Skate Armor™ device for analysis. With the impact film data and high-speed video provided by the Idaho State University research team, Fi-Ber Sports will be able to conduct an analysis of the reaction of the material used in the construction of HOPlite Skate Armor™.

RISE ANALYTICS

Idaho State University

FY2014 Grant Amount: $300,000

Idaho State University partnered with ON Semiconductor for analytical research in the development and improvement of semiconductor products. The Commerce IGEM award allowed for the acquisition and installation of Scanning Electron Microscope and Energy Dispersive Spectroscopy (SEM/EDAX) equipment.

SMART RAISED PAVEMENT MARKINGS (RPM) INTEGRATION WITH TRAFFIC SIGNAL CONTROL SYSTEMS

University of Idaho

FY2016 Grant Amount: $299,651

The University of Idaho, their National Institute for Advanced Transportation Technology (NIATT), and industry partner, Evolutionary Markings Inc. (EMI), have validated the safety benefits of EMI's Smart Pavement Markers in real-time communication and data exchange between raised pavement marker devices and different traffic control systems, connected vehicles, and autonomous vehicles. The Idaho Transportation Department installed EMI markers in different segments of its two-lane rural highway systems to improve safety.

6,000 WATT SPLIT PHASED GALLIUM NITRIDE HIGH FREQUENCY INVERTER

University of Idaho

FY2016 Grant Amount: $178,178

The University of Idaho in collaboration with industry partner, Inergy Solar, has engineered and manufactured a new 2,000-watt Split Phased Gallium Nitride High Frequency Inverter. With the success of this development, researchers designed and are closer to realizing a 6,000-watt capacity inverter. These inverters can augment Inergy Solar's current product offering by advancing development toward a complete home solar solution.

DATA ANALYTICS FOR PRECISION AGRICULTURE

Boise State University

FY2015 Grant Amount: $343,072

Boise State University worked with Simplot to develop a data analytics solution for agronomic decision making based on historic farm and crop yield data. The goal of this project was to leverage Simplot's existing data to give growers new tools and resources they need to optimize their yields. Researchers automated the process of matching the multi-spectral photosynthetic images for Simplot so they can be used to produce predictive models for their network of growers.

SENSOR ADAPTER FOR MACHINE-TO-MACHINE (M2M) MARKET

Boise State University

FY2016 Grant Amount: $211,098

With IGEM funding, Boise State University has developed a sensor device – protocol adapter to improve the collection, modification, and delivery of remotely-sensed GPS, vehicle diagnostics, and other related data. The sensor adapter fills a critical gap in the delivery of data from diverse sensors to the growing internet Platform as a Service (PaaS) marketplace, allowing sensor agnostic and carrier agnostic delivery of data to the cloud for use by a wide variety of applications.

COMMERCIALIZATION OF NEW AQUATIC ANIMAL HEALTH PRODUCT

University of Idaho

FY2016 Grant Amount: $105,452

This project was an inaugural recipient of IGEM funding in FY2013. Since the initial investment, this project has successfully progressed toward the commercialization of a fish vaccine to combat Cold Water Disease (CWD). Due to this secondary round of funding, an exclusive license has been successfully negotiated and executed. The University of Idaho continues to work directly with the company sponsor to gain final U.S. Department of Agriculture (USDA) regulatory approval for this vaccine. The process has steadily moved forward, and initial laboratory safety trials have recently been completed and submitted to USDA for review. Upcoming laboratory efficacy and field safety trials remain to be completed. Once results are reviewed and approved, full vaccine licensing approval is expected from USDA, which is required prior to commercialization, marketing, and product launch.

2E-HEXENAL FUNGICIDE

University of Idaho

FY2014 Grant Amount: $296,917

At the University of Idaho, researchers tested an organic compound called 2E-Hexenal as a fungicide for stored potatoes. Converted to and applied in a gaseous state, this new approach to eradicate fungi would be industry changing. University of Idaho partnered with several companies to study the effectiveness of this fungicide in post-harvest tubers. The product is now patented. University of Idaho licensed the fungicide with one of the partnering companies, which is pursuing EPA registration and will attempt to bring this technology to market by 2023.

