ISEE

Institute for Sustainability, Energy, and Environment

ACTIONABLE RESEARCH

2018-19 Annual Report

From the Director ...

As the Institute for Sustainability, Energy, and Environment (iSEE) begins Year 6 at the University of Illinois, we are pleased to report on our accomplishments in research, education, and outreach — as well as our continued influence on a more sustainable Urbana-Champaign campus.

In 2018-19, iSEE and the Carl R. Woese Institute for Genomic Biology (IGB) fully established a $115 million Bioenergy Research Center. In its second year, the U.S. Department of Energy-funded Center for Advanced Bioenergy and Bioproducts Innovation (CABBI) now employs more than 285 scientists, staff, and students from Illinois and 19 partner institutions.

And by helping to attract more than $13.5 million in new external funding, iSEE saw its research influence progress — and new major projects spawned. The future remains bright as the Institute began new seed funding initiatives to expand its research portfolio further.

In addition, a generous gift from Stu and Nancy Levenick to iSEE and the Department of Natural Resources and Environmental Sciences will allow for a new Resident Scholars program starting in Fall 2019.

The Institute has become a public voice for addressing wicked world problems, having published opinion pieces the past year on the National Climate Assessment as well as on agricultural technology that can reduce nutrient runoff in the Midwest and help alleviate the hypoxic dead zone in the Gulf of Mexico. The latter piece was a result of our 2018 Critical Conversation; another piece on genetically modified mosquitoes from our 2019 Conversation is forthcoming.

On the education and outreach front, our campuswide minor and environmental writing programs have gained enrollment — and the new student-written, professionally curated *Q Magazine* is now in circulation. A new donor-funded educational program will help instructors add sustainability into courses campuswide. And attendance at our annual Congress and other iSEE-supported campus events is thriving.

Campus sustainability programs such as Illini Lights Out and our new Greener Campus programming continue to expand and help the U of I conserve energy and money. And in anticipation of publishing the 2020 Illinois Climate Action Plan (iCAP), we have evaluated and realigned our campuswide teams to help reach current and future goals.

Please turn the page for a closer look at our work; you'll note that we opted for a more featurized look this year that is easier on the eyes and much more fun to read!

Sincerely,
Evan H. DeLucia,
Baum Family Director, iSEE

TABLE OF CONTENTS

Financial Support

❖ The Institute's missions receive continued support from iSEE founding benefactor the **Alvin H. Baum Family Fund**, under the administrative leadership of Joel Friedman and Erika Cornelison. The Fund has given **more than $2.1 million** to support iSEE and its Baum Family Director, Evan H. DeLucia.

Most recently, the Baum Fund supported iSEE's new Critical Conversations series (*page 27*) and supported students in the sustainability minor capstone research experience (*page 28*).

❖ For the second year in a row, **Janelle Joseph** gave **$5,000** to iSEE, and the 2019 gift bolstered our educational offerings.

The gift will result in an upcoming article in *Q Magazine* (*page 29*). iSEE Communications Interns Jenna Kurtzweil and Taylor Jennings, both already published in *Q* and recipients of the new Certificate in Environmental Writing (*page 28*), traveled to the U.S. Southwest to explore water resource management issues on the Gila River.

The 2018 donation funded two summer undergraduate field internships for iSEE's seed-funded Ag for Food research team (*pages 24-25*).

Levenicks Fund New iSEE Scholars Program

In February, the University of Illinois at Urbana-Champaign announced that alumnus Stuart L. Levenick and wife Nancy J. Levenick of Naples, Fla., had made a significant endowment for sustainability leadership, research, education, and practices on campus.

Mr. Levenick, who captained the 1975 Illini football team and received a B.S. in Forestry in 1976, and his wife have designated the endowment in two parts:

• for the Levenick Sustainability Chair Fund, which will establish an endowed chair in the College of Agricultural, Consumer and Environmental Sciences' Department of Natural Resources and Environmental Sciences (NRES); and

• for the Levenick Resident Scholars in Sustainability Leadership Program Fund, to establish a resident scholars program at iSEE.

"As a forestry major on this campus, I learned the value of a strong, resilient environment and humanity's place in nurturing it," Mr. Levenick said. "Nancy and I hope that our funding can play a role by establishing a thought leadership program at Illinois that will benefit future generations."

NRES will select a faculty member to serve as the Levenick Chair in Sustainability. As an iSEE affiliate, this newly funded Chair will also recruit and manage the Resident Scholars Program at the Institute (*page 30*).

This year's gift brings the Levenicks' total support of the University's sustainability and environmental missions into the multiple millions of dollars. A 2014 endowment supported the Levenick iSEE Fellows Program of scholars, research fellows (*page 26*), and instructors (*page 28*) — as well as additions to the U of I curriculum through a new teaching program (*page 31*).

In 2015, Mr. Levenick's former employer Caterpillar Inc. offered a gift match, and funds from the Student Sustainability Committee (SSC) and the Office of the Provost in 2016-17 helped build iSEE's recently opened Collaboratory classroom/meeting space and Media Lab (*page 44*).

EXTERNAL RESEARCH GRANTS AND FUNDING REQUESTS

During 2018-19, the Institute attracted the following funding for new research initiatives:

• **$5 million** from the U.S. Department of Energy (DOE) for a project titled "Next Generation Feedstocks for the Emerging Bioeconomy" (*pages 12-13*).

• A startup **$663,585** grant from the Arizona State University Foundation for a project titled "Can Adaptive Multi-Paddock Grazing Management Increase the Net Greenhouse Gas Sink Strength and Water Use Efficiency of Grazed Pastures?" (*page 13*). The project later received an additional **$135,135** from the ASU Foundation and ExxonMobil.

Existing iSEE seed-funded projects also had funding successes:

• **$5 million** from the Foundation for Food and Agriculture Research (FFAR) to extend the Crops *in silico* project into C*is* 2.0 (*pages 16-17*).

• **$1.2 million** from the U.S. Department of Agriculture's (USDA) National Institute of Food and Agriculture (NIFA) for an Agroforestry for Food (A4F)-led study on cover crops improving resilience of Midwest ecosystems. The A4F team also facilitated a **$899,998** from USDA NIFA and the National Science Foundation's (NSF) National Robotics Initiative (NRI 2.0) for a study on robotics for harvesting, and **$373,906** from the Illinois Nutrient Research & Education Council for another cover crops study on resilience of Midwest ecosystems (*pages 24-25*).

• **$185,000** ($250,000 Canadian) from United Nations Humanitarian Grand Challenges for the Stored Solar Stove team to study the use of Sun Buckets in conflict zones such as the Kakuma Refugee Camp in northern Kenya (*pages 20-21*).

Still pending:

• **$1 million** from the Bill & Melinda Gates Foundation for a 2019 seed-funded project titled "Advancing Sustainability through the Transformation of Water and Sanitation Infrastructure" (*page 14*). That grant was still pending as of the end of FY19.

Rejected proposals through or facilitated by iSEE:

• **$2.5 million** from NSF's Innovations at the Nexus of Food, Energy and Water Systems (INFEWS) for a Campus as a Living Lab agrivoltaics project (*page 15*).

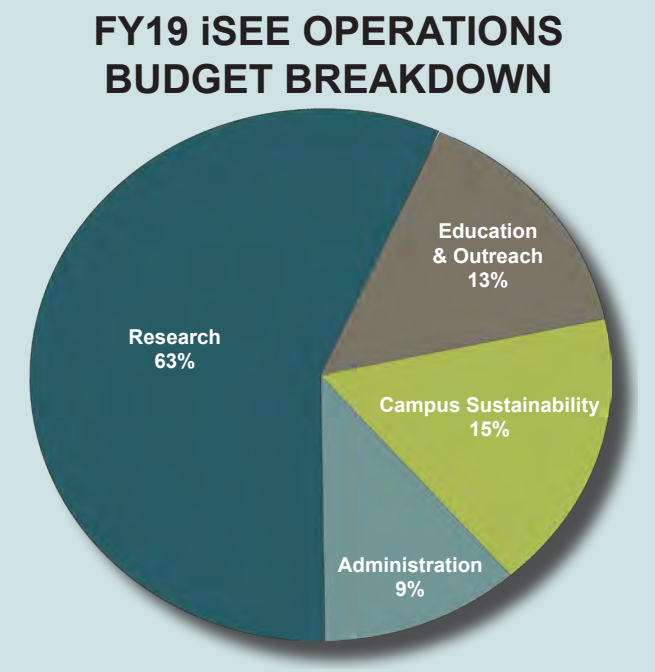
• **$2.5 million** from NSF INFEWS for a Campus as a Living Lab project on environment-enhancing food, energy, and water systems (*page 15*).

• **$499,814** from USDA NIFA for iSEE's 2015 seed-funded pollution treatment project (*page 26*) to create a sensor for bacteria in consumable products.

In the next fiscal year, iSEE already has plans to propose several funding requests, including:

• **$10 million** from the USDA Agriculture and Food Research Initiative (AFRI) for a Campus as a Living Lab project (*page 15*) titled "Optimizing Agrivoltaics for Sustainable Food-Energy-Water Systems." Team members also will submit to USDA AFRI as a **$1.2 million** sub-award to a University of Maryland agrivoltaics project.

• An **amount to be determined** from NSF NRI 2.0 for a Campus as a Living Lab project titled "Creating Adaptable Autonomous Systems for Energy-Efficient Buildings" (*page 15*).



iSEE's Funding Proposal History, By the Numbers

YEARS	FUNDING PROPOSALS	GRANTS RECEIVED	PENDING
2018-19	$13.5 million	$13.4 million*	$1 million
2014-18	$247.6 million	$122.4 million	$10.9 million*
Current Totals	**$261.1 million**	**$135.8 million**	**$1 million**

** Of the $10.9 million pending as of FY18, $6.1 million was funded in FY19. The remaining $7.7 million received in FY19 was from FY19 applications.*

CENTER FOR ADVANCED BIOENERGY AND BIOPRODUCTS INNOVATION

Postdoc Pairs Policy, Research

Sarah Acquah is busy working on three projects as a CABBI Postdoctoral Research Associate at the University of Illinois at Urbana-Champaign. But don't make her pick which one she likes best.

"I don't have a favorite," Acquah said. "I love all of them; they are my babies."

Working for CABBI Sustainability Theme Leader Madhu Khanna, Acquah's passion for modeling and agriculture has flourished. However, her professional journey took several twists and turns before she landed with CABBI.

Originally from Ghana, West Africa, her interest in agricultural economics was inspired by her brother, who advised her to pursue the subject matter because of her love for numbers. While in Ghana, she obtained a bachelor's degree in Mathematics.

"With my math background I ventured into agricultural economics and (my brother) was absolutely right," she said. "It was more applied math in the areas of looking at the agricultural market and pricing."

It wasn't until 2012 that Acquah traveled to the U.S., where she earned an M.S. in Agricultural Economics from Mississippi State University. She then received a Ph.D. in Water-Resource Economics from New Mexico State University.

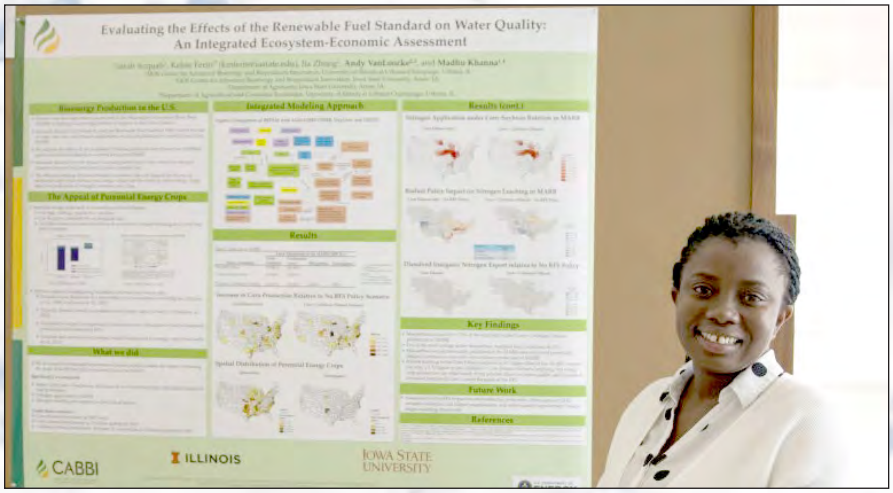
Now, at the University of Illinois, she uses a combination of all three of her degrees to help with her assignments. Acquah's projects focus on using the Biofuel and Environmental Policy Model (BEPAM) to analyze land use change impacts of biofuel production, nitrogen applications, and environmental co-benefits of the Renewable Fuel Standard (RFS).

"This isn't lab work whereby I can have new discoveries and have patents for it, but rather policy research," Acquah said.

For one project, Acquah collaborates with a doctoral student at Iowa State University to examine nitrogen leaching and the export of dissolved inorganic nitrogen (DIN) to the Gulf of Mexico. Those nutrients cause hypoxia — the lack of oxygen due to nutrient loss — and the "dead zone" in the Gulf of Mexico.

"The Midwest does not have a water scarcity problem, but rather they have issues of nitrogen leaching predominantly from agricultural sources and exported via the Missis-

Harvesting sorghum at the Illinois Energy Farm.



sippi and Atchafalaya rivers into the Gulf of Mexico, which currently has the second-largest hypoxia problem globally," Acquah said. "Currently the focus is on corn and soybean rotations in the Midwest and how the establishment of cellulosic ethanol production mandate can replace these feedstocks with a more sustainable feedstock like switchgrass or Miscanthus. These crops use very minimal nitrogen, and can grow on marginal land and significantly sequester soil carbon."

Acquah also studies marginal land usage. Marginal land, as defined in her project, is land that borders on the margins of economic profitability and non-profitability. Typically, marginal land is seen as having less of an economic value, but CABBI researchers are investigating the feasibility of large-scale productive perennial grasses on these land types.

"What this marginal land study is doing is (assessing) how much marginal land exists, determining the economic incentives of using that land for bioenergy production, and (examining) the environmental co-benefits potentially available," Acquah said.

Part of CABBI's mission is to develop efficient ways to grow bioenergy crops and to produce biofuels. Acquah is studying the effects of biofuel production on greenhouse gas emissions — bringing her three projects full circle.

"One of the benefits of having biofuel production is to cut down on greenhouse gas emissions" Acquah said. "Replacing fossil fuels with biofuel and especially producing biofuel from cellulosic feedstocks such as switchgrass and Miscanthus have the potential of reducing carbon emissions and improving water quality."

