ISEE

INSTITUTE FOR SUSTAINABILITY, ENERGY, AND ENVIRONMENT

University of Illinois
at Urbana-Champaign

Sustainability is meeting the needs of the present without compromising the ability of future generations to meet their own needs.

>> iSEE's vision

With the world population projected to increase rapidly in the coming decades, we want to find solutions for the ever-growing demand for food, water, and energy while ensuring a safe, productive, and sustainable environment for all global citizens.

>> iSEE's mission

To foster actionable, interdisciplinary research to address fundamental challenges in sustainability, energy and environment; to provide national and international leadership in these areas through interdisciplinary education and outreach activities; and to develop and implement strategies for a sustainable environment on the University of Illinois' Urbana-Champaign campus and beyond.

>> iSEE's reach

Within its research, education, outreach, and campus sustainability efforts since its inception in December 2013, the Institute has engaged people from across the campus, including:

- more than 300 faculty
- 50 administrative and research support staff (APs and Civil Service)
- 15 Postdoctoral research associates
- more than 75 graduate students
- more than 200 undergraduate students

FIVE RESEARCH THEMES

The Institute is funding and shepherding research in five distinct themes — and provides a focal point for organizing and submitting large interdisciplinary grants (greater than $1 million) involving multiple campus units.

This research requires interdisciplinary collaboration, bringing the brightest of the bright together to solve the world's current and future problems.

*We call it "**actionable research**" — that is, scientific progress toward real-world solutions that can have an immediate and/or lasting impact on the world we live in.*

Climate Solutions

Evaluating risk from climate change; mitigation and adaptation to climate change; human health effects; social vulnerability, conflict, and democracy; ecological integrity

Energy Transitions

Renewables and conservation; optimization of supply and demand; systems and controls; energy transmission and storage; pollution

Sustainable Infrastructure

Transportation; built environment; vulnerability to climate change; pollution and waste; cities and urban environments

Water & Land Stewardship

Land use change; freshwater resources and purity; conservation and biodiversity; land and resource tenure; health

Secure & Sustainable Agriculture

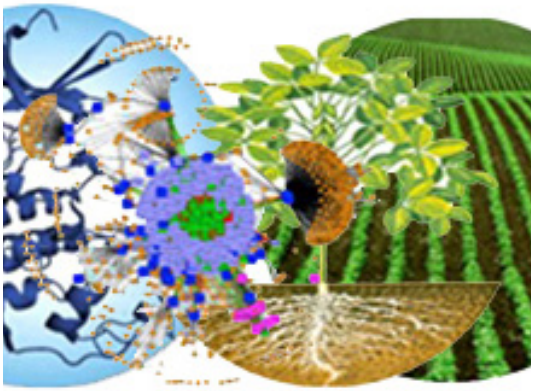
Greenhouse gas emissions and farming practices; soil health and nutrient management; technology for sustainable agriculture; regulation of agriculture; public health, food safety, and policy

OUR PROJECTS

Through two calls for proposals (2014, 2015), iSEE has granted more than $2.5 million in seed funding and salaries for graduate students and postdoctoral researchers to seven interdisciplinary research projects within our five themes. The Institute also has assisted one research team to form and secure funding.

Visit our research webpage to get additional details about all our projects and watch videos explaining many of our research projects: sustainability.illinois.edu/research.

Crops *in silico*



Meet the research team at:
bit.ly/Cropsinsilico

With Earth's climate, water supply, and seasons changing — and a population climbing to 9 billion — predicting crops' responses to climate change is crucial in solving the grand food security challenge.

This project seeks to computationally mimic the growth and development of crops at the molecular, cellular, plant and ecosystem levels as they respond to environmental changes. Creation of an *in silico* — computer simulation — platform that can link models across different biological scales has the potential to provide faster and more accurate simulations of plant response to the environment than any single field model could alone.