EXPANDING PRECISION AGRICULTURE MARKET OPPORTUNITIES WITH UNMANNED AIRCRAFT SYSTEM SENSORS

Idaho State University

FY2015 Grant Amount: $179,755

This project utilizes hyper-spectral imaging via Unmanned Aircraft Systems (UAS) to advance precision agriculture. Idaho State University and the Simplot Company worked together to advance remote sensing applications in the evaluation of multi-platform data collection using UAS. Researchers have discovered a detection methodology that identifies the Potato Virus Y (PVY). The detection of PVY is critical for potato growers. The project team secured additional grant funding through the Idaho Specialty Crop Grant program and ran field tests through the 2019 growing season with the intent of gathering additional data and refinement of their approach to detect the PVY crop threat. This past year Idaho State University has successfully submitted a full patent application.

HIGH SPEED DIGITAL PACKAGE MEASUREMENT & MODELING FOR NEXT GENERATION MEMORY MODULES

University of Idaho

FY2013 Grant Amount: $150,000

Partnering with Micron, this project allowed for the speedier development and design on next-generation memory modules with the acquisition of the Vector Network Analyzer. The acquisition of the Vector Network Analyzer not only helped Micron, but it also prepares University of Idaho students with hands-on education on the latest industry equipment. Additionally, the Micron Foundation gifted $1 million to University of Idaho to fund an endowed professorship in microelectronics in the College of Engineering. This gift has helped University of Idaho's efforts to better position itself as a leader in microelectronics education and research.

AUTOMATED QUANTITATIVE DETECTION OF E.COLI O157:H7 AT BEEF PROCESSING FACILITIES

University of Idaho

FY2013 Grant Amount; $78,076

The project examined if there was a better process to detect and determine the strains of E. coli within the beef processing system. While the project was successful in decreasing the detection time, the new process was not sufficient for commercial use at a beef processing plant. The process did recognize six strains that are considered adulterants in fresh ground beef products. Additionally, beef trim contaminated with E. coli O157:H7 could be identified in approximately 18 hours, which is about 24 hours faster than other generic methods.

N-E-W TECH™: INNOVATION AT THE NUTRIENT, ENERGY, WATER NEXUS

University of Idaho

FY2015 Grant Amount: $427,173

This project validated and brought to scale a new reactive filtration water treatment platform. USPTO patent No. 10,366,468 "Biochar Water Treatment" was issued in July 2019, and a similar EU patent is pending. The potentially carbon-negative advanced water treatment technology has the ability to clean and sterilize contaminated wastewaters while recovering critical phosphorus and clean water for reuse. The system has been successfully trialed at municipal water treatment plants in Moscow and Troy, Idaho, at an agricultural drainage canal near Parma, Idaho, and in Idaho's Magic Valley to address water challenges of the dairy processing industry.

CANINE HIP IMPLANT

Boise State University

FY2014 Grant Amount: $110,454

A new implant, the Bionic Hip System™, has been developed by MWI to improve the standard of care for treating hip osteoarthritis by reducing cost, improving canine mobility and lowering complications. Boise State University characterized the mechanical performance of the implant. MWI has submitted a utility patent on the technology and West Vet is currently developing instruments to use the bionic hip implants in canines.

CONDUCT PRECLINICAL STUDIES ON POTENTIAL ANTICANCER AGENTS

Boise State University

FY2013 Grant Amount: $80,986

The project focused on the analogs of doxorubicin and mitomycin C, two compounds that have an important role in the treatment of a variety of cancer types. Researchers discovered one of the analogs, GPX-160, it to be a more stable analog and a patent has been submitted on GPX-160, with two initial manuscripts following synthesis and anticancer activity and mechanic studies. Industry partner, Gem Pharmaceuticals, has contributed over $100,000 in sponsored research toward this partnership.

SURFACTANT SOLUTIONS

Boise State University

FY2013 Grant Amount: $250,000

Boise State University partnered with BHS Specialty Chemical Products to create renewable chemicals by converting oils into surfactants for use in products marketed to industrial food processing, personal care, and petroleum industries. Researchers were successful in creating surfactants from pure oil feedstocks, as well as developing a method to make surfactants from high grade vegetable oil waste. Likewise, researchers were able to use low grade vegetable oils from food production facilities as feedstock for surfactant synthesis. BHS was bought out by DuBois Chemicals in 2017 and further development of this technology was terminated.