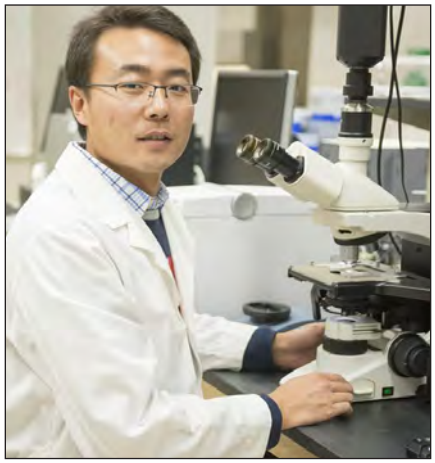
Full article by iSEE Communications Intern Chloe Rice at cabbi.bio.

Postdoc Has Passion for Plant Physiology

Getting your hands dirty is at the top of a plant physiologist's job description. Shuai Li knows this better than anyone, but his love for the research makes hard work well worth the while.

After receiving his M.S. in Plant Ecophysiology from the University of Science and Technology of China and his Ph.D. in Plant Physiology from the Estonian University of Life Sciences, Li is excited to complete his postdoctoral research at the University of Illinois at Urbana-Champaign under the CABBI Feedstock Development theme.

Li's family moved to Illinois so he could join Lisa Ainsworth's Laboratory. Li was previously acquainted with Ainsworth's research, having studied her work while researching his own Ph.D. dissertation. He remarks on the similarity of their research areas even before he joined the group.



"The only difference," Li notes, "is that (her group) studied in the field, while we studied in the lab."

But Li is no stranger to field work: On the contrary, his passion for plant research has led him into the depths of diverse ecosystems and environments in his career.

"During my master's, I worked in the southwest part of China — we were studying the tropical plants there," he says. "In Estonia, we also went to the forest, into the canopy. We had to climb a tower and go to the top, 20 meters high. We had to go there and also move the equipment up to measure photosynthesis in the canopy."

It might not be the most glamorous, but Li has no problem with legwork.

"Here, it's not too difficult," he laughs, "because we measure the crops on the ground."

Scientist Works with Unconventional Yeasts to Produce Valuable Bioproducts

Matt Plutz, a Chemical and Biomolecular Engineering Research Scientist, spends his week immersed in the lab. He grabs a stool to settle in on and uses a microscope to make sure the yeast looks healthy prior to beginning a DNA transformation. He stays focused and precisely gets down to business: genome manipulation.

"Despite being a researcher for over 20 years one thing that still surprises me is how laborious and time-consuming basic research is," Plutz said. "Even with great planning and advanced techniques, the results of experiments don't always turn out as expected. It's something that you get used to, but even after all these years it can be difficult to accept when something doesn't work out how you wanted."

Plutz has worked in the main lab almost since the Center's founding. He joined Conversion Deputy Theme Leader Christopher Rao's group to work on bioenergy development after stints at several other labs across the Illinois campus.

"I had never worked with yeast before this. I work with an unconventional yeast, *Yarrowia lipolytica* (a specific type of yeast known for its lipid production) to convert the lipids to more usable, valuable products," Plutz said.

Though this is Plutz's first time working with the micro-organism, his diverse professional and educational backgrounds have prepared him for switching gears seamlessly.

Plutz graduated from Southern Illinois University with a Zoology degree before trekking to the University of Wyoming for his Master's.

"We work with this yeast because it makes a lot of lipids and stores them for energy" Plutz said. "Many other types of yeast are already being used in the production of biofuel and to make ethanol."

Plutz enjoys the structure of his lab work. As part of the lab team, he's tasked with manipulating the yeast genome to see how the yeast reacts.

The Ainsworth Laboratory's field experiments are conducted at SoyFACE (Soybean Free Air Concentration Enrichment), where Li's team examines how Midwestern agricultural crops respond to elevated levels of ozone and carbon dioxide (CO_2).

"We want to see how our crops respond to the future climate," Li explains, "because the CO_2 concentration and the ozone concentration are increasing."

Li's research group also studies plant biomass in response to elevated ozone and CO_2 concentrations.

"This is a guide for other scientists in the future so they know how they could improve the yield of biomass, and which direction we can go next," he says.

Full article by iSEE Communications Intern Jenna Kurtzweil at cabbi.bio.

Though altering yeast genetics is a fairly simple task at face value, it could be done more efficiently and accurately.

"We're working on using CRISPR to make gene integration and deletion faster and more accurate. Getting CRISPR to work for us will be the next step in our research," Plutz said.

Full article by iSEE Communications Specialist Jordan Goebig at cabbi.bio.

2018-19 CABBI Updates ...

Funded by the U.S. Department of Energy as one of four national Bioenergy Research Centers, CABBI officially started in December 2017. The $115 million center is led by the University of Illinois at Urbana-Champaign.

CABBI
CENTER FOR ADVANCED BIOENERGY AND BIOPRODUCTS INNOVATION

CABBI has more than doubled in size in the last year. As of mid-June, the Center now employs **285 people**: 62 co-PIs, 63 postdocs, 60 graduate students, 33 undergraduate hourlies, seven support staff, and 60 other research staff.

CABBI scientists published **41 papers** in the last fiscal year, and the Center was well represented at the DOE Genomic Science Meeting in February with 20 posters and plenary presentations by Director Evan H. DeLucia and Co-PI Angela Kent. DeLucia also participated in congressional visits with other BRC members in February. And Co-PI Tom Clemente presented to U.S. Sen Deb Fischer's (R-Neb.) staff on aspects of CABBI and its transdisciplinary approach to develop a sorghum feedstock for the bioeconomy.

CABBI scientists disclosed **three new inventions** in early 2019.

In addition, during the past year, CABBI:

❖ Added two new partners — Texas A&M University and Archbold Biological Station in Florida — bringing the total number to **19 partner institutions**.

❖ Completed its Year 1 DOE external review in February 2019.

❖ Brought together its first Governance Board meeting in November 2018.

❖ Hosted its second retreat, attended by more than 200 people including members of other BRCs and the Strategic Advisory Board, which met for the first time.

❖ Hired a data manager in April 2019 to oversee storage and management of all research data.

❖ Added a field site at Archbold to collect sugarcane data.

❖ Hosted a BRC modeling workshop in May in Chicago, bringing 60 BRC researchers together to discuss approaches to sustainability modeling.

❖ Nearly completed upgrades to the Illinois Biological Foundry for Advanced Biomanufacturing (iBioFAB) — thus allowing more techniques for high-throughput phenotyping.

❖ Added to a growing toolbox for novel yeasts.

❖ Opened the possibility for metabolome annotation of less-studied microbes that might have unique properties amenable to industrial bioproduct and biofuel production.

❖ Advanced the ability to engineer sorghum strains and furthered understanding of gene regulatory networks.

❖ Completed Miscanthus genome work along with research into improving winter hardiness and flood tolerance.

❖ Evaluated ozone tolerance for sorghum and other warm-season grasses.

❖ Enhanced genome editing efficiency in sugarcane.

Read more and stay up to date at cabbi.bio.

Postdoc: Sustainable Farming Has its Roots in the Soil

Originally from Sacramento, a vibrant city nestled at the top of California's Central Valley, iSEE Postdoctoral Research Associate Ilsa Kantola grew up surrounded by agriculture both geographically and genetically — Kantola's grandfathers worked in the industry, and her father has a degree in Agricultural Economics. Living in a bustling metropolis did nothing to hinder Kantola's bond with nature. On the contrary, she fondly recalls driving down country roads playing a game called "Name that Crop."

"Which," Kantola jokes, "can be a very boring game in Illinois."

In her work at the University of Illinois at Urbana-Champaign in partnership with the Leverhulme Centre for Climate Change Mitigation (LC3M), Kantola contributes to the industry's most high-stakes conversation: the search for sustainable farming practices of global proportions.

Kantola has long been passionate about her current field: her bachelor's degree from California Polytechnic State University is in Environmental Engineering with a Soil Science minor. Soil Science quickly developed into a central interest area — and influenced Kantola's decision to complete her Ph.D. at Texas A&M in the department of Rangeland Ecology and Management, now Ecosystem Science and Management.

The decision to study soil in Texas was not a difficult one.

"It's chemistry, it's biology, it's agriculture, it's food, and it's people," Kantola says of her passion for the subject. "And it's all together."

When she arrived at Illinois to work for the Energy Biosciences Institute (EBI), her focus shifted from Texas grasslands to Midwest croplands. Her team's BP-funded study sought corn alternatives for the production of bioethanol — a naturally produced fuel supplement — and her objective was to measure the ecological effects of using perennial grasses as a substitute.

Native switchgrass and the Asian hybrid *Miscanthus x giganteus* grown at the Illinois Energy Farm were posited as promising alternatives because perennials — plants with life cycles longer than one growing season — require less management than annuals such as corn, with potential

Basalt is applied to a University of Illinois field.

for similar or greater yields. Additionally, the Miscanthus variety grown at the Energy Farm cannot be consumed by humans or livestock, so bioethanol production would not come at the cost of a viable food source.

Kantola expresses a passion for using focused research to drive big results:

"We start small, digging at the farm. But U of I sites are representative of the larger Midwest, so data we collect can be scaled up to visualize what's happening on a larger scale."

Passion for the big picture informs Kantola's current LC3M research at Illinois. The project aims to combat rising atmospheric carbon dioxide (CO_2) levels by imbuing cropland soil with calcium- and magnesium-containing silicate rocks.

The researchers' process for capturing atmospheric CO_2 involves two chemical reactions. First, atmospheric CO_2 dissolves in rainwater to create carbonic acid. Then, the acid reacts with calcium and magnesium in the soil to form calcium and magnesium bicarbonate, soluble compounds that leach with soil water, resulting in the relocation of CO_2 from the atmosphere to the water cycle.

To enhance this process, Kantola and the team turn to basalt, an igneous rock containing both calcium and magnesium as well as phosphorus and minor nutrients that can benefit soil fertility. Large quantities of finely-ground basalt are spread over twin fields of corn and miscanthus at the Energy Farm and left to react with CO_2-laden rainwater.

"We're trapping atmospheric CO_2 in the water cycle so that it can move out through the drainage tiles, into the Mississippi, down to the Gulf, and potentially benefit the oceans," she said. "That's the dream: that we can cure ocean acidification, reduce atmospheric CO_2, and benefit our crops at the same time."

Because of basalt composition and soil fertility variation across climates and continents — and the potential for plants and soil microbes to change the rates of basalt weathering — LC3M collects data from three ecologically diverse locations. In addition to the temperate Midwest, basalt is similarly applied to a palm oil plantation in Borneo and a sugarcane field at James Cook University in Queensland, Australia.

"The project is getting global," Kantola explains. "That was always the intention."

Full article by iSEE Communications Intern Jenna Kurtzweil at sustainability.illinois.edu.

2018-19 LC3M Updates ...

iSEE partners with the Leverhulme Centre for Climate Change Mitigation (LC3M) at the University of Sheffield, UK and collaborates with researchers in the UK, Australia, and Malaysia to investigate methods for removing CO_2 from the atmosphere. Since 2016, crushed basalt rock has been applied to corn, soy, and miscanthus fields at the University of Illinois Energy Farm. Researchers are investigating the potential of Midwestern croplands to act as sinks for atmospheric CO_2, while still supporting the agriculture critical to the region. A pilot study in all three crops was expanded to field scale in maize in 2017, and maize and miscanthus in 2018 and '19. Early results show that in Illinois, a large effect of this CO_2-capture project is observed in the agricultural nitrogen cycle.

iSEE Director Evan H. DeLucia heads the Illinois LC3M research team, with USDA Researcher Carl Bernacchi, Plant Biology and Crop Sciences Professor Steve Long, Postdoctoral Research Associate Ilsa Kantola, Plant Biology Technician Michael Masters, and two field technicians. More:

❖ In the 2018 research season, measurements of greenhouse gas production from soils, soil carbon and nitrogen, and plant biomass and yield were carried out through the growing season, while eddy covariance towers monitored gas exchange for each of the crops. Water samples were collected throughout the year and analyzed for acidity, electrical conductivity, alkalinity, and numerous other factors including radiogenic strontium isotope ratios, which indicate the presence or absence of basalt. Measurements in 2018 confirmed that, like maize, soils under miscanthus respond to basalt application with increased pH and reduced soil N_2O production. The 2019 season began with basalt application to maize/soybean fields in November 2018 and continued with basalt application to miscanthus and the first full-scale planting of basalt-treated soybeans in May 2019.

❖ Team members made **four** conference presentations and had **six** invited talks in 2018-19.

Read more and stay up to date at sustainability.illinois.edu/research.

NEWLY FUNDED RESEARCH PROJECTS

iSEE Helps Secure New Grants

In September 2018, iSEE announced that it helped attract two grants totaling more than $5.6 million for University of Illinois and partner researchers:

D.K. Lee at the Illinois Energy Farm with the 'Independence' switchgrass variety he developed.

$5M for Energy Crops Study

A U of I Crop Scientist will lead a team of researchers on a five-year study of new crops that could contribute to the production of affordable, sustainable sources for market-ready fuels and other valuable products.

U of I College of Agricultural, Consumer, and Environmental Sciences (ACES) and Crop Sciences Professor D.K. Lee and his collaborators were awarded $5 million from the U.S. Department of Energy (DOE) for a study titled "Next-Generation Feedstocks for the Emerging Bioeconomy." Other team members in the study funded by the DOE's Bioenergy Technologies Office (BETO) are from the U.S. Department of Agriculture's Agricultural Research Service, Iowa State University, South Dakota State University, Argonne National Laboratory, Idaho National Laboratory, and Antares Group Inc. They will collaborate with industry partners POET-DSM Advanced Biofuels LLC, Enginuity Worldwide LLC, and The Climate Corp.

"To provide sustainable sources of energy for an ever-growing world population, we must build a new energy plan on a bioeconomy platform," Lee said. "That means, for starters, that we need to know which energy crops will be the most productive and valuable — and best for the environment.

"We will ... learn what new varieties of energy crops will best be suited to produce the best fuels and most valuable products."

The team will assess field-scale yield of advanced switchgrass varieties such as "Independence" — which was developed by Lee — for pre-commercialization. Team members also will examine other warm-season perennial grasses such as switchgrass blends, big bluestem, prairie cordgrass, and Miscanthus.

iSEE, which helped put forth the successful proposal, is an administrative partner along with the Carl R. Woese Institute for Genomic Biology (IGB) in the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI), a DOE Bioenergy Research Center that is studying energy crop trait improvement; automated conversion of biomass into useful, valuable chemicals; and studies on the economic and environmental sustainability of CABBI crops and processes.

"By including CABBI, the national labs, and industry members, along with other partners' large Midwest energy crop research sites, we can loop our real-world data into today's bioeconomy industry," Lee said. "This will help us find the right varieties of grasses — and speed adoption of practices that increase the growth of this new energy supply while reducing cost.

