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UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Overviews of Campus Sustainability Projects at Illinois: Opportunities for Education and Research

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Executive summary

Campus sustainability projects and initiatives can provide a unique opportunity to explicitly connect campus operations with academia. In fact, forward-thinking institutions have been using campus sustainability projects as an academic resource to provide hands-on learning experiences for students. Furthermore, campus sustainability projects can provide excellent opportunities for research by using campus and the surrounding community as a testbed for research-oriented projects.

As an attempt to enhance the links among the three areas of research, education, and campus sustainability at U of I, this report provides an overview of the campus sustainability projects that demonstrate great potential for future research and education. Through this effort, we promote the idea of the “campus as a living laboratory” and encourage the use of campus as a testbed in research proposals. We first provide a brief introduction of over 500 existing and ongoing campus sustainability projects (also called iCAP — Illinois Climate Action Plan — projects) in Energy, Water, Land & Space, Procurement & Waste, Transportation, Outreach, and Education. We then identify those that can be useful for research and education development — especially highlighting major campus facilities and programs that are landmarks or features at Illinois and have great potential to support research and education development toward sustainability. Further on, we link the campus sustainability projects to national grant programs, which are available online through the iCAP Portal website. Visitors can use the links to search for iCAP projects, which will allow researchers on campus to identify completed and ongoing efforts that can be incorporated into proposal development for a particular national program. This report also provides a list of examples of existing and ongoing research projects that already use the campus as a living laboratory.

Just as the iCAP projects are valuable for research and education development, the realization of many [campus sustainability objectives](#) will also need research support. Nationwide, some universities have one or more funding sources that are specifically available to provide seed funding for faculty to conduct research projects with the focus of sustainability on campus or in the community. To support this two-fold goal, the [Institute for Sustainability, Energy, and Environment](#) (iSEE) has established an iSEE seed funding program for campus sustainability related projects. The program will provide incentives for faculty to demonstrate progress toward improved sustainability performance. This seed money will be leveraged to attract larger external funds that are relevant to iCAP objectives. iSEE seed funding aims to be a win-win solution for research and education and for campus sustainability promotion.

1. Introduction

Since the early 1990s, the study of sustainability has found its way into different dimensions of academia, and institutions of higher education have given increased consideration to sustainability in academic research, curriculum, and campus operations (McMillin and Dyball, 2009; Savelyeva and McKenna, 2010). Specifically, increasing numbers of universities are taking steps to integrate sustainability into different aspects of their facility operation and management, curriculum development, and research initiatives, as reviewed in a companion report prepared by the Institute for Sustainability, Energy, and Environment (iSEE) (Cai and Shafiee-Jood, 2017). Meanwhile, universities play a critical role in training the next generations of leaders to advocate for sustainability by engaging them in real-world sustainability challenges and transforming campuses into *living laboratories* (Evans et al., 2015).

Campus sustainability projects and initiatives can provide a unique opportunity to explicitly connect campus operations with academia (Savanick et al., 2006). In fact, forward-thinking institutions have been using campus sustainability projects as an academic resource to provide hands-on learning experiences for students (Cohen and Lovell, 2014). Furthermore, campus sustainability projects can provide excellent opportunities for research through using campus and the surrounding community as the testbed for research-oriented projects (Cai and Shafiee-Jood, 2017). It is imperative for the universities to demonstrate their commitment to sustainability by explicitly linking the core functions of the institution. The so-called “whole-of-university” approach to sustainability is recommended (McMillin and Dyball, 2009), which emphasizes the importance of linking research, educational and operational activities in the university to successfully address sustainability commitments (Figure 1) (McMillin and Dyball, 2009).

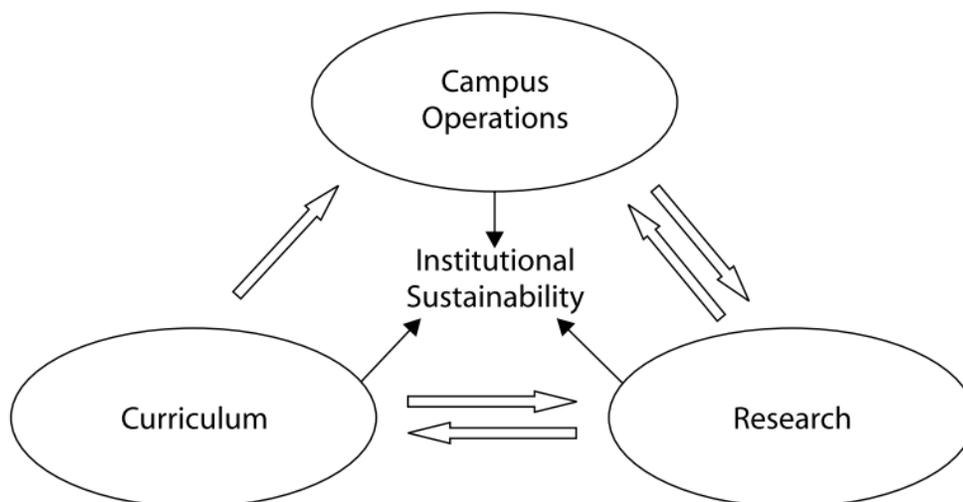


Figure 1. A whole-of-university approach to sustainability (adopted from McMillin and Dyball, 2009).