NANOFABRICATION INFRASTRUCTURE SUPPORT

Idaho State University

FY2013 Grant Amount: $250,000

The project allowed for the acquisition of a Dualbeam-Nanomachine Center. The Dualbeam system provides both high resolution imaging and nano-machining capabilities in a single component. This tool enables the University to provide ultra-precise machining and nanofabrication capabilities that meet the needs of its industry, educational, and research partners.

INNOVATIVE PESTICIDE APPLICATION TECHNOLOGY SYSTEM

University of Idaho

FY2013 Grant Amount: $46,146

The project allowed for field tests to be conducted to quantify the effectiveness of a new pesticide spraying technology compared to conventional spraying. GenZ Technology, the industry partner, learned from field tests that the new spraying technology performed better than existing technology. This new pesticide application system has been used for strawberry and lettuce crops. GenZ Technology was also a Regional Winner of the 1776 Challenge Cup and invited to compete at the Global 1776 Challenge Cup competition. This project has raised $2 million in capital for the industry partner from angel funds and has also hired 8 new employees

DETERMINE COMMERCIAL VIABILITY OF MICROBIAL INDUCED CALCITE PRECIPITATION (MICP)

University of Idaho

FY2013 Grant Amount: $114,864

The project allowed an assessment to be made on the viability of MICP, a process that uses microorganisms already present in the soil to form calcite. Industry partner, BioCement Technologies, Inc., has licensed this technology from the University of Idaho. In addition to receiving IGEM grant funds, this project has also received an SBIR Phase 1 award for $53,968 for a 6-month study to reduce the mobility of lead (Pb) in soils at sites in and near Kellogg.

COMMERCIALIZATION OF NEW AQUATIC ANIMAL HEALTH PRODUCT

University of Idaho

FY2013 Grant Amount: $124,021

This project allowed for trials on a new fish vaccine and a probiotic feed additive aimed at reducing fish losses in aquaculture facilities due to Cold Water Disease (CWD). The iron limited vaccine yielded successful results. Additional funding was awarded in FY16 to aid in the commercialization of this aquatic vaccine. This formula work will be used for final regulatory approval with the USDA.

IGEM - HERC

IGEM – HIGHER EDUCATION RESEARCH COUNCIL (HERC)

IGEM - HERC funds are used to support Idaho public institutions of higher education research and development of projects that foster expertise, products, and services resulting in state economic growth. Priority is granted to those proposals that can show a strong collaborative effort among institutions as well as the private sector or exhibit high potential for near term technology transfer to the private sector. IGEM-HERC funded projects may receive funding for up to three years, contingent on annual review and satisfactory progress toward approved performance measures.

The institutions report to HERC each year on the status of their projects, including progress toward key objectives, budget expenditures, economic impact and commercialization potential. The awards granted in FY2019 included the third year of a three-year award for the University of Idaho for Security Management of Cyber Physical Control Systems, the first year of a potential three-year award for the University of Idaho for Sustaining the Competiveness of the Food Industry in Southern Idaho: Integrate Water, Energy and Waste Management, and the first year of a potential three-year award for Boise State University for Nucleic Acid Memory.

IGEM - HERC awards are granted through a competitive process that is open to each of Idaho's three public research institutions. The process incorporates an independent review of proposals and an evaluation component for identifying the project success and economic benefit to the state.

SECURITY MANAGEMENT OF CYBER PHYSICAL CONTROL SYSTEMS

University of Idaho

$700,000

Cyber-attacks and intrusions are nearly impossible to reliably prevent given the openness of today's networks and the growing sophistication of advanced threats. Knowing the vulnerabilities is not adequate, as the evolving threat is advancing faster than traditional cyber solutions can counteract. Accordingly, the practice of cyber security should focus on ensuring that intrusion and compromise do not result in business damage or loss through more resilient solutions. The project team is creating a platform to facilitate and build complementary and multidisciplinary R&D capabilities to address these pressing problems. The platform will incubate innovative products and services for safeguarding cyber physical control systems (CPCSs) that are ubiquitous and underpin key sectors of Idaho's economy. Early participation of industry will aid in vetting promising technologies. Better methods for assessment combined with more resilient systems design will safeguard against potentially immense economic impact currently being faced by Idahoan stakeholders.