"I'm grateful to Evan DeLucia and the iSEE team for helping us put together a successful proposal. This is a win for Illinois, the College of ACES, and our partners — and I believe a win for what could be a promising future in energy production."

$600K+ for Grazing Study

iSEE Visiting Research Scientist Nuria Gomez-Casanovas and DeLucia received $663,585 from Arizona State University for a study titled "Can Adaptive Multi-Paddock Grazing Management Increase the Net Greenhouse Gas Sink Strength and Water Use Efficiency of Grazed Pastures?"

According to a description of the project, which is part of a collaborative effort to study if a new grazing practice can help sequester carbon in soils: "Future food production needs new agricultural management strategies that increase ecosystem services while enhancing food production. (Gomez-Casanovas) will investigate emerging adaptive multi-paddock grazing management (AMP) that has the potential to increase soil carbon sequestration and compare it to the 'business as usual' continuous grazing (CG). She will explore how those practices affect the delivery of greenhouse gas (GHG) regulation and water use efficiency (WUE) from grazed pastures used for livestock.

GOMEZ-CASANOVAS

"The proposed research will fill major knowledge gaps in how AMP grazing affects ecosystem productivity, net ecosystem GHG exchange, and WUE of pastures."

Next-Gen Feedstocks Updates ...

Project Principal Investigator D.K. Lee, who was recently promoted to full Professor of Crop Sciences at Illinois, reported the following updates from early on in the research project:

❖ "After receiving our funding from the Department of Energy in July, we began distributing money to partners and hiring postdocs and other team members."

❖ All field plots were planted in 2019, and Lee hosted the first project team meeting July 24 during the Switchgrass V International Conference, which Lee's Illinois team put on. Sponsored by the U of I Department of Crop Sciences, iSEE, the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI), Green Lands Blue Waters, Ernst Conservation Seeds, and the Sun Grant Initiative's North Central Regional Center, the conference was at the Holiday Inn in Champaign. More than 100 attendees discussed switchgrass and other dedicated energy crops grown for forage, conservation, and bioenergy production.

Read more and stay up to date at go.illinois.edu/NextGenFS.

Multi-Paddock Grazing Updates ...

PI Nuria Gomez-Casanovas on the first months of this project:

❖ "With global population rising at an unprecedented rate, food production must increase to feed 11 billion people over the next 40 years despite the degradation and loss of ecosystem services due to management intensification and impeding stresses of changes in climate. Society needs management strategies that increase food production without damaging the environment. Discoveries from the AMP team hope to play an important role in addressing this challenge."

❖ The AMP team's research is conducted in Southeastern U.S. subtropical humid grasslands located in Alabama, a biome that comprises up to 30% of grasslands globally. In April 2019, the team installed four eddy covariance towers in four grasslands, two under AMP management and the other two under CG management.

❖ "Since then we have been measuring the exchange of CO_2, CH_4 and N_2O between these grasslands and the atmosphere with these towers," Gomez-Casanovas said.

❖ Samplings for discrete measurements of these GHGs will occur four times a year.

❖ The project received an additional $135,135 grant (2019-20) from the Arizona State University Foundation and ExxonMobil to continue investigating how AMP and CG impact the delivery of GHGs and water-related regulating services from subtropical humid grasslands.

Read more and stay up to date at go.illinois.edu/MPGrazing.

2019 iSEE SEED FUNDING

New Interdisciplinary Initiative

In February, iSEE announced that it was earmarking more than $150,000 in seed funding for five new interdisciplinary research projects.

Researchers will focus on collecting preliminary data or information that will help secure future funding from major external granting agencies.

"We are excited to announce funding for projects that propose innovative, interdisciplinary solutions to the grand challenges our planet faces," iSEE Associate Director for Research Madhu Khanna said. "iSEE was created to foster this type of 'actionable' research."

Projects selected for iSEE's 2019 seed-funding initiative:

• The investigation of air pollution transport through the atmosphere and international trade — led by Illinois Associate Professor of Agricultural and Consumer Economics Sandy Dall'erba.

• The exploration of water and sanitation systems in peri-urban Ugandan communities to improve overall health and nutrition through resource recovery — led by Assistant Professor of Civil and Environmental Engineering Jeremy Guest.

• The creation of a Farm Vulnerability Index and immediate water sample research at 2019 hurricane locations to determine pathogen risks to livestock and food storage after natural disasters — led by Associate Professor of Civil and Environmental Engineering Thanh H. Nguyen.

• The collection and modeling of social media data from disaster events to improve response and infrastructure management — led by Associate Professor of Industrial and Enterprise Systems Engineering Pingfeng Wang.

• The development of a CyberGIS system that will bring together complex geospatial community data to help cities lead better, healthier, more sustainable lives — led by Professor of Atmospheric Sciences Don Wuebbles.

Updates ...

Guest's water and sanitation team:

❖ Held the first of two public workshops toward advancing nature-society interactions in developing communities. The meeting In March at the iSEE Collaboratory (*page 44*) was expected to establish a cohort of multidisciplinary researchers interested in pursuing external funding to build these concepts into a large-scale initiative for international development.

❖ Published a paper in *Nature Sustainability* titled "Resource Recovery from Sanitation to Enhance Ecosystem Services."

❖ Requested $1M from the Bill & Melinda Gates Foundation for a research project that would evaluate the economical and environmental impact of toilets and sanitation systems under development.

Update ...

The CyberGIS team has assigned a postdoc and a senior research scientist to begin preliminary work on the new system.

Read more and stay up to date on these projects at sustinability.illinois.edu/seed-funded-research-2019/

2019 CAMPUS AS A LIVING LAB SEED FUNDING

Campus Sustainability/Research Program Extended

In February, the Institute announced that it was earmarking more than $100,000 in seed funding for four new additions to its Campus as a Living Laboratory research portfolio.

The Campus as a Living Lab program now includes seven projects that tie iSEE's research and campus sustainability missions closely together.

"Renewable energy generation, transportation, and healthy environments are all key elements of the Illinois Climate Action Plan," iSEE Associate Director for Campus Sustainability Ximing Cai said. "These projects and others in our living lab program might ultimately lead to fewer emissions on our campus — saving natural resources and money — and a safer, cleaner place to work and learn."

Projects selected for 2019 seed funding:

• The construction of an autonomous robot that collects indoor air quality data — led by Associate Professor of Civil and Environmental Engineering Nora El-Gohary.

Update ...

El-Gohary's team intends to submit a full funding proposal in January 2020 to the National Science Foundation.

• The examination of geothermal systems on Illinois' John Bardeen Quad — led by Assistant Professor of Civil and Environmental Engineering Tugce Baser.

Update ...

Geothermal project lead Basar recently submitted a technical paper for review for the American Society of Civil Engineers (ACSE) annual conference Geo-Congress 2020.

• The study of Illinois student's transportation and mobility habits while on campus — led by Professor of Geography and Geographic Information Science Julie Cidell.

• An assessment of geopolymer-based construction materials in a building that uses geothermal energy — led by Professor of Civil and Environmental Engineering Timothy Stark.

These four projects join three other initiatives in the Living Lab program that began in 2018:

• Creating a battery pack capable of storing heat from industrial waste through a series of chemical reactions, led by Professor of Mechanical Science and Engineering Sanjiv Sinha.

• Testing a waste processing system that will produce renewable energy, clean water, and bonus organic fertilizers, led by Professor of Bioengineering Yuanhui Zhang.

Update ...

Zhang's team applied for a $2.5M grant from the National Science Foundation, but the proposal was not funded.

• Investigating agrivoltaics, a strategy by which crop production and solar panels can be merged within a landscape to increase food and energy production, led by Professor of Agricultural and Consumer Economics Professor Madhu Khanna.

Update ...

After a $2.5M grant proposal to the National Science Foundation was rejected, the agrivoltaics team intends to apply for $11.2M (one full grant; one subaward) from the U.S. Department of Agriculture in 2019-20.

Read more and stay up to date on at sustinability.illinois.edu/campus-as-a-living-laboratory-research-campus-sustainability-working-together/

C*is* 2.0: FFAR Grant Funds Next Steps

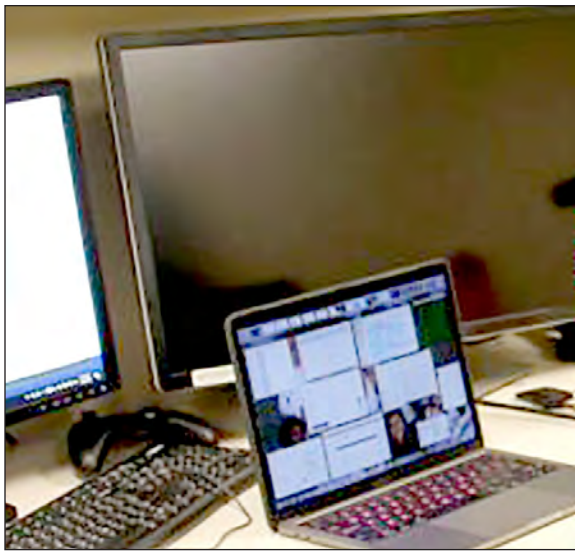
In March, iSEE learned that its seed-funded Crops *in silico* (C*is*) project received a $5 million grant from the Foundation for Food and Agriculture Research (FFAR) to continue building a computational platform that integrates multiple models to study a whole plant virtually.

"Corn, soybean, sorghum, and wheat account directly or indirectly for about 60 percent of human calories. Yet they are susceptible to declining yields due to the impending stresses of climate change, including water shortages, elevated carbon dioxide levels, and soil degradation," said Amy Marshall-Colón, U of I Assistant Professor of Plant Biology and the Principal Investigator for the new four-year grant.

Understanding how crops respond and may be adapted to combat environmental changes can help address current and future food insecurity. C*is* allows researchers to quickly determine and test characteristics that help crops thrive in specific environments. This modeling allows billions of combinations to be tested to achieve more productive and sustainable crops in different environments.

Co-Investigators on the new grant include Illinois' Matthew Turk, Assistant Professor of Astronomy and Research Scientist at the National Center for Supercomputing Applications (NCSA); Stephen P. Long, Professor of Plant Biology and Crop Sciences; Kaiyu Guan, Assistant Professor of Natural Resources and Environmental Sciences; and Meagan Lang, NCSA Research Scientist. Collaborators from other institutes include Jonathan Lynch, Professor of Plant Science at Pennsylvania State University; Bedrich Benes, Professor of Computer Graphics Technology at Purdue University; Lee Sweetlove, Professor of Plant Sciences at Oxford University; and James Schnable, Assistant Professor of Agronomy and Horticulture at the University of Nebraska.

The Crops *in silico* 2.0 team includes: front row, from left Kaiyu Guan, Bedrich Benes, Amy Marshall-Colón, Stephen P. Long, and Traci Quigg Thomas; and back row James Schnable, Meagan Lang, Lee Sweetlove, and Matthew Turk.



Reading

It might come as a surprise that Colleen Heinemann, a Ph.D. student in the Informatics Department at the University of Illinois at Urbana-Champaign, wasn't always convinced of her passion within computer science. Through curiosity, determination, and refusing to remain in her comfort zone, Heinemann unites her strengths in research and creative problem-solving with her scientific interests to blaze new trails in high-performance computing research.

Heinemann began her undergrad at Bradley University studying Computer Science and Animation, interested in both but unsure of how they might add up to a career. Undeterred, Heinemann embraced every opportunity that came her way to apply her skills in and out of the classroom.

Now, Heinemann's work with the U of I's Crops *in silico* project enables the jump from computer to life science via a field she never anticipated entering: plant biology.

the Leaves ...

Crops *in silico* (literally, "crops in computers") is a collaboration between iSEE and the National Center for Supercomputing Applications (NCSA). C*is* leverages computational modeling to optimize crops' nutritional value.

"As populations continue to grow, we need more food … but the Earth is only so big, and there are only so many places that you can plant sustainable crops," she said. "Rather than continuing to expand the number of crops, the idea is to maximize on what we have available."

To do this, she uses a graphics technique called ray tracing to simulate how a beam of sunlight interacts with a specific point on a leaf. From there, she draws conclusions about how the plant photosynthesizes and how its nutrients can best be optimized.

"The plant can be constructed as a 3D model by triangles," she said. "Looking at each individual point, or triangle, on a leaf, we can determine how much light hits it. That's going to be the meat of figuring out how many nutrients you can get out of that plant."

Heinemann is developing this software from scratch, often with a "blank slate." She appreciates the flexibility and mental agility required of the creative process.

"You're continuously changing not only your short-term goals to a certain extent, but how you approach the goals," she said.

Full article by iSEE Communications Intern Jenna Kurtzweil at sustainability.illinois.edu.

C*is* Updates ...

As the team transitions to C*is* 2.0, Principal Investigator Amy Marshall-Colón helps wrap up the C*is* 1.0 project, seed-funded by iSEE in 2015:

❖ "The aim of the Crops *in silico* 1.0 project was to lay the foundation for generating virtual plant models that accurately capture whole-system dynamics in response to *in silico* environmental and genetic perturbations. We built a computational framework that allows asynchronous communication between models without altering their original code or timesteps. This framework allows the exchange of inputs and outputs between models, mimicking the flow of biological information across scales. We used the framework to successfully build a multiscale model of the soybean photosynthetic response to elevated CO_2 concentration. The vetted model was used to perform in silico genetic perturbations and simulate the anticipated outcomes on photosynthetic efficiency."

❖ After dozens of simulations, the team identified three top transcription factor gene candidates that will be tested experimentally for their regulatory role in controlling photosynthetic efficiency. The computational framework was also used to link whole-plant models of roots and shoots to form the core structure of virtual soybean and corn plants. These linked models were subjected to advanced visualization approaches so that *in silico* observations can be made on an entire stand of plants. The use of three-dimensional architecture was shown to improve model simulations of light capture throughout a soybean canopy, providing new insights about plant competition for light resources.

❖ In May 2019, the new Cis 2.0 team hosted the fourth annual Crops *in silico* Symposium, Workshop & Hackathon. The event featured more than 60 registrants from 13 institutions. The third annual meeting, in August 2018, was also at the University of Illinois — and it featured 55 registrants from 27 institutions and companies and nine countries.

❖ Team members also published **two** new papers in 2019.

Read more and stay up to date at bit.ly/Cropsinsilico

SMC Researcher Takes the Battle to the Mosquitoes

EDITOR'S NOTE: Parker received her doctorate and is a new faculty member at Northern Kentucky University.

The saying goes that in war you must "know your enemy" to defeat it, and that's exactly the aim of Allison Parker's research. She's a fifth-year Ph.D. Candidate in Entomology at the University of Illinois, and for more than half a decade, she's been collecting, inventorying, and raising mosquito larvae to learn more about them so she can force their retreat from urban environments.