However, campus operation and management is usually considered as the “physical operation” side of a campus and is perceived to have little relevance to curriculum or research (Savanick et al., 2006; McMillin and Dyball, 2009). In many cases, campus sustainability projects are designed to make the construction and operation of facilities and services more efficient. Those projects have research or educational potentials for the “academic” side of the university. Despite the potential benefits to all parties involved, many universities have not implemented an approach integrating campus sustainability and academic work. One of the key reasons is that faculty and researchers are not aware of campus sustainability projects and the potential opportunities they have for research, and collaboration involving faculty and staff needs to be enhanced to address sustainability issues (Savanick et al., 2006; Cai and Shafiee-Jood, 2017).

The University of Illinois at Urbana-Champaign, as one of the world’s renowned and leading institutions of higher education, is committed to promote sustainability in research and education. To this end, the [Institute for Sustainability, Energy, and Environment](http://sustainability.illinois.edu/) (iSEE) was established in 2013 to coordinate and elevate sustainability efforts across campus in three main areas: “1) to foster actionable, interdisciplinary **research** to address fundamental challenges in sustainability, energy and environment; 2) to provide national and international leadership in these areas through **education and outreach**; and 3) to help the **Illinois campus** become a model of sustainability, energy efficiency and environmental friendliness for the world to see” (<http://sustainability.illinois.edu/>). In particular, through the campus sustainability program, iSEE, under the Office of the Vice Chancellor for Research (OVCR), has been collaborating with Facilities & Services, the Office of the Provost,

and other campus units to formulate, help implement, and evaluate campus sustainability policies and initiatives, thereby contributing to the practice of sustainability by integrating campus efforts (iCAP, 2015).

As an attempt to enhance the links among the three areas of research, education, and campus sustainability at Illinois, the objective of this report is to provide an overview of the campus sustainability projects that demonstrate great potential for future research and education. Through this effort, we promote the idea of the “campus as a living laboratory” and encourage the use of campus as a testbed in research proposals. Given that many of these projects have not been widely recognized among faculty members and researchers, we first provide a brief introduction of more than 500 existing and ongoing campus sustainability projects (also called iCAP — the Illinois Climate Action Plan — projects) and identify those that can be useful for research and education development. Especially, we highlight some major facilities and programs, some of which are landmarks or features of our campus, that have great potential to support research and education development toward sustainability. Further on, we will link the campus sustainability projects to national grant programs, which will be available online at the iCAP Portal website and will serve as a tool for researchers to look for relevant campus sustainability projects when they work on proposals for national programs. This report also provides a list of examples of existing and ongoing research projects that already use the campus as a living laboratory.

2. iCAP Projects

In 2010, the Illinois campus developed the Illinois Climate Action Plan (iCAP) that provided a comprehensive roadmap toward a sustainable campus environment. The 2015 iCAP provided an update and revision to the original plan by restating many of the 2010 iCAP targets, adding new targets and revising some targets. Many projects have been completed, are in progress, or are proposed to pursue the iCAP objectives. The [iCAP Portal](#) provides a repository for summary information about all these projects. After reviewing the more than 500 iCAP projects that appear on iCAP Portal (as of April 15, 2017), we identified the projects that we believe have research or educational potential and can be used as a testbed for project development. Tables A1-A8 in **Appendix I** show a complete list of projects categorized by themes: Education, Energy, Land & Space, Outreach, Procurement & Waste, Transportation, and Water), including a brief summary and keywords. **More detailed introductions to these projects, including data and project outputs and other relevant iCAP projects, are available online at the [iCAP Portal](#).**

A number of iCAP projects have been funded by the Student Sustainability Committee (SSC). Those projects are chosen by SSC, with the advice of a faculty and staff group, from proposals submitted from students, staff and faculty. Funding requirements and evaluative criteria can be seen at http://ssc.sustainability.illinois.edu/?page_id=231. **Appendix II** provides statistics on the projects funded by SSC. **Although research is not a primary objective of these projects, they can be a resource to researchers nonetheless. For instance, these projects may serve as a testbed for research activities or a setting for the educational component of grant proposals.**

3. University facilities and programs with potential for sustainability education and research

Among the iCAP projects available on the [iCAP Portal](#), we have selected a list of special projects that represent some major facilities and programs on campus — many of which are landmarks. Some of the facilities and programs have been used or have great potential for research, and we believe there can be an even larger use of them. An incomplete list of these facilities and programs is shown in Table 1. Some examples are briefly introduced in this section.