Objective outcomes include:

1. **Strengthen capacity by adding key faculty and enhancing laboratories**

   In this third year of the project, four new faculty members were working. Substantial progress has been made on deploying the new video technology infrastructure, continuing laboratory enhancement projects, forming additional industry collaborations, producing research results, and planning for the post-grant period.

   In the original proposal, the team planned to use the existing space dedicated to the Power Laboratory (PowerLab) and just enhance the equipment in it. However, the team took advantage of an opportunity presented by the M.J. Murdock Charitable Trust to invest an additional $285,000 of their funding plus an additional $200,000 of College of Engineering funding to create a distributed Industrial Control Systems (ICS) Testbed with locations in Moscow, Idaho Falls, and Coeur d'Alene. The ISAAC testbed enables research and development of novel and secure techniques and algorithms for securing today and tomorrow's Power Grid (PG) along with other types of Industrial Control Systems (ICS) and Industrial Internet of Things (IIoT). Its major advantage is that it enables researchers and engineers to perform and collaborate on ICS-specific cybersecurity research, development, and testing on a system that closely resembles current distributed critical infrastructure cyber-physical control systems. It exposes commercial and prototype equipment to hardware-in-the-loop simulation, enabling the capture and use of real operational data; integrates current and future components of the power grid and other industrial control systems; and enables realistic attack-defend scenarios for research and development, evaluation and testing, and education and training.

2. **Strengthen collaboration with Idaho industry and Idaho Universities**
   The team had numerous on-going and one-time collaborations with industry and other universities. Collaborators include INL, ABB Corporation Corporate Research, University of Illinois, Argonne National Lab, Bonneville Power Administration, Avista Corporation, and Schweitzer Engineering Laboratories.

3. **Foster technology transfer and commercialization through technology incubation**
   The project team had 11 proposals funded, 3 funding proposals submitted and under review, 37 publications published or accepted, 7 publications submitted and under review, and 5 presentations.

4. **Strengthen and expand the workforce**
   During the Summer of 2018, at least 9 students conducted internships focused on cybersecurity. Organizations where students interned include US Department of Defense, Idaho National Laboratory, Pacific Northwest National Laboratory, and US Department of Homeland Security.

   During the Summer of 2019, Michael Haney developed and hosted the 3rd Cybercore Summer Camp held in Idaho Falls, receiving support from the College of Eastern Idaho and Idaho National Lab's Cybercore Integration Center. The two-day camps (basic and advanced) hosted high school students as well as several teachers from across eastern Idaho for five days of hands-on learning projects and "hacking" activities to introduce students to advanced computing and cyber-physical systems programming. Plans are in place and a grant application has been submitted to expand future camps for beginners and advanced students and teachers to be sustained for years to come.

   As a follow-up to the successful summer camp, Haney has worked with the College of Eastern Idaho and Compass Academy to develop and host after-school programs supporting cyber-physical control systems and embedded device programming and cybersecurity activities for local high school students, which will greatly strengthen the future workforce by fostering interest and skills at an early age.

SUSTAINING THE COMPETITIVENESS OF THE FOOD INDUSTRY IN SOUTHERN IDAHO: INTEGRATE WATER, ENERGY AND WASTE MANAGEMENT

University of Idaho

$700,000

Food production and processing are vital to the social and economic integrity of the Eastern Snake River Plain. However, in some areas, there are limits on both existing operations and growth due to water supply and water quality limits. Additionally, food processing companies are on the front line of rapidly increasing consumer expectations for sustainability in both their operations and supply chain. Reducing the energy, water, and the waste footprint of Idaho producers and processors will enhance their market competitiveness. Recovery of valuable products from waste will generate economic value and improve the environment. Reduced resource use allows more stakeholders to sustainably maintain their operations, including producers, processors, and communities.