In most temperate and tropical areas of the world, mosquitoes pose a serious human health threat because of the diseases they transmit through bites. In a world growing more urban each day — and as the world climate warms extending mosquitoes' livable range — a way to combat these pests in developed residential areas has become a grand world challenge. Pesticides are one option, but those chemicals have some negative environmental consequences. iSEE's Stormwater and Mosquito Control team seeks less chemically reliant solutions.

Parker's work focuses on the egg-laying stage of the mosquito lifecycle. Simply put: Intervening at that stage can reduce the number of babies that survive to become disease-spreading adults.

What makes a good mosquito nursery?

Mosquitoes start their lives as water-dwelling larvae, little worm-like creatures without wings or long legs. So, mother mosquitoes are searching for water. And not just any water; it needs to be stagnant water that's been sitting around long enough for leaves, sticks, and other debris to fall in, start decomposing, and become a microorganism buffet table for mosquito larvae.

Lots of seemingly harmless backyard items can turn into such sanctuaries after a rainfall. Are all created equal, or do mosquitos prefer one type of container over another? To find out, Parker reviewed her notes from past habitat studies and identified four of the most frequently occurring to test for mosquito preference: curbside trash cans, flowerpots, flowerpot drainage saucers, and corrugated plastic downspout extenders. Eight houses in residential neighborhoods of Champaign were given a set of these items to be placed outside and filled with a grass-infused water mixture to attract mosquitoes.

Every day, she and a few undergraduate research assistants visit all the test sites to gather the eggs and baby mosquitoes they find in each container type. In the middle of the summer months, it's hot and sweaty work. They record the number and kind of specimens collected in each container at each house. These data will tell whether one type of container consistently outperforms another over an entire mosquito season.

Spending four to six hours a day in the field means there isn't much lab time to process all the samples — counting mosquito eggs, hatching them, and then raising the larvae to identify the adult species. Luckily, Parker has the help of seven undergraduate students who work in shifts throughout the week to make sure that the lab work doesn't lag behind.

"My favorite part of this research is working with the undergrads. They're very enthusiastic, and we all share the fun and not-so-fun tasks," she said.

Training and mentoring younger students actually inspired Parker to return to school for an advanced degree.

After completing a Bachelor's Degree in Biology from the University of Richmond, she served as a high school science teacher in Dallas through the Teach for America program. While she was there, the area experienced an outbreak of West Nile virus. Pulling from her undergraduate research experience, she taught students about mosquito life cycles, how they're controlled, and self-protection from bites.

"I really enjoyed those lessons. I realized I could combine a lot of different interests into mosquito research: microbiology, ecology, toxicology, social sciences, or health care fields. You can have a diverse group of people all working on similar projects," she said.

On its own, Allison's research has a narrow scope: a handful of species in a single city in containers 1, 2, 3 or 4. However, combined with all her teammates' work, she thinks that her work is contributing to an overall shift in how Champaign and other cities may create mosquito control programs.

"We're all tackling the problem in our own little way," she said, "but taken together our results can make really good recommendations for control measures for city- and resident-implemented mosquito control programs."

SMC Updates ...

Principal Investigator Brian Allan reports that the fourth year for this 2015 iSEE seed-funded project "has been highly productive in several major areas:"

❖ The team continues to develop a research program using "social sensing" (geo-located social media activity data) to model networks of human movements and contacts to recreate the pattern of spread of Zika virus in the Americas and apply this to future outbreaks, part of its newly funded $1.5 million study as a subcontractor for the University of Maine.

❖ Additionally, several of the team's field-based projects into the effects of stormwater management practices on mosquito-borne disease risk have matured, and **two** research papers were published, led by Allison Gardner on the use of native vegetation as an ecological trap for mosquito control and by Allison Parker on competition between mosquito species in container environments, as well as on the potential effects of gutter guards.

❖ "Our findings to date have motivated several additional field and laboratory studies, including surveys of green and conventional stormwater infrastructure here in Illinois to explore the consequences of the adoption of green technologies for mosquito control and the impact of the stormwater environment on the assembly of the mosquito microbiome," Allan said. The additional efforts stem in part from the research of several SMC graduate students.

❖ In addition, Co-PI Carla Cáceres continues leading her $800,000 National Science Foundation study along with several SMC team members, examining potential feedback loops between the food web where mosquito larvae are born and the chemistry of their guts.

❖ And Allan helped lead iSEE's Critical Conversation in May on genetically modified mosquitoes (*page 27*), a controversial topic on many levels.

Read more and stay up to date at bit.ly/stormmosq.

Selling Sun Buckets to the Next Generation

EDITOR'S NOTE: Lindgren continues to pursue her doctorate, and working for Sun Buckets — and is in the midst of a two-year Link Energy Fellowship (read more in the update to the right).

Sam Lindgren is a Ph.D. Candidate in Agricultural and Biological Engineering and a member of iSEE's Stored Solar Stove research team. While her teammates work to technically perfect the "Sun Bucket" solar-powered clean cooking device, she examines the communications and relationship-building needs for adoption of the device.

User-centered design is a big focus of the Solar Stove group — the team is committed to building a product that meets all the needs of the users.

Even when the technology is right, Lindgren said, adoption doesn't always happen:

"(I've found that) there needs to be a lot of follow-up support and communication to keep people using something that's new," she said. "Even if someone is really interested in it, it's very easy to fall back into old habits.

"I see it with myself. I'll give up drinking soda for two months, but then I slide back, even though I know I shouldn't because it's not healthy for me. Ongoing support, communication, and education with the end user is really important."

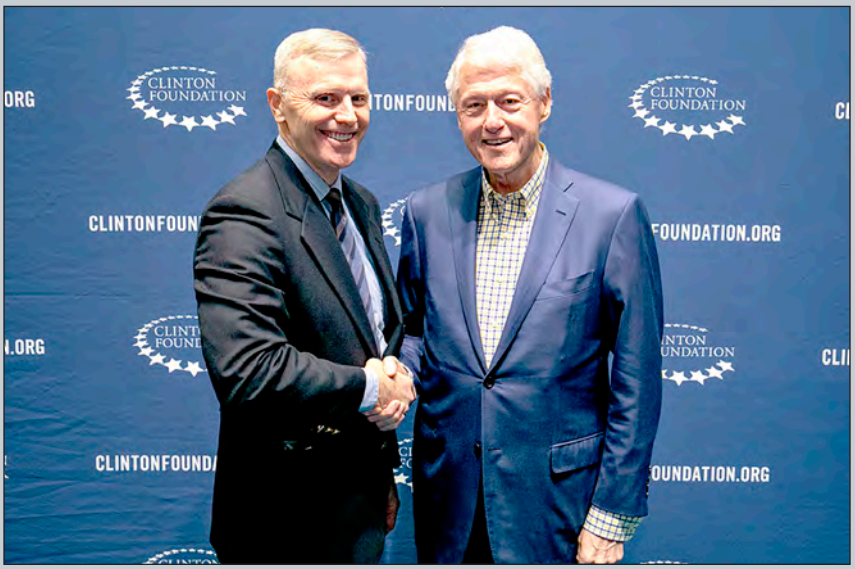
Listening to women is by far the most important piece. All over the world — in countries developed or underdeveloped or somewhere in between — women do most of the cooking. Their perspectives and feedback are essential. What do they need, and what do they wish they could do that they can't do now?

Lindgren and her teammates have made several trips to communities in the Navajo Nation at the Four Corners region of the United States and to partner organizations in Haiti to observe women cooking, to learn the ways that they cook, and to see how their children interact in the kitchen.

During visits with fire cookers, Lindgren enthusiastically shares about being a mom. She also shares that she frequently uses her own Sun Bucket to cook meals for her family.

When she's not gathering data to drive user-centered design or testing the latest prototype on her home countertop, she is dialing in on her Ph.D. thesis: How do you — or should you — convince someone in a different part of the world that they should change behaviors that have been part of their culture and their family for generations?

Full article by former iSEE Communications Specialist Olivia Harris at sustainability.illinois.edu.



Sun Buckets Updates ...

Principal Investigator Bruce Elliott-Litchfield offers the following updates from the fifth year of this 2014 iSEE seed-funded project:

❖ As part of her $29,500-per-year Link Energy Fellowship, Ph.D. Candidate Sam Lindgren spent the Spring 2019 semester in Namibia (*photo top left*) studying the impact of children on their parents' cooking energy decisions.

❖ "We have begun fabrication of the beta model Sun Bucket, including casting of the inner vessel by a central Illinois foundry," Litchfield said.

❖ United Nations Humanitarian Grand Challenges (UNHCR) facilitated an approximately $185,000 (250,000 Canadian dollars) grant (one of 22 funded by the U.S. Agency for International Development (USAID) from among 643 applicants) to study the use of Sun Buckets in conflict zones. In August 2018, Sun Buckets sent a team to field test and demonstrate prototypes in the UNHCR Kakuma Refugee Camp in northern Kenya (pictured right). That same month, another team tested the Sun Buckets in Somaliland, Somalia. And several Sun Buckets systems were shipped to the Indian Oil Co. for testing.

❖ Postdoc Matthew Alonso and Intern Rashna Raham are conducting peanut drying tests that use Sun Buckets as the energy platform for a new off-grid dryer (*photo far left*), funded with a $50,000 grant from the Archer Daniels Midland Institute for the Prevention of Postharvest Loss.

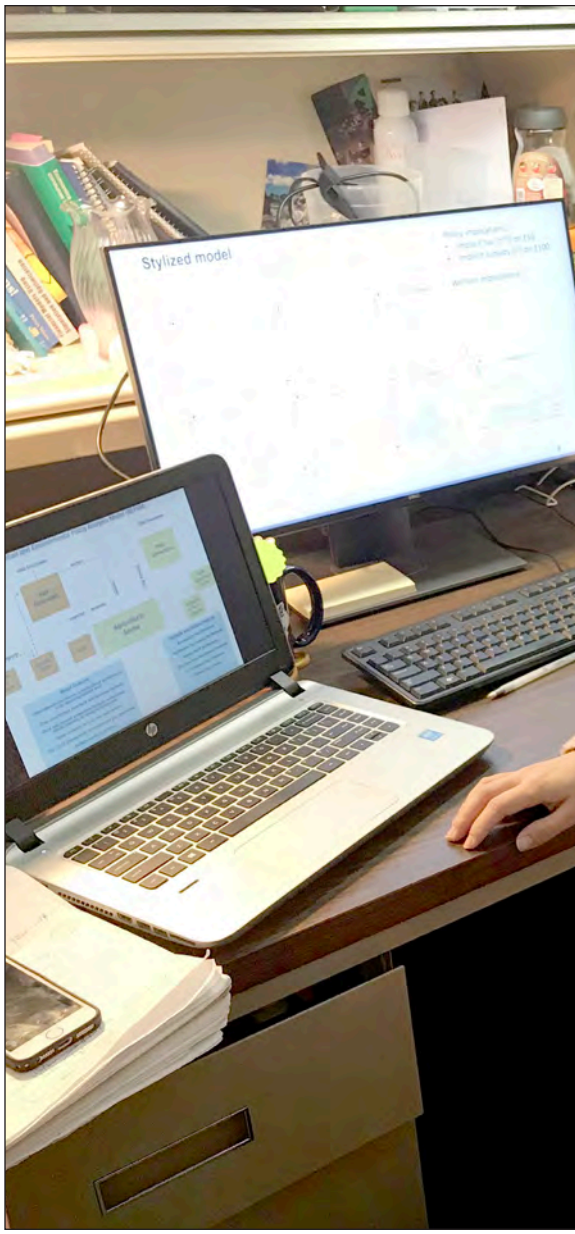
❖ "We continue exploring partnership options with organizations that can facilitate marketing, distribution, fabrication, and financing," said Litchfield, who attended a Clinton Global Initiatives meeting in January 2019 in San Juan, Puerto Rico (*photo near left*). The meeting included more than 500 leaders from business, government, and philanthropy.

❖ In Spring 2019, Sun Buckets was featured in a documentary on the Big Ten Network, and in June 2019, Alonso collected the Governor's Award for New Exporter of the Year in Chicago.

Read more and stay up to date at bit.ly/sunbuckets.

CRITICAL INFRASTRUCTURE & TRANSPORTATION PROJECT

Modeling a Better Future



Most people don't look to economics to solve issues in sustainability. However, Jia Zhong, a member of the Critical Infrastructure and Transportation project and a Ph.D. student in the Department of Agricultural and Consumer Economics, does just that.

By building economic models from complex data sets, Zhong and her teammates can answer the "what-ifs" surrounding renewable energy and national transportation systems, allowing policy-makers to enact changes for a healthier society and environment.

Her specific "what-if" is about cars — in particular flexible-fuel vehicles (FFVs) that can run on multiple types of fuels (such as gasoline mixed with a higher content of ethanol) in a single tank. By studying these vehicles, she can see if increased usage could help improve a current government policy requiring a certain volume of renewable fuel to be mixed into petroleum-sourced fuel.

From an environmental standpoint, these cars are a great alternative to standard vehicles due to their lower emissions. In a perfect world, all people would adopt active transportation or use zero-emissions vehicles because it's the right thing to do. Zhong's work, however, is in finding more probable — and practical — solutions in an imperfect world. For sustainability economists, the best options for creating a better environment are ones that have the best chance of widespread adoption.

She poses a series of economic questions to begin teasing out the optimal conditions for FFVs to comply with government standards: Under what conditions would flex-fuel cars be economically attractive to consumers and compliant with government standards? How can blended fuel be priced to appeal to consumers? How can these cars be incentivized while being economically feasible? While it may sound tedious, challenges like these allow economists like Zhong to shine.

"Some of the main factors we are dealing with are fuel pricing and the potential welfare cost," she said, and the goal is to predict the conditions that would benefit the largest amount of people for the lowest amount of money.

To discover such conditions, Zhong jumps into economic simulation — a computer-generated alternate "world" where she can manipulate the circumstances that could make the "what ifs" of FFVs possible. To an untrained eye, the simulation looks like an indecipherable web of graphs, spreadsheets, and variables. But to an economist, it's a thrilling opportunity to construct a better future.

Yet at the end of the day, these simulations are just suggestions — not reality. Despite multitudes of tests and simulations, researchers will never be able to accurately predict some aspects of economics.

"Usually the No. 1 question we get is, 'What percentage can you be sure that this will run the way you predict?' We always try to supplement real-life data to make it as accurate as possible," Zhong said. "But what we suggest are just implications, not a direct output.