Table 1: University facilities and programs with potentials for sustainability education and research

Theme	Facility/Program	Description
Energy	Energy Dashboard Project	This online program provides clearly visible, understandable data and information to students and staff of selected University buildings describing real-time energy consumption rate with historical data daily, monthly, and yearly data.
	Thermal Energy Storage (TES) tank	The storage tank allows the campus to use energy when costs are low at night and store energy in the water until it is needed during the day. The University of Illinois at Urbana-Champaign built a Thermal Energy Storage (TES) tank for the Campus Chilled Water System (CCWS).
	ECE Building	With the new Electrical and Computer Engineering (ECE) building, the University is determined to achieve LEED platinum certification, and is striving for a net-zero energy design that will enable the building to supply all of its own energy. From a vast array of photovoltaic cells, to a chilled beam system to cool and heat the classroom tower, ECE was a major campus addition with maximum space and minimal carbon footprint.
	Abbott Power Plant	Abbot Power Plant has incorporated several sustainability projects into its running. Some examples of these projects include a carbon capture pilot project, retrofitting, a shift away from burning coal, improving water efficiency of cooling towers and using renewable forms of energy such as bioenergy and solar.
	Allerton Park	Allerton Park is the site of an innovative geothermal energy system that will reduce the park's dependence on fossil fuels. Other sustainability projects at the park include a wood-fired boiler system, a bike sharing program, a compost toilet, solar arrays and many more. All of these projects are included in the park's own Climate Action Plan (apCAP).
	Energy Farm - Biomass Boiler	This project converts existing (and future) biomass from the Energy Farm into power for the on-site Energy Farm facility.
	Anaerobic Digester at Beef and Sheep Study	This study investigated the feasibility of installing an Anaerobic Methane Digester in the area of the University's South Farms to capture renewable energy from beef, sheep, and/or dairy cow waste.
	Solar Energy on Campus	Several buildings in the U of I campus have installed rooftop solar photovoltaics.
	Solar Farm	Phoenix Solar South Farms LLC was hired by University in 2015 to design, build, and operate a 20.8-acre Solar Farm at the Windsor Road site. The University signed a 10-year power purchase agreement with Phoenix Solar to purchase all electricity produced by the Solar Farm and deliver it directly to the campus.

	Solar House (2007, 2009, 2011)	As part of The Solar Decathlon (a bi-annual international competition hosted by the Department of Energy and the U.S. Green Building Council (USGBC)), university teams have built model solar houses showcasing a commitment to the education of the public about how solar power and sustainable design are feasible and attractive options.
Transportation	Campus Bike Center	A collaboration between the University of Illinois and The Bike Project of Urbana-Champaign — the Campus Bike Center is dedicated to empowering individuals with knowledge about how to repair and maintain bicycles and encouraging mode-shift away from single-occupancy vehicles.
	Bike Sharing	There are several varieties of bike sharing, departmental bikes for employees, and short-term bike rentals on campus and in the community.
	Use Electric Vehicles for Campus departments	To evaluate the options for transitioning to EVs for campus, this project reviewed vehicles that are permanently assigned to departments on campus. This is a project that would benefit from a research project considering options for sustainable change without undue financial burden on the campus operations.
	Public Use Electric Vehicle (EV) Charging Stations	Electric vehicle (EV) charging stations have been installed around campus to encourage low-emission vehicles by providing the supporting infrastructure.
Land and Space	50 acres of U of I agroforestry farm	The Agroforestry for Food team is studying an alternative option for agriculture in the Midwest: Multifunctional Woody Polycultures, initially targeting areas that are not best suited for row crops. The group is comparing a variety of systems — mixtures of trees, shrubs, and forage or hay — that yield multiple food (and fuel) products including fruits and nuts.
	Sustainable Student Farm	This farm acts as a living laboratory to connect students, community members, and the state at large with regional, small-scale food systems. The team plan to broaden their focus to include the research, education, and outreach missions of the University.
	Orchard Downs Community Gardens	Gardens built on the farmlands at Orchard Downs are available to community members for growing their own food.
	Natural Areas	A committee is set up to provide and facilitate long-term research and teaching opportunities on University-owned natural areas. Sites are managed to protect both the integrity of the ecological systems and the biological research that takes place on them.
	Native Plants at Arboretum	The University of Illinois Arboretum contains gardens, collections, and habitats that transform 160 acres of the south campus. It serves as a “living laboratory” for University students studying plants, sciences, and fine and applied arts.