The objective of this project is to build capacity and partnerships among the three research institutions to assist Idaho food producers and processors in reducing water, energy and waste footprints.

Objective outcomes include:

1. **Recovery of energy, nutrients, water and bioproducts from waste streams: bench to place-based pilot projects**
   Bench scale process improvements and system modeling for assessing commercial scale feasibility of the integrated system were evaluated. Specifically, the waste streams from a variety of producers and processors in the Twin Falls area were analyzed and the optimal process sequences (biological, chemical, physical, thermal) to recover energy, bioproducts (biofuels and bioplastics) and nutrients from mixed waste were assessed. There has been initial work on conducting pilot scale evaluations and producing prototype products (bioplastic mulch film, biochar, biofuel) for evaluation.

2. **Decision-support tools for industry for industry and community leaders to quantify and visualize trade-offs among water, energy, land use, and municipal growth**
   This year, the team began the process of upgrading the existing system dynamics model. The team has also

compiled a literature review and reviewed the data used in the original version of the existing model and identified data needs in order to make the model more current and representative of climate changes and drought that have occurred during the past ten years. Finally, the team has initiated collaborations with Idaho Department of Water Resources, the Surface Water Users Association, and Idaho Power in order to understand how to develop a module that would incorporate energy use for irrigation in the model.

3. **Technical innovations/sensing systems to reduce water/energy/nutrient use in targeted production systems**
   The team has developed a prototype of a decision support online tool for sustainable agriculture decision making and developed a pilot project to use drone-based, other field-based and satellite sensors to reduce water, nutrient, and energy use in production of targeted crops.

4. **Engage the present and future workforce in the adoption of new technologies**
   Preliminary discussions on current and near-term workforce development tools have started. The team has also hosted a hands-on education program known as "Idaho Drone League (iDrone)" to promote STEM pipelines in the Treasure Valley and to promote skills important to the Idaho food industry in the future.

5. **Project Management/Stakeholder Engagement**
   The team formed the Stakeholder Advisory Board and held the first in-person meeting this year. The primary goal of this initial meeting was to enhance existing relationships, build new ones, and to build a sense of collaboration and shared vision with regard to the specific nature of the experiments we perform and the products we target. The Stakeholder Advisory Board was very excited and supportive of the details of the project.

NUCLEIC ACID MEMORY

Boise State University

$700,000

The vision of this project is to pioneer a digital data storage paradigm in Idaho by designing, building, and testing accessible, editable, and non-volatile nucleic acid memory (NAM) technologies that are inspired by DNA circuits and made possible by the team's innovations in DNA nanotechnology. With support from IGEM-HERC, the Nucleic Acid Memory Institute is being created to meet critical innovation, economic, and workforce development needs in Idaho. To expedite this vision of Idaho becoming a global leader in NAM, five tasks will be met over the life of this IGEM-HERC project.

Objective outcomes include:

1. **Create efficient algorithms for coding information into data strands**
   Error correction strategies will account for DNA insertions, deletions, and substitutions, as well as screen for biological sequences to ensure that the data has no genetic function. This year, one of the team members successfully defended a master's thesis in which the researcher created a software package that includes a novel-mapping scheme that converts digital information into codons while accounting for important constraints when working with DNA. The researched developed a schema mimicking how information has evolved to be efficiently encoded into natural DNA while also accounting for the errors that often arise when working with synthetic DNA. The thesis has resulted in one publication and two conference presentations. Another accomplishment in this goal is the creation of the first proof-of-concept that digital Nucleic Acid Memory is possible by encoding and decoding "NAM" and "IGEM" onto blocks of DNA. The DNA block was optically decoded via a super-resolution microscope and error-correction was performed using hard encoded indexing and structure averaging of the resolved images.

2. **Create a high-throughput, integrated analytical engine to design and select data strands using quantitative metrics based on an in-house algorithm.**
   A project researcher is currently completing dissertation research that hypothesizes that observed kinetic variation among DNA strands arise due to unintentional base pairing in DNA. The researcher was able to engineer DNA devices with favorable interference profiles using his software packages, the researcher experimentally demonstrated that DNA kinetics vary by a factor of two or less when sequences satisfy four conditions. Taken together, the researcher's findings support the hypothesis that kinetic variation arise due to interfering events and that kinetic reproducibility is possible through sequence optimization. These insights will help inform the design, build and test cycle of Nucleic Acid Memory at Boise State.