"That's just the nature of all research: There's always a difference between the laboratory and the real world. By being involved with policy, we're able to contribute our knowledge and make reasonable suggestions for a positive impact," she said. "I'd love to take what I've learned and return to China and work on environmental policy there.

"I have a responsibility to learn as much as I can with my education so that I can help make the world a better place."

Full article by former iSEE Communications Intern Katie Watson at sustainability.illinois.edu.

ICI Updates ...

A few quick updates from the fourth year of this 2015 iSEE seed-funded project:

❖ In Summer 2019, Principal Investigator Ximing Cai was named an American Geophysical Union Fellow.

❖ Cai and team members have completed the second year of their three-year, $2.43 million NSF INFEWS grant research into food-energy-water resilience in the U.S. Corn Belt by modeling nutrient cycling.

❖ Team members are working on a comprehensive life-cycle emission assessment and cost comparison for electric vehicles. Among many things, they found that hydrogen fuel cell electric vehicle and full EVs account for about half the greenhouse gas emissions of a typical internal combustion engine vehicle.

❖ ICI team members also developed a spacial decision support framework for adoption of EVs, evaluating the social and cultural aspects of adoption across the nation.

❖ The team has simulated dynamic operations and pricing of electric UAV systems and power networks.

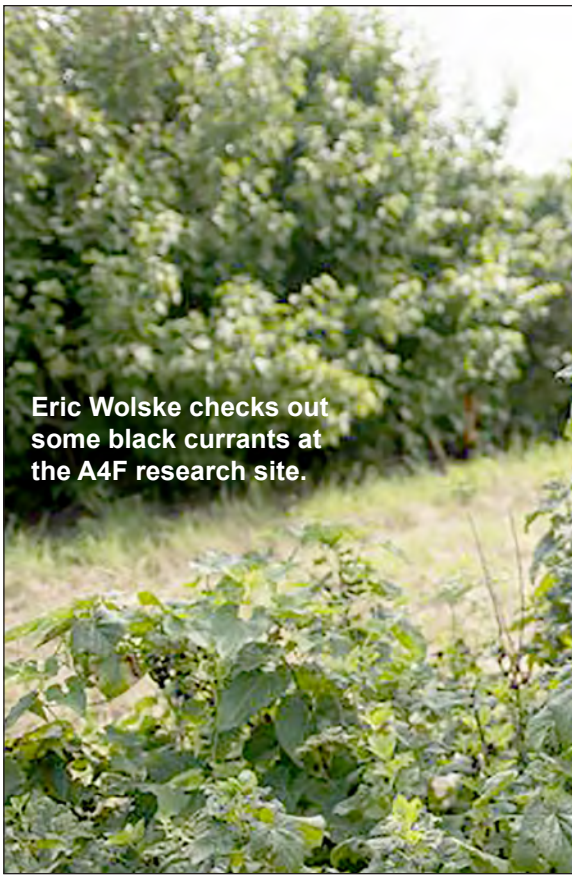
❖ Team members are creating a "sytem of sytems" modeling framework for planning EV charging infrastructure in intercity transportation networks. The framework considers users' travel behavior and the relationships between transportation and power systems, aiming at facilitating long-distance EV travels and providing an effective tool to evaluate the total emissions from both the transportation and power sectors.

❖ Other ICI team members hav examined the impact of the tightened Corporate Average Fuel Economy standards on the pricing of vehicles and types of vehicles produced since 2012: on average, the implied incremental cost of an additional mile-per-gallon vehicle-level CAFE standard was $600-$700 for ICE vehicles. This cost of CAFE standards was unanimously lower for high-mpg vehicles and flex-fuel vehicles.

❖ ICI researchers' findings were published in **four** papers in scientific journals during the past year — with two more pending and two under preparation.

Read more and stay up to date at bit.ly/ICI-project.

Back Home, Researcher Just Keeps Digging


Eric Wolske checks out some black currants at the A4F research site.

Eric Wolske, a member of Illinois' Agroforestry for Food (A4F) team, has found a simple way to explain the project's work:

"Agroforestry is growing crops with trees. That is the most basic level."

Originally from the Champaign-Urbana area, Wolske decided to go to Southern Illinois University in Carbondale for his B.S. in Plant and Soil Science. That campus' main quad is a forest, which was a big draw for Wolske. His college experience felt like trees were more than just campus décor.

"At the time I was more interested in booze crops: grapes, cider apples, all that fun stuff," he said.

After earning his undergraduate degree, Wolske spent time working in a vineyard — Southern Illinois has a lot of these.

"I'm from the fruit side; I think even fruits could be more sustainable," he said. "They're already in a sustainable category. They're perennials, they stay there. There's a fairly low amount of tillage, but it just seems like there's still a pretty big gap between getting all the potential ecosystems services and protecting your soil and everything else."

His interest in sustainable agriculture eventually brought Wolske to the Urbana-Champaign campus. A huge reason he decided to come home for the Crop Sciences M.S. and Ph.D. programs here was the iSEE seed-funded A4F project, which is pursuing alternative agriculture options in the Midwest.

Wolske's master's thesis focused on shade tolerance of black currants, a woody shrub that produces edible berries. This work transferred into Wolske's Ph.D. research, where he is now testing shade tolerance across 24 species of currants.

"We're just trying to see, is (shade tolerance) just in general something they're good at as a species? Or are there traits that some varieties have that others don't?" he said. "How can we help them perform better under shade?"

This passion for the environment and polyculture systems is evident when touring the experimental fields that Wolske has worked over the years. Every element used in experimentation was handmade, crafted, and recrafted (when the Illinois winds had other plans for his canopies).

"A ton of research still needs to be done to see if these systems have potential," he said. "We're starting to see while they work this way, they don't work that way. We're puzzling it all out. And what we're doing here is just scratching the surface."

Walking through fields, you can see just how much agroforestry is trying to integrate diversity back into the environment.

Right now, the A4F team works with a variety of plants — from peaches and raspberries to hazelnuts and chestnuts. But Wolske said all these crops share a common theme:

"They're natives, or they can be natives. The chestnuts have a high carbohydrate to them, which is pretty similar to what corn has, which is why corn is grown all over the place."

Planting native species could be commercially successful and a more sustainable agriculture option. Wolske's day-to-day projects vary just as greatly as the crops that agrofor-

estry produces in the fields. And much like the crops, Wolske's work changes with the season.

Starting in the early spring, pruning is the first task.

"That switches over to getting a lot of the experiments all set up," he said. "Then we have all the field work and everything else, like harvest times. And then I'll go into the lab and do a bunch of chemical assays on the berries and everything else. And then I'll go back into the writing period."

The perennial side of the A4F project is another factor that Wolske enjoys: "I don't like planting stuff every year, so stuff you just plant and let it go and you take care of them after that is way more my style."

In the future, Wolske hopes to continue his work with perennials and polycultures. He enjoys the research side of the project, but there is still a lot outside of research that Wolske would like to pursue.

"Teaching would be nice. Or maybe having my own winery someday would be pretty cool, too," he said.

In the meantime, he will watch the A4F farm he helped plant on his first day on the job continue to grow and evolve.

Full article by iSEE Communications Intern Taylor Jennings at sustainability.illinois.edu.

A4F Updates ...

Outgoing Principal Investigator Sarah Taylor Lovell and Co-PI Wendy Yang offer updates from the fifth year of this 2014 iSEE seed-funded project:

❖ A4F Co-PI Nick Paulson and other U of I faculty received **$1.2 million** from USDA NIFA and **$373,706** from the Illinois Nutrient Research & Education Council for assessing cover crops' ability to improve resiliency of Midwest ecosystems.

❖ The A4F site will serve as a field site for testing new robots and their ability to replace labor needs for berry harvesting and more in a new **$899,998** NSF NRI study.

❖ Irrigation was installed on the 30-acre plots, funded by a **$50,000** grant from the Student Sustainability Committee (SSC).

❖ Maintenance of the field trial has become more routine, and interest/curiosity from individuals within and outside of the University has grown. A4F researchers have experienced challenges with certain species/cultivars that were sensitive to the extreme wet and cold winters. Conversely, plots containing a diversity of native fruiting plants have continued to thrive, creating a full hedge between trees.

❖ Yang's team completed the second year of a USDA study, and preliminary results show that soil nitrogen emissions are not affected by fertilization of woody polyculture and that chestnut yields decreased likely due to a shift to vegetative growth in response to the first year of fertilization.

❖ The USDA AFRI project by Lovell and others was initiated in spring 2019 to gather baseline data for the comparison of the Conservation Reserve Program with multifunctional woody polyculture treatments.

❖ The team published **three** papers in scholarly journals with a fourth pending, and team members made **four** presentations at science meetings.

Read more and stay up to date at bit.ly/ag4food.

A Few More Updates ...

Levenick Research Fellow Publishes Paper

One of the first things iSEE funded from a 2014 gift by Stuart and Nancy Levenick (*page 4*) was a research project by Assistant Professor of Agricultural and Consumer Economics Erica Myers and Ph.D. Candidate Mateus Souza.

A paper by Myers and Souza, finished in October 2018 after more than two years of research, reported that students living in University of Illinois dormitories don't really consider energy costs — or conservation — even when provided with their energy consumption data. Students turned down thermostats over winter break, but did not do so after subsequent requests while they were actually occupying the dorms. Myers and Souza have submitted the paper to an academic journal for review.

Water Council Reconvenes

James Best, the Jack and Richard Threet Professor of Geology and a Professor of Geography and Geographic Information Science (GIS), was named Chairman of iSEE's Water Council, a steering committee that will help lead the Illinois Water Scholars as they work on major interdisciplinary research opportunities at Illinois.

Other Council members: Entomology Associate Professor Brian Allan; Geography and GIS Associate Professor Trevor Birkenholtz; Civil and Environmental Engineering Professor Marcelo Garcia (who also directs the Ven Te Chow Hydrosystems Laboratory); Agricultural and Consumer Economics (ACE) Associate Professor Benjamin Gramig; Soil and Water Resources Engineering Professor Prasanta Kalita; Illinois State Hydrologist Laura Keefer of the Illinois State Water Survey; iSEE Associate Director and ACE Professor Madhu Khanna; Illinois Water Resources Center Director and Illinois State Geological Survey (ISGS) Hydrologist Yu-Feng Forrest Lin; ISGS Geologist Andrew Phillips; and U.S. Geological Survey Hydrologist Ryan Jackson.

Team Wraps up Work

A project seed-funded by iSEE in 2015 examined use of a nanoparticle to remove pollutants from water. The project is now concluded, but Co-PI BK Sharma offers a few notes:

• In 2018, researchers published a paper in *Journal of Materials Chemistry A* on their novel approach to removing pharmaceuticals and personal care products from water.

• The team put forth a $500,000 grant proposal in August 2018 to the USDA for a study titled "Electrically Receptive and Thermally Responsive Sensor (ER-TR Sensor) for Rapid, Quantitative Detection of Bacterial Cells in Consumable Products." That proposal was not funded.

CACHE Closed

With the departure of Director Tami Bond, the Center for Applied Collaboration on Human Environments (CACHE) seed-funded by iSEE, the Grainger College of Engineering, and the Department of Civil and Environmental Engineering has wrapped up operations. Bond left the U of I for Colorado State University. Some final highlights:

• iSEE and CACHE hosted an October workshop for 30 individuals representing three universities, nonprofit organizations working on healthy home issues, and industry representatives with practical knowledge on home systems met at the University of Illinois' Indoor Climate Research and Training (ICRT) facility in Champaign.

• In August 2018, CACHE researchers hosted Aerodyne Research Inc. for a two-week experiment at ICRT. The collaboration on "pre-ignition emissions," supported by NSF, explored the complex chemistry that occurs in wood during the moments just before it bursts into flames.

Solar Study Application

Civil and Environmental Engineering Professor Timothy Stark, Chair of iSEE's Energy Sustainability Working Advisory Team (*page 37*), applied for more than $250,000 in internal grant funding from the Illinois Center for Transportation for a "Technical and Financial Feasibility Study for Installation of Solar Panels at IDOT-Owned Facilities." The application was rejected.

The grant, submitted through iSEE and in response to the Future Energy Jobs Act of 2016 (the state must acquire 25 percent of its energy from renewable sources by 2025), would have let Stark's analyze if it was feasible and economical to install solar panels on Illinois Department of Transportation-owned buildings and rights-of-way.

Illinois Entomology Professor May Berenbaum delivers a keynote to kick off the 2019 Critical Conversation.

Genetically Modified Mosquitoes a Lively 2019 Discussion Topic

In May, iSEE hosted academic, industry, nonprofit, government, and NGO representatives in downtown Chicago's University Club for a conversation on the issues and potential solutions surrounding genetically modified mosquitoes (GMMs).

Keynote speaker May Berenbaum, U of I Professor of Entomology, got the conversation started the evening of May 23, and three panel and breakout sessions continued the discussion the next day.

More than 60 people attended the Critical Conversation, paid for by a generous donation from the Alvin H. Baum Family Fund, iSEE's founding benefactor (*page 4*), administered by Joel Friedman and Erika Cornelison.

The event was co-hosted by Entomology Associate Professor Brian Allan (PI for iSEE's Stormwater and Mosquito Control team, *pages 18-19*), Illinois Natural History Survey Medical Entomology Lab Director Chris Stone, and INHS Vector Ecologist Holly Tuten. The three are preparing a paper for a scholarly journal as well as an op-ed piece for a national news outlet.

Plans for 2020 Underway

iSEE Associate Director for Research Madhu Khanna has opened a campuswide call for topics for the third iSEE Critical Conversation. iSEE wants a topic that can help identify solutions to wicked grand societal challenges. Conversations typically revolve around a point of conflict or disagreement among multiple stakeholders.

Published!

The 2018 Critical Conversation on the nitrogen reduction challenge in the Midwest — exploring ways to reduce runoff affecting the Gulf of Mexico with a hypoxic "dead zone" — have resulted in two published works.

❖ iSEE Associate Director Madhu Khanna, Director Evan H. DeLucia, Associate Director Ximing Cai, Agricultural & Consumer Economics Professor Benjamin Gramig, and Civil & Environmental Engineering Professor Praveen Kumar are close to publishing a paper in *Nature Sustainability* titled "Harnessing Emerging Technologies to Mitigate the Hypoxia Challenge." Based on the Critical Conversation, the authors make five recommendations: improving understanding of how big data-enabled precision farming can reduce nutrient loss; understanding barriers to adoption of best management practices and new technology; educating and training farmers; lowering regulatory barriers on genetic engineering for crops that better use nitrogen; and pursuing legal and regulatory methods to make better practices mandatory.

❖ The authors also published an op-ed piece in July 2019 based on the Critical Conversation in *The News-Gazette*, titled "Big Data, Other Tech Can Help with Nutrient Runoff in Midwest, Gulf Coast."