Principal investigators: Stephen P. Long, Gutgsell Endowed Professor of Crop Sciences and Plant Biology;
Amy Marshall-Colón, Assistant Professor of Plant Biology

Crude oil pollution treatment with the Nano-CarboScavenger

As demand for petroleum increases, so will transport of oil — leading to inevitable spills and environmental disasters. The aim of this project is to optimize a Nano-CarboScavenger (NCS), a particle designed to clump oil molecules together for easy removal using nets and booms and in some cases to disperse oil for natural digestion by microorganisms.

Current chemical dispersant and coagulant treatments for oil spills create environmental problems of their own when they are added to water bodies. In contrast, the NCS leaves behind no residual footprint because it degrades in the environment and in living systems with no harmful effects to organisms.

Principal investigator: Dipanjan Pan, Assistant Professor of Bioengineering

Meet the research team at:
bit.ly/NCS-project

Stored solar stove

Watch a video of this research at:
youtu.be/TiLc1YnBTZs

Nearly 3 billion people rely on solid fuels like wood, charcoal, animal dung, and grasses to cook daily meals. The resulting indoor air pollution causes 4 million deaths per year — more than malaria, tuberculosis, and HIV/AIDS combined.

The earth receives more solar energy every hour than civilization uses in an entire year. By developing a technology to collect, concentrate, store, and recover solar thermal energy at near-flame temperatures, this project hopes to eliminate harmful emissions from fire cooking.

The charging vessel (shown left) takes roughly two hours of sunlight to reach full charge, and can be used as a cooktop, a space heater, and — with an attachment — an electricity generator to charge phones or provide lighting.

Principal investigator: Bruce Elliott-Litchfield, Professor of Agricultural and Biological Engineering

Critical infrastructure and transportation

Changes in the availability of water and fuel, in energy production methods and regulation, and in community iterations have made the interdependencies between critical infrastructure systems in the United States an important topic of study.

This project focuses on developing an analytical framework for modeling and analyzing these Interdependent Critical Infrastructure (ICI) systems, incorporating both renewable energy and national transportation systems.

The results will be used to create a wealth of knowledge that will drive future energy and environmental policies, infrastructure design and management, and educational curricula.

Principal investigator: Ximing Cai, Lovell Endowed Professor of Civil and Environmental Engineering

Meet the research team at:
bit.ly/ICI-project

Extreme events and resilient communities

Meet the research team at:
bit.ly/28SYkGF

This project models the impacts of natural disasters — as well as human actions such as terrorist attacks or interventions — on communities and ecosystems.

Originally funded in 2015 with $220,000 from the U.S. Army Construction Engineering Research Laboratory (CERL), and renewed by CERL in 2015 with another $500,000, this team brought together by iSEE is using an extensive database and additional modeling to predict the extent of impact on a community and length of recovery after an event.

Going beyond traditional measures of impact like fatalities and injuries, the team is building a mathematical model to understand vulnerability of interdependent infrastructural systems (such as water pipelines, roadways, power grids, and communication networks) that are closely attached to communities.

Principal investigators: Paolo Gardoni, Associate Professor of Civil and Environmental Engineering;
Colleen Murphy, Associate Professor of Law and of Philosophy;
Yanfeng Ouyang, Associate Professor of Civil and Environmental Engineering

Stormwater & mosquito control

Mosquito-borne diseases pose a major threat worldwide despite substantial global eradication efforts. Most of the time, synthetic pesticides are liberally applied to kill mosquito larvae, but this tactic is largely unsuccessful. A better solution may be to eliminate the aquatic breeding habitats for mosquitoes in urban areas altogether.