	Burrill/ Morrill Walkway	This project is meant to transform the walkway between Burrill and Morrill Halls into a sustainable and multifunctional landscape. In addition, to curb rainwater collection problems, a rain garden has been proposed to be added to the center of the walkway.
	Tree Campus USA	Illinois is recognized as a Tree Campus USA, as of 2015. This program recognizes college and university campuses that effectively manage their campus trees, develop connectivity with the community beyond campus borders, and strive to engage their student population by utilizing service learning opportunities centered on campus and community forestry efforts.
	Green Roofs on Campus	Green roofs located on the Art & Design Building, Newmark Civil Engineering Lab – Yeh Center, Foreign Language Building Plaza, and others can be used for research and educational purposes.
	LEED Certification on Campus	Leadership in Energy and Environment Design (LEED) is a voluntary, consensus-based, market-driven program that provides third-party verification of green buildings that was established by the U.S. Green Building Council (USGBC). The program addresses the entire lifecycle of a building, assessing if it satisfies all LEED requirements. LEED certified buildings are designed to lower operating costs and increase asset value, reduce waste sent to landfills, conserve energy and water, be healthier and safer for occupants, and reduce harmful greenhouse gas emissions.
Water	Porous Asphalt Parking Lot C9	Porous asphalt has been used in parking lot C9 to reduce stormwater runoff.
	Rain Gardens on Campus	Rain gardens are a good option for planted spaces on the University campus since they add a sustainable aspect to what are still attractive spaces while reducing watering and flooding concern.
	Hartley Garden Renovation	The Hartley Garden is declining and a renovation proposal is being put together which includes all elements of the garden, especially the irrigation system which is antiquated and wastes large amounts of potable water. Also, using/collecting grey water and/ or rainwater for irrigation is being considered.
	Red Oak Rain Garden	This garden is beautiful and smart. It addresses flooding in an innovative way: by planting an attractive landscape feature that captures and filters stormwater; it uses water as a resource instead of allowing it to rush into storm sewers and flood downstream.
	Boneyard Creek	Boneyard Creek is a highly channelized and engineered waterway that flows through Champaign, draining much of the city, including the central business district and the University of Illinois Campustown area.
	Chiller Plant at Oak Street and Vet Med	Energy- and water-saving measures have been implemented here.
	BIF Greywater Pipe System	Although the building is fed from the potable water supply, there is separate piping for the urinals and water closets in the building, which can be used if greywater system becomes available.

Outreach	Student Sustainability Leadership Council (SSLC)	The Student Sustainability Leadership Council (SSLC) is iSEE's finger on the pulse of student-led initiatives in sustainability. It is also the bridge between iSEE and the student body, serving as a two-way conduit of information and concerns about campus sustainability issues.
	Illinois Biodiesel Initiative (IBI)	IBI has the mission to produce biodiesel and soap from waste vegetable oil collected from campus dining halls. The IBI goal is to become self-funded. The IBI group also worked on an educational component and created a class.
	Mapping Sustainability	This project is meant to map sustainability related programs, facilities and organizations in the Champaign-Urbana area.
	Certified Green Office Program (CGOP)	An initiative to engage the University community in a campuswide commitment to sustainability and spread the sustainability culture.
	Resilience Commitment Efforts	The Resilience Commitment is focused on climate adaptation and community capacity-building to deal with a changing climate and resulting extremes in our local Urbana-Champaign urbanized area.
	Solar Urbana-Champaign	The University is helping to promote and encourage participation in the Solar Urbana-Champaign program: solar group buy in the Champaign county. This program provides a unique opportunity to observe conservation through community collaboration.
Procurement and Waste	Waste stream characterization	The objective of the assessments is to characterize the waste generated from a lab building, a classroom building, and a housing building. The primary goal of the waste stream characterization study is to provide the campus with an accurate and precise baseline measurement of the solid waste generated at each facility type.
	Enviropure	EnviroPure is a food waste elimination system that is a self-contained unit that can be continually fed food waste and dispose the waste. There are four Enviropure machines installed in University Housing.
	Vermicompost	The aim of this project is to collect food waste from a university dining hall, decompose the food waste into organic fertilizer on the Student Farm in a self-contained vermicomposting unit, and use the fertilizer to grow transplants for the Student Farm.
Research	Illinois Sustainable Technology Center (ISTC) research	The Illinois Sustainable Technology Center (ISTC) mission is to be at the forefront of environmental and energy research and innovative technological advances that protect natural resources and reduce wastes.
	iSEE	A hub for the sustainability community: iSEE's mission is to develop a comprehensive gateway for faculty, staff, students, potential donors, and all interested parties to find information about sustainability research, education, outreach, initiatives, and operations.

A selected list of the facilities and programs is highlighted below:

- The Abbott Power Plant has incorporated several sustainability projects into its running, including a carbon capture pilot project, retrofitting, a shift away from burning coal, improving water efficiency of cooling towers and testing renewable forms of energy such as wood chips.
- A biomass boiler was recently installed in Energy Farm, and it will convert biomass grown on the Energy Farm into power and heat for the buildings there.
- Solar Farm: A 20.8-acre solar farm along the south side of Windsor Road. The university signed a 10-year power purchase agreement with Phoenix Solar to purchase all electricity produced by the solar farm and deliver it directly to the campus grid. Moreover, through Solar Urbana-Champaign, the University is helping to promote and encourage participation in solar energy production in the surrounding communities.
- 50 acres of U of I Energy Farm are being used by the Agroforestry for Food team to study an alternative option for agriculture in the Midwest: Multifunctional Woody Polycultures. This activity targets areas that are not best suited for row crops but can be used to produce multiple food (and fuel) products including fruits and nuts via a variety of systems — mixtures of trees, shrubs, and forage or hay.
- Green roofs located on many buildings (e.g., Art & Design Building, Newmark Civil Engineering Lab – Yeh Center, Foreign Language Building Plaza) can be used for research and educational purposes.
- Boneyard Creek is a highly channelized and engineered waterway that flows through Champaign, draining much of the city, including the central business district and the University of Illinois Campustown area. It has been a classic research site for urban stormwater management and ecosystems restoration.
- The Red Oak Rain Garden is a ten-year old rain garden in the heart of campus, near McKinley Health Center and Allen Hall. This rain garden was one of the first Living Lab facilities on campus, designed and implemented in collaboration with Professor Tony Endress and his students. Now ten years old, the students in Allen Hall, community members in the Master Naturalist and Master Gardener programs, and water scholars and advocates are working together to renovate it.