❖ In late 2018, DeLucia, Khanna, Cai and Associate Director Gillen D'Arcy Wood published an op-ed piece in *The News-Gazette*, in response to the National Climate Assessment titled "Flyover States Face Serious Issues."

CAMPUSWIDE MINOR & CERTIFICATE IN ENVIRONMENTAL WRITING

iSEE Programs on the Upswing

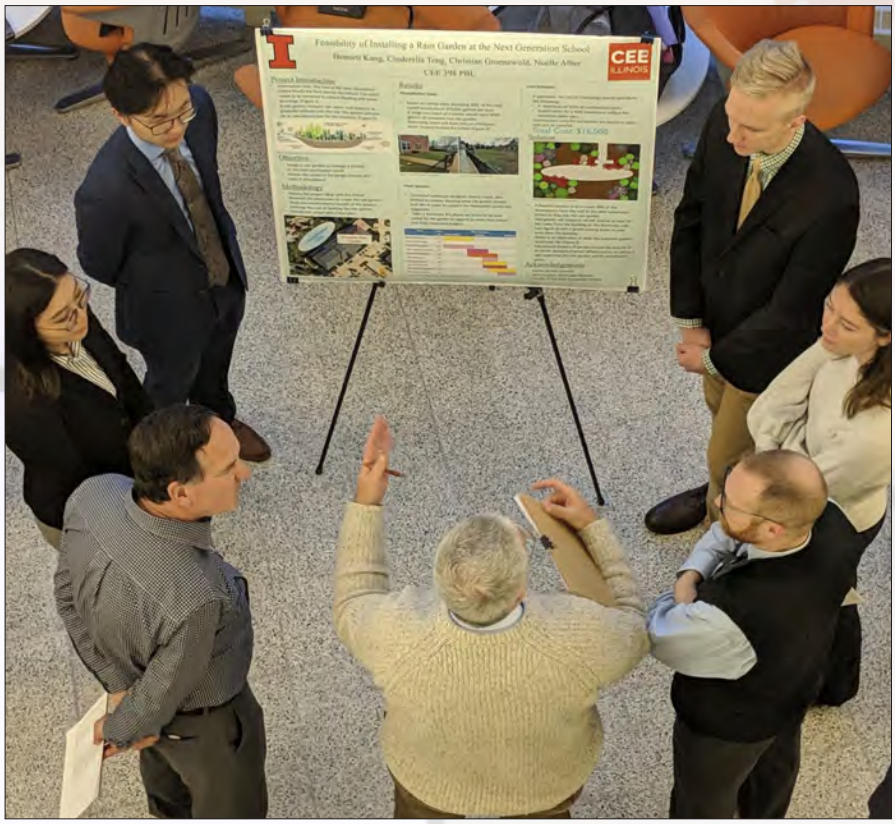
Sustainability, Energy, and Environment Fellows Program (SEE FP)

This campuswide sustainability minor led by iSEE and six academic units (Department of Agricultural & Consumer Economics, Department of Civil & Environmental Engineering, School of Integrative Biology, Department of Natural Resources & Environmental Sciences, School of Earth, Society & Environment, and Department of Urban & Regional Planning) has seen major enrollment boosts during 2018-19, bringing the four-year total to about 140 students and more than 50 graduates.

The minor attracts people from across campus and has featured students from six colleges and more than a dozen departments.

A new "rolling" enrollment policy at iSEE allowed students to join the minor throughout the year — and the SEE FP set a record with nearly 50 new students to start the 2019-20 academic year.

The minor capstone course, in which teams of students work with industry, government, NGO, nonprofit, and/or campus partners on a sustainability challenge (*December 2018 poster session pictured*) continues to be a successful partnership with instructional help from faculty across campus, who serve as Levenick Teaching Fellows (*more about the Levenicks, page 4*).



Potential external partners have included Accenture, Ameren, Anheuser-Busch InBev, the U.S. Army Construction Engineering Research Laboratory (CERL), Carus Corp., Champaign Park District, Champaign-Urbana Mass Transit District, Champaign County Forest Preserve District, City of Urbana, and the Orpheum Children's Science Museum. Other past partners included Chip Energy, Johnson Controls, and The Land Connection.

Undergraduate Certificate in Environmental Writing (CEW)

The second year of the program saw growth as well, as nearly a dozen students have now taken the three required courses and received the Certificate.

In addition, 15 articles by CEW students were published in the professionally curated *Q Magazine* online and in print (*page 29*).

Q Magazine Has Online, Print Presence

In September 2018 and March 2019, respectively, iSEE published Issues 1 and 2 of *Q Magazine* online. And in Summer 2019, the two issues were combined to compose the Volume 1 print edition.

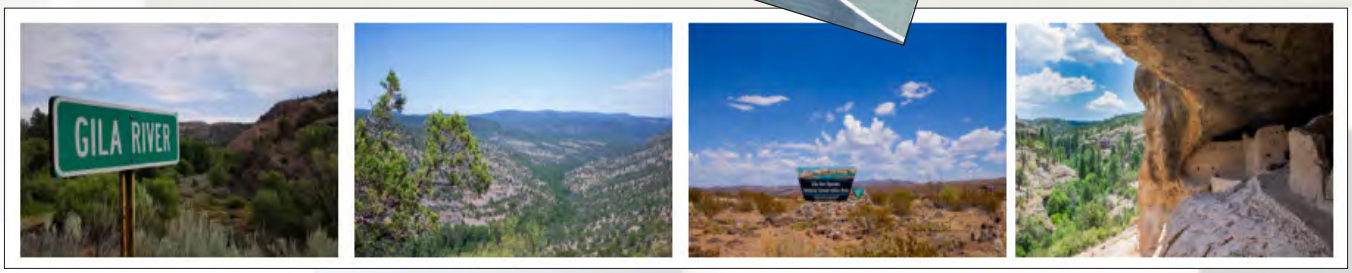
Fifteen articles, written by 13 different student authors enrolled in ENGL/ESE 360, 477, and 498 (the capstone course for the undergraduate Certificate in Environmental Writing) were chosen for publication, and 2018 graduate Katie Watson, a former iSEE Communications Intern served as the Student Editor for Volume 1.

Articles from 2018-19 CEW classes will make up Volume 2, Issue 1, scheduled for online release in September 2019. iSEE Communications Intern Jenna Kurtzweil, a 2019 grad, serves as the Student Editor.

Plans are already in the works for Volume 2, Issue 2, as well — for which iSEE Intern April Wendling will serve as Student Editor.

Among the pieces planned is one about water resource management issues on the Gila River in the Southwest United States. Kurtzweil and CEW grad Taylor Jennings traveled to New Mexico and Arizona to research the issues near the Gila National Forest (*photos below*).

The students' travel was funded by a generous gift from donor Janelle Joseph (*more, page 4*).



ENVS 301 'Tools for Sustainability' meets in Spring 2019 in the iSEE Collaboratory classroom.

Bioethicist Named iSEE's First Resident Scholar

In Summer 2019, iSEE invited Founder and Director of *Editing Nature* Natalie Kofler to the University of Illinois at Urbana-Champaign as the first Stuart L. and Nancy J. Levenick Resident Scholar in Sustainability Leadership.

Kofler, a molecular biologist and bioethicist, has authored numerous scientific research articles, reviews, and commentary pieces, and chaired international seminars and summits.

Kofler is passionate about ensuring diverse voices and viewpoints steer science and technology.

"At *Editing Nature*, we think a lot about how to tap into collective wisdom to steer responsible technological development," Kofler said. "I am so excited to learn from and collaborate with the faculty and students at U of I. Together, I think we can come up with some really innovative ways to integrate cross-disciplinary and cross-cultural perspectives and address some of our most pressing environmental challenges."

The Levenick Resident Scholars in Sustainability Leadership Program was funded by a generous endowment in early 2019 from U of I Alumnus Stuart Levenick and wife Nancy Levenick of Naples, Fla. (*page 4*), to iSEE and the Department of Natural Resources and Environmental Sciences (NRES). It was created to bring in experts from other universities, the private sector, and nonprofit organizations to share fresh perspectives and innovations with the Illinois community.

Kofler's work with *Editing Nature* advances and supports the responsible and ethical decisions guiding the development of genetic technologies released into the environment.

"We are excited to have Natalie on board as our first Resident Scholar," iSEE Baum Family Director Evan H. DeLucia said. "She is known for engaging experts from different backgrounds worldwide to examine wicked sustainability and environmental issues — those that don't have a simple answer and affect multiple stakeholders. She was a vital, vibrant voice during our Critical Conversation on genetically modified mosquitoes this past spring (*page 27*), and we feel there is much more we at Illinois can learn from her expertise.

"Scientists, educators, and students on campus will have access this year to a unique thought leader who takes a holistic approach to her work."

During her time at iSEE Kofler will also serve on the Editorial Board for *Q Magazine* (*page 29*). And she will teach a graduate-level course in NRES in Fall 2019.

In early 2020, NRES expects to name a Levenick Sustainability Chair, the Department's first endowed chair, who will oversee the Resident Scholars Program.

With backgrounds from a variety of disciplines, Resident Scholars will enhance and accelerate the broader impact of sustainability research and innovation, DeLucia said. As the Levenick Chair leads the program, it will help "close the circle" on sustainability efforts already established among the College of ACES, iSEE, and NRES.

"This campus will become a destination for worldwide sustainability experts — offering them creative opportunities and exposing faculty, students, and staff on our campus to real-time sustainability solutions from across the globe," DeLucia said.


BENSON


LAVEY


PETTIJOHN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Cohort of 7 to Bolster Sustainability in Curriculum

In Spring 2019, iSEE named its first cohort of Levenick iSEE Teaching Sustainability Fellows. The Institute awarded grants to seven instructors seeking to add sustainability elements in current courses on the University of Illinois' Urbana-Champaign campus — or to create new courses directly tied to sustainability.

This new program, announced in December 2018 and funded by a gift from Stuart and Nancy Levenick (*page 4*), offers U of I instructors $1,000 for adding sustainability elements to existing courses or $2,000 for creating a new course with a sustainability centerpiece.

"iSEE is constantly looking for ways to expand educational offerings on campus in sustainability," Associate Director Gillen D'Arcy Wood said. "This Fellowship is our newest offering to incentivize adding sustainability to the curriculum in an intentional manner."

The courses starting in Fall 2019:

• ARTD 451 — Ethics of a Designer in a Global Economy (taught by Eric Benson, Associate Professor and Chair of Graphic Design in the School of Art + Design, and Nekita Thomas, Assistant Professor of Graphic Design);

• ESE 466 —Climate Change, Health, and Law (taught by Warren Lavey, Adjunct Professor of Natural Resources and Environmental Sciences, and Dr. Holly Rosencranz, Clinical Associate Professor of Medicine);

• GLBL 298/ESE 389 — Food Systems Sustainability (taught by J. Cory Pettijohn, Research Assistant Professor of Geology and Teaching Assistant Professor in the School of Earth, Society & Environment);

• FSHN 499 — Environmental Impacts of Food & Nutrition Systems (a new course taught by Melissa Prescott, Assistant Professor of School/Childhood Foods and Nutrition); and

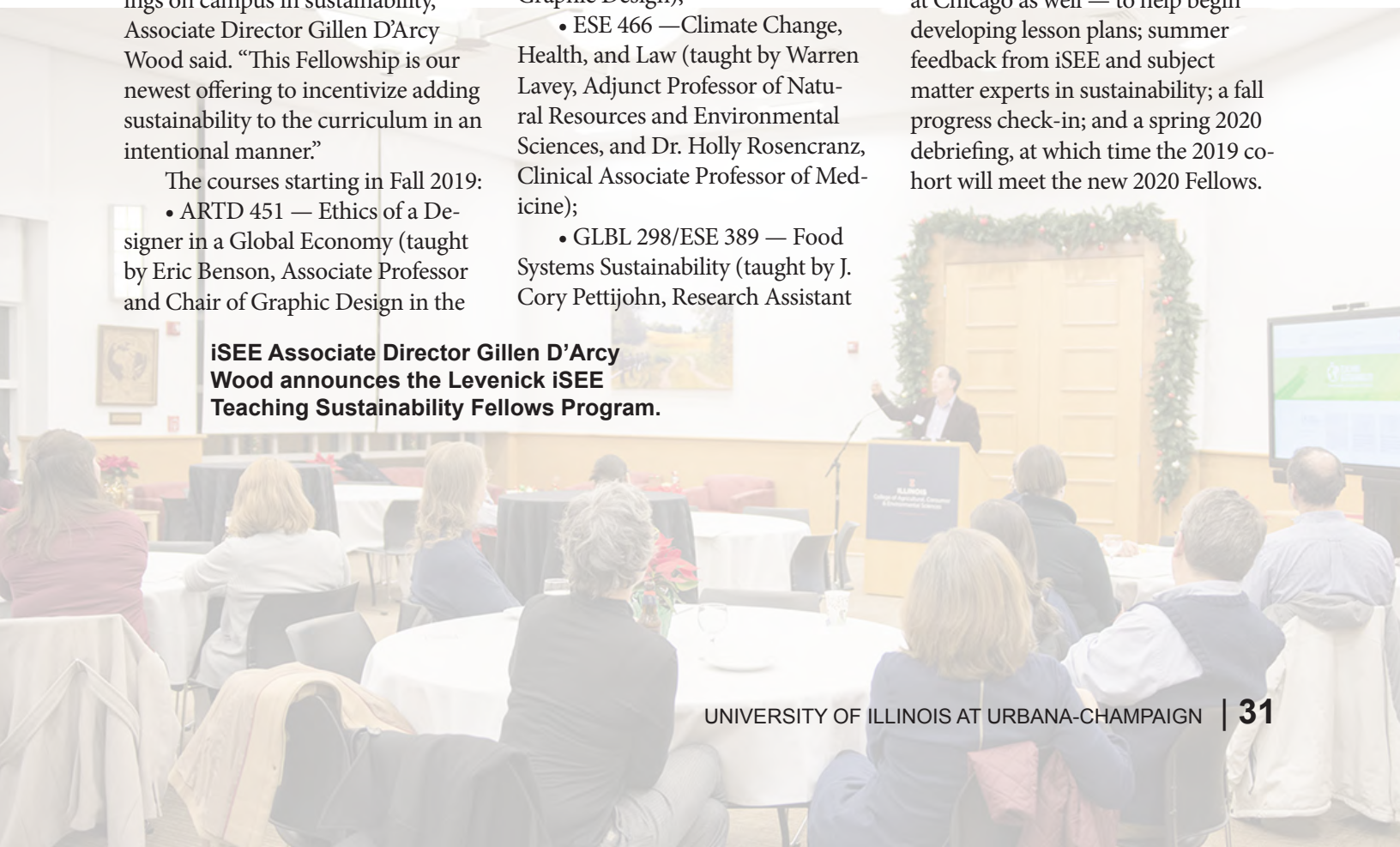
• ARCH 576 — Building Energy Use (a new course taught by Yun Kyu Yi, Assistant Professor of Architecture).