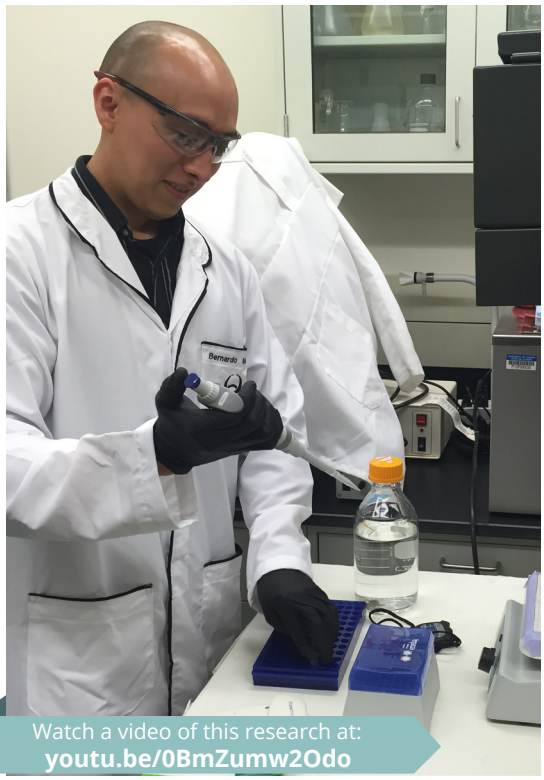
This project studies how "green infrastructure" — technologies to manage stormwater, runoff, and contaminants — can be used to limit aquatic breeding habitats for mosquitoes. The team also studies how the aquatic microbiome can be manipulated to "starve" larvae to control mosquito populations.

The combination of these approaches may offer innovative and environmentally sustainable alternatives for mosquito-borne disease control and reduced dependency on insecticides.

Principal investigator: Brian Allan, Assistant Professor of Entomology

Watch a video of this research at:
youtu.be/exH2CJO3oTM

Smart water disinfection



Billions of people around the world rely on drinking water sources contaminated with disease-causing bacteria and viruses. Much research attention has been paid to fighting bacterial illness, but viruses have been largely ignored. No more. This project seeks a more detailed understanding of how viruses become noninfectious after contact with common disinfection treatments, including ultraviolet light exposure and chlorine. The hope is to create new ways to control viruses at the molecular level.

Researchers in this project are also creating a real-time sensor that can be dipped into a water sample and indicate via color change whether infectious viral particles are present. Researchers will develop an economically and technically self-sustaining model for these advances that could be implemented by local entrepreneurs in rural communities throughout the world.

Principal investigator: Benito Mariñas, Professor and Head of Civil and Environmental Engineering

Agroforestry for food

Agroforestry is the practice of farming with fruit- and nut-bearing perennial trees and shrubs rather than resource-intensive annual crops — like corn and soybeans. In a 30-acre field trial, this project will examine the ecological, economic, and climate benefits of perennial mixed-crop agriculture.

In May 2015, roughly 12,000 seedling trees and shrubs of 10 different species were planted. Forage crops like alfalfa and hay were planted between the rows of trees and harvested as the young trees grow to fruiting age. In addition to providing food and fiber in abundance, these alternative systems could offer environmental benefits such as permanent wildlife habitat, efficient use of nutrients, and storage of carbon — all of which the team is measuring. Team members are also accounting for all costs and income streams to compare with a conventional corn-soybean rotation.

Principal investigator: Sarah Taylor-Lovell, Associate Professor of Crop Sciences

ISEE TIES TO MAJOR ILLINOIS RESEARCH CENTERS

CABBI
Center for Advanced Bioenergy and Bioproducts Innovation

• In July 2017, the U.S. Department of Energy announced it is funding a $104 million Bioenergy Research Center (BRC), a collaboration between iSEE, the Carl R. Woese Institute for Genomic Biology (IGB), and 17 partner institutions. The Center for Advanced Bioenergy and Bioproducts Innovation (CABBI) over five years will develop fuels and products by integrating three highly interconnected DOE priority areas.

• In 2016, iSEE and the Department of Civil and Environmental Engineering provided seed funding for a new Center for Applied Collaboration on Human Environments (CACHE), led by CEE Professor Tami Bond, a MacArthur Fellow.

• In 2016, iSEE secured funding for an Illinois study of enhanced weathering (EW) as part of the newly formed Leverhulme Centre for Climate Change Mitigation.