- EnviroPure: A food waste elimination system that is a self-contained unit that can be continually fed food waste and dispose the waste. There are four EnviroPure machines installed in University Housing.
- Campus Bike Center: A collaboration between the University and the Bike Project of Urbana-Champaign dedicated to empowering individuals with knowledge about how to repair and maintain bicycles and to encouraging mode-shift away from single-occupancy vehicles.

In addition, **Appendix III** provides a description of [the Solar Decathlon](#), [the Solar Farm](#), [the Illinois Biodiesel Initiative](#), [the Geothermal Test Well](#), and [the Agroforestry for Food Research Site](#).

4. Connecting iCAP projects with national research programs

In order to facilitate the use of the campus as a testbed for research and education development, we provide an easy-to-use interface within the iCAP Portal that links iCAP projects with national programs that involve sustainability research. These programs fall under several funding agencies or departments, such as the NSF, DOE, DOT, USDA, EPA, NASA, NOAA, etc., and can be found on the iCAP portal by clicking the [Research](#) Theme  icon in the icon bar present at the top of every iCAP Portal page (highlighted in Figure 2). The funding programs are listed under “[National Research Programs](#)” and can be reviewed in a single page by choosing “Expand all” from the Research Theme page.

Home Goals Projects Map Suggestions

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Home » Theme: Research

🔬 Research

Research is central to the sustainability of the University and the region. Already a world leader in sustainability and climate research, Illinois is developing opportunities for researchers from diverse disciplines to come together to explore new frontiers in discovering solutions to the challenges ahead. Innovative research collaborations focused on creating knowledge and new technologies are being developed to discover, analyze, and implement new approaches for addressing sustainability and climate change challenges.

[Expand all](#) | [Collapse all](#)

- ☐ **Research Opportunities and Projects** Ongoing
 - ☐ **Campus Research Projects** In Progress
 - + **Incentives for Sustainability Research** In Progress
 - **Inventory Sustainability Research** Completed
 - **Definition of Sustainability Research** In Progress
 - **Interdisciplinary Research Seminar** In Progress
 - **Promotion & Tenure: Interdisciplinary Research** Proposed
 - + **Research Institutions on Campus** In Progress
 - ☐ **National Research Programs** Ongoing
 - + **Department of Commerce (DOC)** Ongoing
 - + **Department of Defense (DOD)** Ongoing
 - + **Department of Energy (DOE)** Ongoing
 - + **Department of Housing and Urban Development (HUD)** Ongoing
 - + **Department of Interior (DOI)** Ongoing
 - **Department of State** Ongoing
 - + **Department of Transportation (DOT)** Ongoing
 - + **Environmental Protection Agency (EPA)** Ongoing
 - + **National Aeronautics and Space Administration (NASA)** Ongoing
 - + **National Science Foundation (NSF)** Ongoing
 - ☐ **U.S. Department of Agriculture (USDA)** Ongoing
 - **Agricultural Marketing Service (AMS)** Ongoing
 - **Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Assistance Program** Ongoing
 - **Farm Service Agency (FSA)** Ongoing
 - **Food Waste Reduction** Ongoing
 - **Forest Service** Ongoing
 - + **National Institute of Food and Agriculture (NIFA)** Ongoing
 - + **Rural Utilities Services (RUS)** Ongoing

Map of Research-themed Projects

Figure 2: Screenshot of the iCAP Portal under the research theme

Each funding agency or department is typically divided into several offices or agencies with their own funding programs. One may expand the list under any department sub heading to view relevant programs belonging to the respective division. Clicking on a program will lead to more information about the program and related iCAP projects (as demonstrated in Figure 3).

Clicking on one of the programs listed under each government office, for example, Solid Waste Management Grants under the U.S. Department of Agriculture (USDA), will load the program page in the portal. A short description is provided along with a list of iCAP projects that may be relevant



Figure 3: Screenshot of a National Program page

to the program under “Related Projects.” The website URL link provided in the screen (Figure 3) will also take a user outside the portal to the national program website, where the user can read more about the program and its requirements. A click on any of the hyperlinked projects will lead to that project’s iCAP Portal page, where one can know more about the particular iCAP project and its relevance to the selected national program.