The iSEE program consists of four elements to help Fellows best incorporate sustainability into courses: a retreat each April — attended via teleconference by interested instructors from the University of Illinois at Chicago as well — to help begin developing lesson plans; summer feedback from iSEE and subject matter experts in sustainability; a fall progress check-in; and a spring 2020 debriefing, at which time the 2019 cohort will meet the new 2020 Fellows.

Online Portal

In 2018-19, iSEE revamped its website to include a new portal for educational offerings, including the Levenick iSEE Teaching Sustainability Fellows Program, the campuswide minor, the environmental writing program, U of I major, minor, and certificate programs, SEE-related courses, and more.

Visit sustainability.illinois.edu/education.



iSEE Associate Director Gillen D'Arcy Wood announces the Levenick iSEE Teaching Sustainability Fellows Program.

iSEE FALL EVENTS: CONGRESS, SUSTAINABILITY WEEK

From 'Sustainable Cities' to 'Sustainability Justice'

iSEE's fifth Congress, "Sustainable Cities" in early October 2018 drew hundreds of people to discuss the issues facing urban transportation, housing, food, water, infrastructure, and public health.

More than 400 faculty, staff, students, and community members registered to participate in the discussions at the Illini Union — highlighted by keynotes from Gerrit-Jan Knaap, Executive Director of the National Center for Smart Cities; Bobby Hambrick, Founder and CEO of AutonomouStuff; and Brian Stone, Professor of City and Regional Planning at Georgia Tech. The event also featured a Joint Climate Resilience Proclamation signed by U of I Chancellor Robert J. Jones and representatives from the cities of Urbana and Champaign (*page 36*).

For its sixth annual Congress, "Sustainability Justice," iSEE is tackling environmental and social justice issues as the world attempts to become more sustainable.

On Sept. 24-25 at the Union, iSEE will bring together a diverse group of researchers, educators, journalists, and activists to participate in panels and roundtable discussions on urgent questions surrounding sustainability justice. Highlights include keynotes by Kimberley Wasserman, Executive Director of Little Village Environmental Organization in Chicago; and Wake Forest University's John Knox, the first U.N. Independent Expert on Human Rights and the Environment.

Sustainability Week Celebration 2018

More than 100 people gathered in October 2018 to celebrate campus accomplishments during the Sustainability Celebration.

The event also featured updates on progress toward Illinois Climate Action Plan (iCAP) goals from the iCAP Working Group and Sustainability Working Advisory Teams, a ceremony for the top buildings and offices that were able to conserve energy on campus, and more.

Other highlights:

• To kick off the week, students were invited to participate in "Plogging" — picking up plastic while you jog. More than 30 people participated in the event, which was part fitness, part environmental action, part community service.

• A tour of Abbott Power Plant.

• iSEE's Illini Lights Out (*page 39*) event in which students turned off lights in buildings around the Main Quad while in Halloween garb.

• And other student- and department-led events.

Gerrit-Jan Knaap drew a large crowd for his iSEE Congress 2018 keynote.

Campuswide, It's All about the Earth

Departments, student organizations, and community members celebrated Earth Month in April 2019.

iSEE brought in climate change experts Kerry Emanuel of MIT (*pictured bottom left*) and Jonathan Overpeck of Michigan (*top right*) for the Charles David Keeling and MillerComm lectures, respectively, about severe weather and its impact on the U.S. climate.

Earth Week kicked off with Environmental Quad Day (*top left*) as a dozen environmental-focused student groups provided educational activities and information.

Several events each day the week of April 22-26 were hosted by student organizations — Students for Environmental Concerns (SECS) takes the lead on Earth Month each year — and academic units.

In addition, iSEE hosted a Student Climate Action Forum led by the Student Sustainability Leadership Council (SSLC; *page 43*), in which students learned about current campus efforts and helped rank priorities for the future.

The week ended with an Arbor Day event celebrating the University's state champion tree and iSEE's student-led Illini Lights Out (the second of the month; *more, page 39*).

ENERGY GENERATION

Campus Continues to Expand Renewable Energy Portfolio

In early 2019, at the urging of the Sustainability Council chaired by Chancellor Robert J. Jones, the University of Illinois at Urbana-Champaign started taking proposals for Solar Farm 2.0 — an expansion of more than 50 acres of solar panels.

Facilities & Services (F&S) and Prairieland Energy Inc. are seeking to increase campus on-site renewable energy generation to 25,000 mega-watt-hours — meeting an objective in the Illinois Climate Action Plan (iCAP).

Construction was expected to begin in Fall 2019 after harvest on U of I South Farms land. When added to the 21-acre original Solar Farm (*pictured*) that began operations in December 2015, the completed array will give the University about 75 acres devoted to solar — making the campus "the third-largest user of on-site renewables for higher education facilities in the United States," F&S Executive Director Mohamed Attalla said.

Solar Farm 2.0 will include habitat for pollinators under the solar panels, and iSEE researchers also intend to use the farm as a "living laboratory" to explore agrivoltaics (in which crop production and energy generation can coexist; *see more, page 15*).

Geothermal Exploration

The University also remains on the cutting edge as it examines geothermal options on campus — another energy generation tactic that will reduce its greenhouse gas (GHG) emissions.

A $240,000 project, funded by F&S and iSEE through the Carbon Credit Sales Fund and a grant from the Student Sustainability Committee (SSC, *pages 42-43*), began in Summer 2019 with installation of geothermal energy foundations in an expansion of the Hydrosystems Laboratory.

According to F&S, "Geothermal systems use the relatively constant underground temperature to provide heating and cooling at remarkably high efficiencies. The system functions by circulating fluid through heat exchangers in the ground leading to a heat pump in the building."

This project will also serve as a "living lab" for iSEE researcher Tugce Baser (*page 15*), who will install sensors to measure strains and temperatures in the foundation. The outcomes of the research will help create guidelines for future installations of geothermal foundations on new construction.

The latest geothermal installation follows testing on both the Bardeen Quad and at the Energy Farm on campus.

Champaign Mayor Deborah Frank Feinen hands the pen to Chancellor Robert J. Jones during the Joint Resilience Proclamation signing ceremony as Urbana Alderman Bill Brown looks on.

Campus, Cities on Same Page

In early October at iSEE Congress 2018, the University of Illinois at Urbana-Champaign as well as the cities of Urbana and Champaign officially proclaimed their shared dedication to preparing for the impacts of climate change.

Chancellor Robert J. Jones, Champaign Mayor Deborah Frank Feinen, and Urbana Alderman Bill Brown all signed a joint proclamation that reads, in part:

"Whereas there is a strong scientific consensus that climate change is happening at an accelerating rate ... we do hereby proclaim that the cities of Champaign and Urbana, working alongside the University of Illinois at Urbana-Champaign, affirm our joint commitment to bolstering our community's resilience to the impacts of climate change."

The proclamation also has charged a new Resilience Working Advisory Team with representatives from campus, the cites, and other local entities (*page 37*) to incoporate the resilience of the greater community into the new Illinois Climate Action Plan (iCAP) so it will be prepared for the challenges of a warmer climate, more severe weather, and potential threats to infrastructure and public health.

Working Advisory Teams Realigned to Incorporate Resilience, Education

In preparation for writing the 2020 Illinois Climate Action Plan (iCAP), iSEE along with Facilities & Services and other campus entities have made some slight changes to the teams of students, faculty, and staff working toward iCAP goals.

Campus sustainability leadership will remain the same with the Sustainability Council (the Chancellor and upper-level campus leaders) and the iCAP Working Group (midlevel campus managers, *pictured*). But to better incorporate climate resilience and educational components, iSEE transformed its Sustainability Working Advisory Teams (SWATeams) of 2014-19 into six new, and larger, Working Advisory Teams.

The new groups, which will include three to four faculty, three to four staff members, and three to four students, are:

- Energy SWATeam (incorporating generation, purchasing, distribution, conservation, and more);
- Land & Water SWATeam (incorporating agriculture, land use, sequestration, water, stormwater, and more);
- Zero Waste SWATeam (incorporating purchasing, waste, recycling, food, and more);
- Transportation SWATeam (largely unchanged — seeking sustainable, healthy, low-emissions options on and off campus);
- NEW — Education SWATeam (seeking to complement the disciplinary educational goals of campus with opportunities for interdisciplinary learning, research, and independent study on sustainability, energy, and the environment); and
- NEW — Resilience Working Advisory Team (bringing campus and the greater community together to address what must be done to prepare for vulnerabilities to extreme weather and other results of climate change).

SWAT Process at Work

In 2018-19, SWATeams sent 19 recommendations to iSEE, the iCAP Working Group, and campus leadership. Among them:

- hiring of a Zero Waste Coordinator for campus;
- pursuing a large-scale solar Power Purchasing Agreement;
- funding for critical energy conservation projects;
- planting more trees campuswide;
- incorporating sustainability into ethics and compliance training;
- carbon subsidies for both high-emissions and lower-emissions travel choices; and
- creating a policy and master plan for incorporating geothermal energy options on campus.

CAMPUS RECOGNITION

Let it Bee! The Student Behind New Campus Certification

Communities across the country are pulling together in support of the nation's pollinators, and the University of Illinois recently added its name to the list.

In 2018, the U of I applied for Bee Campus certification through Bee City USA, an initiative of the Xerces Society dedicated to fostering a pollinator-friendly environment. The process was fairly smooth sailing: It turns out that the U of I did not have to make any drastic changes to be considered eligible. And so Illinois became the 53rd Bee Campus USA — and the first Big Ten Conference school with that designation.

The idea to pursue Bee Campus USA certification originated with Rachel Daughtridge, an undergraduate in Natural Resources and Environmental Sciences.

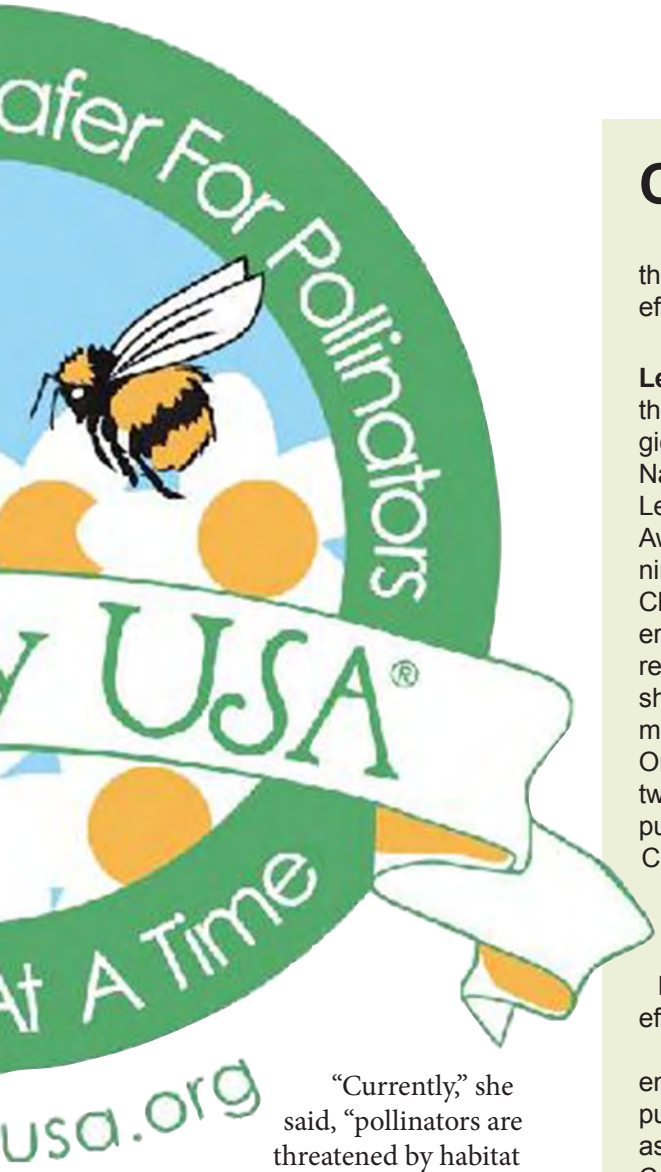
One of the many ways that Daughtridge (*pictured back row, third from left*) engages with on-campus sustainability is through her internship for Lincoln Avenue Residence Hall's Sustainability LLC, a floor designed for students interested in environmental issues. Having lived there her freshman year, she jumped at the opportunity to help coordinate the program and support students with sustainability projects of their own.

In October 2017, Daughtridge attended a student sustainability summit that featured a workshop with Phyllis Stiles, founder and director of Bee City USA, during which Stiles outlined certification steps.

"I knew that we could make this happen," Daughtridge said, "because the university already met so many of the requirements."

Founded in 2012, Bee City USA aims to make the nation a safe place for pollinators (not only bees, but butterflies, beetles, bats, hummingbirds, and more) to live happily and healthily. Any city — or campus — can pledge to uphold a list of requirements to join the rapidly growing list of certified communities. The application outlines seven steps that Daughtridge was responsible for overseeing.

In January 2018, Daughtridge completed Step 1: forming an on-campus Bee Campus USA committee, which composed an integrative pest management plan outlining best practices for pollinator-conscious landscaping and pesticide use and put together a native plants roster, which tracks and maintains what's currently planted on campus as well as what the U of I plans to incorporate in the future.



"Currently," she said, "pollinators are threatened by habitat destruction and pesticides, so it's important that we create an integrative pest management plan to figure out whether we are a threat to them with our landscape management."

But Daughtridge was happy to report that the university had very little to change.

She then helped with Steps 3-6 (putting on an awareness event; authenticating the number of pollinator-focused courses on campus; permanent signage for "pollinator pockets;" and a student website), and Step 7 will be ongoing — to maintain certification.

Full article by iSEE Communications Intern Jenna Kurtzweil at sustainability.illinois.edu.