3. **Create synthetic biological factories for manufacturing DNA scaffolds using rapid design-build-test cycles of genomes**
   A researcher has currently established the experimental and instructional infrastructure in support of over 10 undergraduate students who have developed training modules on synthetic biology concepts needed to understand, design, and produce customizable single-stranded DNA from phagemides in E. coli. Based on this project, some of these students were hired this summer and are working on designing and building DNA plasmids needed to produce custom scaffolds for DNA origami.

4. **Design and fabricate NAM storage platforms using the DNA scaffolds and validate the functionality of genome scaffolds using atomic force microscopy**
   Research is being conducted that leads insight into how one might site-specifically deposit dNAM onto semiconductor-grade substrates in preparation for super-resolution microscopy and how the surface density of dNAM may vary based on its local environment. All of these insights will help inform the design, build, and test cycle of Nucleic Acid Memory.

5. **Read arbitrary data files into NAM storage nodes using super-resolution microscopy**
   Two researchers with expertise in super-resolution microscopy, coding, biology, and imaging, have been recruited as key members of the Nucleic Acid Memory Institute.

IGEM - CAES

The Center for Advanced Energy Studies is a research and education consortium between Boise State University, Idaho National Laboratory, Idaho State University, University of Idaho, and University of Wyoming.

CAES DELIVERS NEW 20-YEAR STRATEGIC PLAN, BEGINS IMPLEMENTATION

CAES completed a significant milestone in fall 2018, delivering a new 20-year strategic plan supported by all five members of the CAES consortium. The new strategy rests on three strategic pillars: research, education, and innovation. These pillars help guide investments and capabilities needed to develop an energy workforce; accelerate the development of research and technology; and enable collaboration between industry and business, researchers, students, and faculty. The new strategy is a detailed implementation matrix that charts the focus areas, activities, milestones, operational requirements, and timelines necessary for the success of CAES. It calls for CAES to focus on leveraging the collective expertise, capabilities, facilities, and diversity of the five CAES entities – representing more than 8,000 researchers, engineers, and university faculty, more than 63,000 students, nearly 100 laboratories and engineering facilities, and more than 1,100 degrees and certificate offerings – to create win-win opportunities that make each member stronger together than it would be on its own.

CAES CONCLUDES FIRST ANNUAL SUMMER VISITING FACULTY PROGRAM, BEGINS SECOND ANNUAL EDITION

In summer 2018, CAES launched the Summer Visiting Faculty Program to connect university faculty members with INL researchers. The goal is to promote collaboration among the CAES entities on research projects focused on the focus areas identified in the new CAES strategy. In August, six university faculty members and four Idaho National Laboratory researchers gave presentations on their research project and discussed their proposals, which were then submitted for funding consideration. The program expanded to 18 teams of faculty members/INL researchers in 2019.

CAES-AFFILIATED RESEARCHER LEADS PROJECT THAT RECEIVES IGEM GRANT

Two CAES-affiliated researchers are members of a research team that recently landed a state grant through the Idaho Global Entrepreneurial Mission (IGEM) grant program initiative. University of Idaho Professor Indrajit Charit is the principal investigator of the project, which calls for using laser beams to manufacture complex and unique metallic parts, with potential applications in nuclear reactors and food processing plants. Brian Jaques, an assistant professor at Boise State University, 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.

CAES RESEARCHER SECURES ENERGY STORAGE GRANT FROM DEPARTMENT OF ENERGY

In late August 2018, CAES laboratory lead Dr. Travis McLing secured a $300,000 grant from the Department of Energy's Office of Energy Efficiency and Renewable Energy. McLing, along with Idaho National Laboratory colleagues Robert Podgorney and Ghanashyam Neupan, and Patrick Dobson, Nic Spycher, and Christine Doughty from Lawrence Berkeley National Laboratory, Dakota Roberson from the University of Idaho, and Fred McLaughlin from the University of Wyoming, are studying the potential for waste-heat energy storage in underground reservoir systems. The Dynamic Earth Energy Storage proposal will examine grid-scale energy storage using the earth's natural heat sources essentially as a thermal battery. This project supports the objectives of the DOE Grid Modernization Initiative by exploring approaches to utilize geothermal energy in order to create the modern grid of the future.