The [iCAP Portal](#) also provides a way to look for newer funding opportunities within the portal. Every funding offer is categorized under a Federal assistance program listed in the Catalog of Federal Domestic Assistance (CFDA). The Portal provides links to a subset of these grant programs that may be useful for campus sustainability research. These links can be found either in the description of a department/agency or as a website URL in the same page. CFDA program pages contain a brief overview of the funding program as well as a CFDA number that can be used in the [grants.gov](#) website to search for active funding opportunities within the program.

5. Completed and ongoing research projects that use the campus as a living laboratory

Transforming university campuses into “living laboratories” is a timely, important issue for sustainability research and education and campus sustainability enhancement. On the Illinois campus, a number of projects from various research areas have already shown promise. An incomplete list of the projects with their summary is listed below.

1) Using the Gable Home - An award-winning solar house for research and education into sustainable living, by Mark Taylor

The Gable Home was built to compete in the U.S. Department of Energy’s 2009 Solar Decathlon Competition, a competition that brings together 20 teams from around the world to be tested through 10 events over the course of a week. The Gable Home performed exceptionally well in the competition being ranked first or second in six of 10 contests, and an overall ranking of second in the competition.

The house draws reference from vernacular architectural forms found in Illinois, while at the same time employing many innovative technological features. The house is equipped with a 9kW solar array on the south side of its distinctive gable roof; it was one of the first houses in the competition to use a heat pump hot water system, and following the competition the house has had its air conditioning system upgraded to ensure that good air quality is maintained in a house that is highly insulated and airtight.

More than 200 students from numerous units on campus helped in the design and construction of the Gable Home, and more than 24,000 people have toured the house either while it was competing in Washington, D.C., or since it returned to campus. This year, the house will enter another new phase, as it will be relocated onto a permanent foundation at the Energy Farm on Race Street in Urbana. The Gable Home is open to fellow researchers who could use it to further their research into sustainable living. More information about the Gable Home can be found via the following link: <http://2009.solardecathlon.illinois.edu/>



Figure 4. The Gable Home being set up from competition in Washington, D.C., in 2009

2) Abbott Power Plant serving as a testbed for cutting-edge research on next-generation carbon capture, by Kevin O'Brien

Abbott Power Plant is serving as a testbed for cutting-edge research on next-generation carbon capture. The U.S. Department of Energy selected the campus' 75-year-old plant to serve as a model of advanced improvements to existing coal-fired power generation plants worldwide. The project has already drawn the interest of U of I engineering students and is planned to provide laboratory experiences with top engineers from campus as well as from multinational partners including BASF Corp. and the Linde Group. In addition to educational benefits, successful implementation will create a ready supply of purified CO₂ for carbon utilization research on campus and in Illinois. A campus research Center for the Utilization of Carbon Dioxide is also being planned to close the loop on turning this troublesome gas into a valuable commodity. Partnerships are also being formed with Illinois colleges to plan for workforce development for this supply chain. Our state is one of the richest in coal deposits so enabling its responsible use will keep energy costs low and benefit our economy. The project has engaged experts worldwide to advise on this project so success is likely to have impacts in parts of the globe where coal is certain to be a fuel of choice for the foreseeable future. More information can be found at <https://news.illinois.edu/blog/view/6367/313666>.

3) Biological growth and community structure shifts in tap water during stagnation in indoor plumbing, by Wen-Tso Liu

Indoor water supply systems support the daily water use of humans in built environments and have a direct impact on microbes in contact with humans through water use. This part of water supplies are more prone to frequent and prolonged water stagnation than the municipal water supplies. Currently there is limited understanding on the impact of stagnation in indoor plumbing on microbial community in drinking water. In this study we conducted a stagnation experiment in water supply systems of dormitory buildings on the Urbana-Champaign campus and examined how stagnation would interact with the design of plumbing pipelines to influence the composition of microbial communities in tap water. Our results showed that the microbial abundance increased from $<10^3$ cells/mL to $\sim 10^5$ cells/mL after weeklong stagnation. The cell count significantly depended on the volume of water flowing out of the faucet, indicating an influence from the pipeline structure. The biological growth during stagnation was associated with drastic change in community structure (ANOSIM $R=0.9$, $p=0.001$). Furthermore, within the stagnant water, we observed a spatial differentiation in community composition that correlated to the configuration of water supply pipelines ($R=0.508$, $p=0.001$). Other spatial factors did not cause a comparable difference, including building ($R=0.039$, $p=0.03$) and floor ($R=0.028$, $p=0.049$). Temporal variation did not significantly influence the community structure ($R=0.011$, $p=0.182$), suggesting the communities in the stagnant water, although ephemeral, was composed in a pattern resilient to perturbations from water use.

4) Characterization and mitigation of rapid renewable energy variation for improved electricity grid support, by Phil Krein

One of the most difficult challenges in the implementation of large-scale photovoltaic (PV) energy systems is that they impose rapid and stochastic variations on the electric power grid. This project seeks to characterize rapid variations and develop dynamic strategies to mitigate their impact on the electricity grid. We seek to create strategies that support 50% or more PV energy resources into the grid. One purpose is to ensure that fossil fuel power plants can be retired, or at least shut down, on nearly a one-to-one capacity basis as more PV is brought on line.