Illinois Water Scholars

Four areas of excellence in water research:

- Adapting in a Changing Climate
- Balance in the Water-Food-Energy Nexus
- Safe Drinking Water and Public Health
- Resilient Watersheds and Ecosys-tems

Website: **water**.illinois.edu

Illinois Energy Scholars

Four areas of excellence in energy research:

- Production/harvesting
- Delivery
- Storage
- Demand/Conversion

Cross-cutting research areas:

- Conservation/efficiency
- Environmental sustainability
- Materials
- Modeling/simulation
- Chemistry
- Cyber
- Reliability/Risk/ Resilience
- Economics/policy

Website: **energy**.illinois.edu

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CAMPUSWIDE MINOR IN SUSTAINABILITY

The Sustainability, Energy, and Environment Fellows Program (SEE FP) is a campuswide interdisciplinary undergraduate minor that prepares students to pursue careers in the corporate sector and with nonprofit organizations, government agencies, and environmental advocacy groups.

This program is offered in concert with ACE; CEE; NRES; SESE; SIB; and DURP.

go.illinois.edu/SEE_FP

iSEE has also collaborated with SESE and the Department of English on a new Certificate in Environmental Writing program:

The motto of the CEW is "turning data into narrative" — learning about the latest scientific research on the environment and how to communicate that research effectively.

sustainability.illinois.edu/cew

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ISEE CONGRESS

The Institute hosts a major international conference each fall, which we call iSEE Congress. This event is an assembly of leading University of Illinois, national and international scientists from different disciplines to present the latest scientific research on grand world challenges of sustainability, energy generation and conservation, and the environment.

Each Congress provides a forum to not only discuss the challenges facing global water availability, but also to highlight an agenda for actionable research. By bringing experts from academia, industry, governments, and NGOs together for these discussions, iSEE is fostering new research collaborations across disciplines and across continents to solve grand world challenges.

Congress topics:

- 2014: "Feeding 9 Billion"
- 2015: "Water Planet, Water Crises?"
- 2016: "Energy 2030"
- 2017: "Building Resilience to Climate Change"

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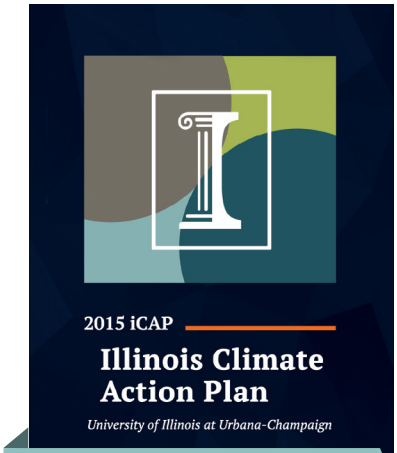
ILLINOIS CLIMATE ACTION PLAN (ICAP)



Explore the iCAP online:
bit.ly/IllinoisCAP

The iCAP represents a roadmap to a new, prosperous, and sustainable future for the University. It outlines strategies, initiatives, and targets toward meeting the stated goal of carbon neutrality (no net emissions) by 2050, if not sooner. With the approval of this document, campus recognized the urgent need to dramatically reduce its greenhouse gas emissions in order to help mitigate the dangerous effects of climate change that are already becoming evident.

Sustainability Working Advisory Teams (SWATeams)
Volunteer teams of faculty, staff, and students examine the six broad themes within the Illinois Climate Action Plan and recommend concrete steps the campus should take to meet its goals.

Read more about this official process at sustainability.illinois.edu/swateams.

The six teams:

- Energy Conservation & Building Standards
- Energy Generation, Purchasing, & Distribution
- Transportation
- Water & Stormwater
- Purchasing, Waste, & Recycling
- Agriculture, Land Use, Food, & Sequestration

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CERTIFIED GREEN OFFICE PROGRAM

Through the Certified Green Office Program, iSEE invites campus faculty and staff to make a pledge to reduce resource use and improve overall sustainability in the day-to-day practices of the office or laboratory. Small actions make a big difference when many take those small actions! To date, 33 offices with more than 1,500 employees have participated.

See our recommended green office practices at go.illinois.edu/greenoffice.

CERTIFIED GREEN OFFICE

AND MORE!

Discover all the ways iSEE and others are making our campus home greener — and the awards Illinois has won through its efforts:
sustainability.illinois.edu/campus-sustainability/