Campus' Leadership Lauded

The University of Illinois at Urbana-Champaign was recognized throughout the past year for its sustainability and environmental efforts. Among the most notable:

❖ **Second Nature Climate Leadership Award.** In January, the campus won of the prestigious Second Nature Climate Leadership Award. In its ninth year, Climate Leadership Awards recognize innovation and leadership in climate action, including mitigation and resilience. One four-year and one two-year signatory campus of the Presidents' Climate Leadership Commitments are selected annually as overall winners; the U of I was the four-year winner. Key efforts that led to the recognition:

• sustainability, energy and environmental research on campus — including serving as a host institution for CABBI (*pages 6-9*);

• measures to make facilities and the campus more sustainable, including a solar farm, renewable energy purchasing, comprehensive energy savings efforts from Facilities & Services, and the overarching framework developed in the Illinois Climate Action Plan to reach carbon neutrality by no later than 2050 (*pages 35-37*);

• educational offerings across the campus, with participation from the majority of academic units in integrating sustainability into coursework (*pages 28-29, 31*); and

• behavior change and student-facing efforts like Greener Campus programs, zero-waste events, and student organizations and events dedicated to sustainability (*pages 40-41*).

❖ **STARS Gold Recertification.** In March 2019 — for the fourth time in a row — the campus earned Gold Level honors in the Sustainability Tracking, Assessment & Rating System (STARS), the nation's most comprehensive sustainability rating system.

STARS is a self-reporting framework, and 942 institutions have used the tool. As of its certification, Illinois was one of 108 schools to achieve Gold in version 2.1 of the tool — and it had the top score in the Big Ten Conference.

❖ **Tree Campus USA.** In addition to its first Bee Campus USA designation (*story at left*), in April the U of I was designated a Tree Campus USA for the fourth straight year by the Arbor Day Foundation.

❖ **Freezer Challenge Champs.** In August 2018, the U of I won the International Laboratory Freezer Challenge's Academia category after 45 labs in 17 buildings reduced energy usage by 262,800 kilowatt-hours.

More campus awards — and updates — may be found at sustainability.illinois.edu/recognition.

iSEE Expands Greener Campus

In 2018-19, the Institute took the Certified Green Office Program concept several steps further, adapting it into several new programs, called "Greener Campus." Among these new sustainability initiatives:

Labs

In September 2018, iSEE announced that the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI, *pages 6-9*) became the first Certified Green Laboratory at the University of Illinois at Urbana-Champaign.

CABBI personnel (*pictured*) demonstrated a firm commitment to sustainability through actions like reducing waste, conserving energy, and abiding by the 12 Principles of Green Chemistry. The Certified Green Lab Program (CGLP) began in August 2018.

For almost five years, the Certified Green Office Program (CGOP) provided offices and departments across campus an opportunity to make the University more sustainable. Given that research laboratories are one of campus' biggest utility consumers, the CGLP is a natural complement — and through the program iSEE offers resources to help support campus labs as they go greener.

Chapters, RSOs

The CGLP and CGOP — for which the CABBI office also in September became one of more than 25 certified units thus far — were joined

Offerings

in the Spring 2019 semester by the Certified Green Chapter and Certified Green RSO programs, offering — for the first time — guided opportunities for student groups to actively participate in campus sustainability efforts.

In 2019-20, iSEE will ramp up these offerings to sororities, fraternities, and registered student organizations.

Coming Soon: Events

Also in 2019-20, the Institute intends to make its presence known at campuswide events. It will begin certifying events that feature sustainable attendance practices (teleconferencing, for instance), catering options, and more.

And it all starts with Quad Day, the annual event before the fall semester at which new students check out all the exciting offerings on campus. For the second straight year thanks to a grant from the Student Sustainability Committee (SSC, *pages 42-43*), iSEE's Greener Quad Day program will offer an introduction to sustainability by being there to help with recycling and talking about how all students can be more sustainable in campus life.

For more information about the Greener Campus initiatives, visit sustainability.illinois.edu/greener-certifications/.

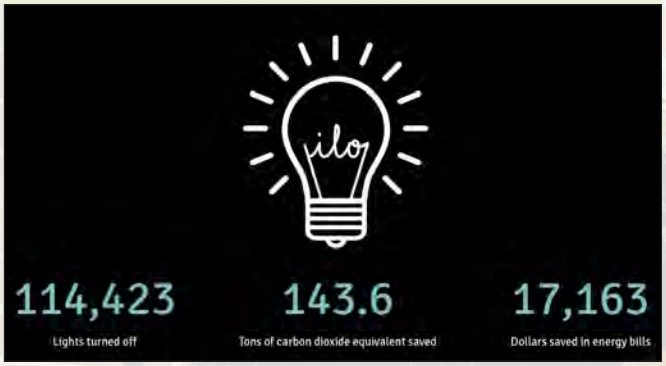
ILO Grows, Goes National!

Illini Lights Out (ILO), a student-led energy conservation initiative through iSEE and funded by the Student Sustainability Committee (SSC, *pages 42-43*), ended the 2018-19 academic year on a high note. U of I students turned off 10,000 more lights than the previous year, resulting in a 20,000 kwh energy savings increase.

Totals for ILO events since the first one in Spring 2016: 114,423 lights turned off; 143.6 tons of CO_2 equivalent saved; and more than $17,000 in energy bill savings. This past year, iSEE Interns Claire Kredens and Vince Spagnola provided leadership for the hundreds of volunteers who took the time on a Friday evening to make a difference!

The success of this program has led the ILO team to start National Lights Out (NLO), providing tools for other college campuses to start their own Lights Out programs.

Read more about both programs and stay updated at sustainability.illinois.edu.



Students get their marching orders for an Illini Lights Out event after class on a Friday.

SSC Update

The Student Sustainability Committee awarded more than $1.7 million in 2018-19 — nearly $425,000 of it for student-led initiatives. A breakdown:

- **Energy Projects: $834,000**, including $495,000 for two separate geothermal explorations on campus.
- **Food & Waste Projects: $308,000**, including $29,000 for new recycling centers at the Illini Union.
- **Education Projects: $288,000**, including $144,000 for a sustainable auxiliary building at the Bee Research Facility.
- **Land & Water Projects: $195,000**, including $103,000 for a nitrate monitoring system on South Farms.
- **Transportation Projects: $79,000**, including $10,000 for Illini Hyperloop to build a pod for a SpaceX competition.
- **Microgrant Projects: $3,900**, including $750 in support of the annual Eco-Olympics competition.

Bevier Goes Green — Times 3 — Thanks to Funded Projects

Tucked away on Bevier Hall's second floor, Bevier Café is part east campus eatery, part learning laboratory, and part sustainability trailblazer at the University of Illinois at Urbana-Champaign.

Each semester, undergraduates in the Food Science and Human Nutrition Quantity Food Preparation and Service course spend time in the café managing the establishment's day-to-day operations, mastering the ins and outs of food service, and learning how to be sustainable in the workplace. The café functions as a hub for three Student Sustainability Committee (SSC)-funded projects: the Bevier Café Reusable Carry-out Program, Turner Hall's Aquaponics System Demonstration Unit, and the Bevier Café Herb Garden.

At the helm of these campaigns is Carter Phillips, the café's Quantity Foods Manager and Instructional Chef. A U of I alumnus and seven-year employee, Phillips is a testament to the program.

"I've worked in full-service restaurants, high-end catering, and most recently with dining services and premium seating in Memorial Stadium. I had an opportunity to come back and help teach the class that I took … and it's been

Meet the Appropriately Named

In Summer 2019, the Student Sustainability Committee (SSC) hired Eric Green as its new Coordinator.

Green will identify and support sustainability projects around campus. Once the student Committee members make decisions about funding projects from the nearly $1.2 million annual budget collected through student fees, Green is responsible for administering those funds. He also will do marketing on the projects and engage students in these new initiatives. Working closely with iSEE, he will support other student-led groups and campus sustainability programs as well.

He hopes to see unique and experimental projects come from the applications sent to SSC.

"Before iSEE was even founded, I had a friend who was the chair of the SSC," Green said. "I loved that students had a say in how their campus

Carter Phillips at the Bevier Café Herb Garden.

exciting to help spearhead some of these projects," he said.

Like its website says, Bevier Café is "more than just a great place to eat" — it's teaching a new generation of sustainability-conscious food-service professionals.

"That's the impact that will be the most beneficial," Phillips said.

Full article by iSEE Communications Intern Jenna Kurtzweil at sustainability.illinois.edu.

Eric Green: New Coordinator

was shaped with regards to sustainable changes. Through my experience as a project manager and as an educator, I knew that I wanted to continue to support the students in their efforts. The opportunity to work with students and support sustainable efforts is a blessing."

Green obtained both his bachelor's and master's degrees from the University of Illinois at Urbana-Champaign, with his B.S. in Electrical Engineering and his M.S. in Natural Resources and Environmental Sciences. He wrote his thesis on energy economics and how CO_2 policy could influence demand for electricity.

Since his time as a student, Green has worked for a fuel cell research start-up company, as an automated software test engineer at Motorola, and most recently, a construction manager for Illinois' own Red Oak Rain Garden.

"I first came to C-U in 1999 for my undergrad, and basically never left," he said.

SSLC Update

Leaders from Registered Student Organizations on campus with ties to sustainability and environmentalism make up the Student Sustainability Leadership Council (SSLC), iSEE's finger on the pulse of student activities and initiatives on campus.

With guidance from the Student Sustainability Committee (SSC) Coordinator, the Council was much more active in the 2018-19 academic year.

The highlight was a Student Climate Action Forum during Earth Week 2019, during which students with environmental interests gathered in the iSEE Collaboratory to discuss their concerns on campus and beyond. iSEE representatives were there to listen for input on the upcoming 2020 Illinois Climate Action Plan.

NEW PERSONNEL & FACILITIES

Classroom/Meeting Space, Studio Open for Business

iSEE staff members check out the newly constructed Media Lab.

iSEE's new learning and meeting Collaboratory opened to classes Jan. 14. The space, outfitted with state-of-the-art presentation screens and teleconferencing capabilities, seats up to 36 students with the potential for larger meetings and events.

The first classes taught in the space include ENVS 301, the introductory course for the SEE Fellows Program campuswide minor (photo above); two courses that are part of the undergraduate Certificate in Environmental Writing (CEW); and one Natural Resources and Environmental Sciences (NRES) course.

The iSEE Collaboratory is designed for discussion, creation, and communication — and it hosted several student and faculty events and workshops in its first few months.

In addition, work in iSEE's new media lab/studio was completed in Summer 2019. Run by Adam Rahn (*more, right*) the facility will allow the Institute and users who book the space to create high-quality video and audio.

Generous funding from Stu and Nancy Levenick, Caterpillar Inc., the Student Sustainability Committee (SSC), and the Office of the Provost made this possible (*page 4*).

Learn more about the facilities at sustainability.illinois.edu/about/.

iSEE Associate Director Gillen D'Arcy Wood teaches Environmental Writing for Publication in the iSEE Collaboratory.

Meet the New iSEE Staffers!

As the Institute continues to expand its role in research, campus sustainability, and education, it has added more personnel to support this three-fold mission. In 2018-19, three new staffers were hired:

❖ **John Pirtle.** Pirtle joined iSEE in February 2019 as a Proposal Developer and Financial Specialist.

He received both his Bachelor's in Business Administration and Masters of Public Administration from the University of Illinois at Springfield. Prior to coming to iSEE, Pirtle held grant proposal positions at Ohio State University and Illinois' Beckman Institute and the National Center for Supercomputing Applications (NCSA).

As a Proposal Developer and Financial Specialist for iSEE, his day consists of preparing budget projections for faculty and other researchers, developing budgets and budget justifications, and working with granting organizations and faculty/staff to submit proposals.

❖ **Meredith Moore.** After graduating from St. Norbert College with bachelor's degrees in Environmental Science and French and working for the Minnesota Chamber of Commerce, Moore attended Auburn University for her M.S. degree. There, her research focused on local water policy and drought management.

Now, Moore is iSEE's Sustainability Programs Coordinator. She will oversee many different projects on campus.

"I will be overseeing and helping to coordinate the Working Advisory Teams, and helping to craft the 2020 Illinois Climate Action Plan (iCAP)," Moore said. "I am also excited to expand the Greener Campus programs and certifications while developing new ways that Illinois can become more sustainable."

Because of her passion for bettering the environment and her ability to work with different demographics, iSEE is the perfect fit for Moore.

"I am thrilled to work with iSEE because I am surrounded by progressive, proactive thinkers who are passionate about being at the forefront of environmental initiatives," Moore said.

❖ **Adam Rahn.** Rahn is the iSEE Media Lab Coordinator. He is part-time at Illinois; full-time, he runs his video production company, Droi Media. Adam is an award-winning producer, director, editor, and videographer with almost 15 years of professional production experience.

After completing his bachelor's degree in Broadcast Journalism, he went on to pursue a Master's in Communication, both from Illinois State University.

As the Media Lab Coordinator, Adam creates, shoots, and edits video content for iSEE and the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI).

Read more about these and other iSEE staffers, and stay up to date, at sustainability.illinois.edu/about/contact/.

Keep up with iSEE

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Contact info for iSEE directors, staff, and interns may be found at sustainability.illinois.edu/about/contact/.

WEBSITES

iSEE: sustainability.illinois.edu
Energy at Illinois: energy.illinois.edu
Water at Illinois: water.illinois.edu
CABBI: cabbi.bio
Leverhulme Centre for Climate Change Mitigation (LC3M): lc3m.org/research/theme-3/
Agroforestry for Food: agroforestry4food.com
Crops *in silico*: cropsinsilico.org
Sun Buckets: sunbuckets.com
***Q* Magazine:** q.sustainability.illinois.edu
iCAP Portal: icap.sustainability.illinois.edu
SSC: ssc.sustainability.illinois.edu

SOCIAL MEDIA

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iSEE
INSTITUTE FOR SUSTAINABILITY, ENERGY, AND ENVIRONMENT

Campus Engagement 2018-19

Our Institute takes pride in engaging University of Illinois students, faculty, staff, and community members all across campus. This is a rough estimate of people reached through iSEE efforts during the most recent academic year.

RESEARCH

825

Centers, projects scholars
- *Principal Investigators, Co-PIs*
- *Water, Energy, etc., Scholars*
- *Postdocs*
- *Grad & undergrad students*
- *Lab & field technicians*
- *Support staff*

EDUCATION

150

Academics for students
- *SEE Fellows Program (campuswide minor)*
- *Undergrad Certificate in Environmental Writing*
- *Levenick iSEE Teaching Sustainability Fellows*

SPONSORED EVENTS

1,100

Hosted campus and off-campus gatherings
- *Congress*
- *Critical Conversation*
- *Research conferences, workshops hosted*
- *Earth Month Keeling, MillerComm lectures*
- *Sustainability Celebration*

CAMPUS SUSTAINABILITY

4,750

Campus programs and organizations
- *Greener Campus (offices, labs/freezers, chapters, RSOs)*
- *Illini Lights Out*
- *Green Quad Day, study breaks, staff interactions*
- *iCAP teams*
- *Student groups*

University of Illinois
at Urbana-Champaign

Office of the Vice
Chancellor for Research