When a cloud passes over a solar panel or PV array, the power fluctuates over a wide range in very little time. These rapid variations are much more challenging than day-to-day impact of broad weather patterns, such as overcast skies and rain. An overcast day (or a clear day) is often known in

advance, and can be planned into conventional day-ahead resource markets in the power grid. Fast variations, in contrast, require rapid backup resources at the same scale as the PV resource. The implication is that new PV added to the grid does not reduce fossil fuel plant inventory.

Even though the challenge of fast variability is well known, very little hard data are available that fully characterize it in any sense. Previously, no one really knew how rapidly or how deeply a PV array could vary. Typical solar databases record power on an hourly basis. There is a little one-minute data, but even this is not fast enough to capture dynamics of passing clouds, wind-blown leaves, or many other rapid disturbances in PV systems. Our team has gathered a unique resource: a full year of solar data, recorded on 200 unconditioned stimulus intervals. This is single-panel data, however, so it does not show how arrays of various sizes respond to small-scale diversity in cloud edges and other fast variations. In essence, it captures temporal effects but not spatial effects.

Our further work is to gather data from multiple points across a utility-scale array, at the fastest possible time scales, to supplement our 200 and unconditioned stimulus data. **This is precisely the type of data that is possible at the University of Illinois Solar Farm.** The necessary data will help us characterize fast variability in both time and space – an unprecedented resource for the research community. We plan to gather data over at least a year, and assemble it into a form suitable for archival use. The data we have so far, plus the additional needed data, allow us to test a range of mitigation strategies. The industry discusses battery-based energy storage approaches, but these are inherently expensive. We plan to explore methods that combine thermal storage (such as modulating the temperature in a thermal-storage water tank) with fast solar panel control, seeking low-cost ways to offset as much variability as possible. Early results suggest an order of magnitude size and cost reduction compared to all-battery solutions. The work is partially supported by the Grainger Center for Electric Machinery and Electromechanics at the University of Illinois and Sandia National Labs. The project is also associated with the NSF [Power Optimization of Electrothermal Systems \(POETS\) Engineering Research Center](#).

5) Real-time meter data calibration tool, by Yun Kyu Yi

This project aims to improve the means through which energy used in Illinois campus buildings is predicted and measured over time. To strategize and efficiently maintain building energy usage, real-time meters for energy sources (chiller, steam, and electricity) were installed in about 40 campus buildings.

This device comes with a certain shortfall that is embedded within its hardware — a problem of reliability. Often, the collected data from the meters are inaccurate and imprecise. As a countermeasure, certain mechanisms are used to filter these outliers and increase its credibility. However, the capacity of this hardware to correct all outliers is very limited, making it difficult to rely on the data.

As an initial test of this idea, a campus building was selected as a case study to examine the accuracy of its real-time meter data. The result showed that data were not reviewed properly, raising the concern of the credibility of energy benchmarks or strategic plans based on such data.

The project team proposes to develop a new computational tool that can be used by Faculties and Services (F&S) to help identify campus buildings that are underperforming in energy efficiency, with the goal of strengthening strategic planning for the improvement of overall energy performance in campus facilities. More details can be found at <http://www.arch.illinois.edu/faculty/yun-kyu-yi-phd>.