CAES DIRECTOR TESTIFIES ON CAPITOL HILL

In March, CAES Director Dr. Noël Bakhtian testified before the House Appropriations Energy and Water Subcommittee on energy workforce opportunities and challenges. Dr. 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 the Center's efforts.

CAES HOSTS 8TH ANNUAL ENERGY POLICY RESEARCH CONFERENCE AT BOISE STATE UNIVERSITY

In early September, CAES' Energy Policy Institute hosted the 8th annual Energy Policy Research Conference at Boise State University. Since 2011, the Energy Policy Research Conference has been bringing researchers together from across the country and around the globe to discuss a wide range of energy research topics. A capacity crowd of more than 200 scholars, students, and practitioners from academia, industry, government, and nonprofits were on hand during this year's event. CAES Director Dr. Noël Bakhtian and CAES Fluids Laboratory Lead Dr. Travis McLing participated on an energy-water nexus panel session.

NEW CAES ENERGY POLICY INSTITUTE DIRECTOR TAKES HELM

Dr. Kathleen Araújo began her tenure as the new director of the CAES Energy Policy Institute (EPI) in July 2018. The Institute is a CAES Center of Excellence housed at Boise State University. Dr. Araújo earned her Ph.D. at MIT, completing post-doctoral research at the Harvard Kennedy School on science, technology and public policy, and nuclear safety. She also has worked as an assistant professor of energy-environmental innovation systems and policy at Stony Brook University; and as a researcher with Brookhaven National Laboratory where she worked in the divisions for nuclear non-proliferation and national security, and sustainable energy. She also is a book series editor for Routledge's Studies in Energy Transitions. Since 2006, EPI has focused on strategic problem-solving and opportunities in energy by conducing cross-cutting, socio-technical analysis that informs policymakers, communities, and industry to train the next generation of leaders.

BOISE STATE UNIVERSITY MOVES TO R2 CLASSIFICATION

The Carnegie Classification of Institutions of Higher Education elevated Boise State University within its three-tiered doctoral university classification system in February. The change to the R2 classification is a result of Boise State's high research activity only two years after being classified in the system as a doctoral research institution. Boise State offers 12 doctoral degrees, including materials science and engineering, computing, and biomolecular science, and boasts an enrollment in Ph.D. or other doctoral programs of approximately 350 students. The Carnegie Commission developed the classification system in 1970 to support its research program and judge quality research and education.

CITY OF BOISE PARTNERS WITH THE ENERGY POLICY INSTITUTE AND IDAHO POLICY INSTITUTE

The City of Boise recently adopted a target to derive 100 percent of its electricity from clean energy by 2035. The decision was informed by research completed by the CAES Energy Policy Institute and Idaho Policy Institute, both based at Boise State University. The Institutes surveyed city 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.

CAES BY THE NUMBERS

Investments:

- $3 million – State of Idaho annual investment in CAES
- $7.7 million – INL investment in CAES*
- $4.7 million – INL-directed research and development to CAES researchers
- $4.2 million – Federal nuclear energy funding to CAES faculty

Outreach:

- 1,375 visitors experienced the CAES Computer-Assisted Virtual Environment (CAVE) 3D data immersion research environment
- 65 workshops, seminars, and speeches sponsored by CAES

Student Impact:

- 109 students from CAES-affiliated universities interned at INL**
- 18 faculty members from CAES member universities participated in the second annual CAES Summer Visiting Faculty Program
- Five students from CAES-affiliated universities were offered graduate fellowships at Idaho National Laboratory

* Amount included in FY2019 budget

** Federal fiscal year, Oct. 1, 2018 – Aug. 20, 2019

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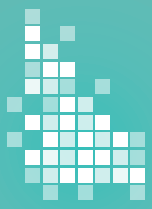

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