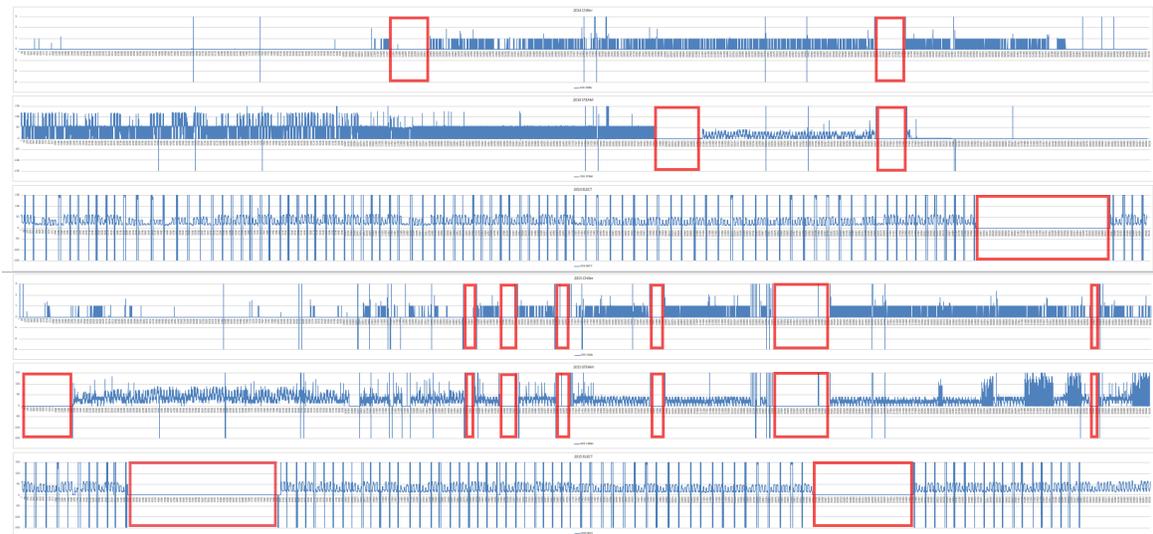


Figure 5. Plot of real-time meter data (Enclosed in red boxes are abnormal patterns of the collected data for steam, chiller, and electricity readings Nov. 2014-2016 in 15-minute intervals. Source: F&S)

6) Attacking supercomputers through targeted alteration of environmental control: A data driven case study, by Ravishankar K. Iyer

At the University of Illinois, the National Center for Super Computing Applications (NCSA) operates Blue Waters, a petascale supercomputer used for performing computation-heavy scientific research (e.g., genomics, physics, astrophysics, etc.). The system is housed in a dedicated facility (at the National Petascale Computing Facility, NPCF), which has adopted a state-of-the-art building

automation system (BAS). Like all other supercomputers, Blue Waters generates a massive amount of heat that can potentially damage the physical internal parts and requires a cooling system to remove the heat from the system and its surrounding environment. At NPCF, Blue Waters deploys a chilled water-based cooling system where the building automation system regulates the chilled water fed from two different sources, i.e., the campus chilled water loop and a set of cooling towers dedicated to the building. While most data centers operate with a single source of chilled water, the deployment of dedicated cooling towers contributes toward reducing the operational cost by taking advantage of cold weather for preparing the system and green energy. In terms of keeping the operational environment within an optimal region, the reliability and security of the BAS play a critical role. In this project, we study the impact of BAS reliability and security on the operation of Blue Waters. Collaborating with NCSA, F&S, and Cray (the manufacturer of Blue Waters), we have been studying the incidents at Blue Waters that relate to the cooling system of the BAS. Our study shows that while most of the incidents were temporal with trivial impact, severe incidents were often caused by unforeseen abnormal events (e.g., changes in the physical parameters due to management operations etc.). In addition, our study considers the relatively weak security of the BAS as a potential threat to the computing infrastructure. As part of our effort on looking ahead of possible attack vectors, we study the case of attackers exploiting the BAS, which Blue Waters heavily relies on, to corrupt the environmental control and eventually cause outages of the super computer and study the deployment of reliability and security monitors to prepare against the potential threats. For example in our publication "Attacking Supercomputers through Targeted Alteration of Environmental Control: A Data Driven Case Study," in the IEEE International Workshop on Cyber-Physical Systems Security, Philadelphia, (Chung et al., 2016), we have demonstrated that with access to the control network of the BAS, the attacker can corrupt the availability of the computing infrastructure by emulating an abnormal event within the BAS. Building upon this basic model, we are exploring the possibility of advanced attack models, and are designing monitoring and detection tools for better security and reliability.

7) Behavioral interventions for campus energy consumption, by Erica Myers

Energy costs in a campus dormitory setting are often not well understood or salient for students. They do not see billing or consumption information, making it difficult to translate use of particular energy services into costs. As a result, energy consumption is often “out of sight, out of mind” as

students go through their busy days. Our research aims to enhance our understanding of how best to address these issues of saliency and understanding. In the fall of 2017, we will test the relative effectiveness of behavioral interventions such as educational campaigns, usage information provision, and social comparisons for taking advantage of savings opportunities and reducing energy consumption in campus dorms. Our findings will be shared with University of Illinois stakeholders, presented at academic conferences, and made publicly available in a University of Illinois white paper by the end of 2018. Our results will not only be relevant for the University of Illinois in meeting its campus sustainability goals, but for other campus and commercial settings where energy use is not well understood or salient for consumers.

8) Working with campus and surrounding community units on energy reduction and emission control, by Xinlei Wang

We have conducted several projects on energy reduction and emission control in the Agriculture Engineering Science Building (AESB) and with the Champaign-Urbana Mass Transit District (CUMTD).

The Solar Decathlon Project: Decathlon is the largest interdisciplinary student project on the Illinois campus. It provides an exceptional opportunity and a great learning experience for more than 200 undergraduate students across many disciplines including engineering, architecture, industrial design, landscape architecture, horticulture, business and communications. The Solar Decathlon is an international competition attended by approximately 20 college teams. Each student team designs, builds and operates an energy efficient, solar-powered home for this competition. Dr. Xinlei Wang served as a faculty advisor for the 2007 and 2009 Solar Decathlon projects, and later served as the leading faculty advisor for Solar Decathlon 2011, Solar Decathlon China 2013, and DOE Race To Zero 2015. He continues to serve as the leading faculty advisor for the Solar Decathlon China 2018.

CUMTD Bus Emissions Reduction: We have been working with the Champaign-Urbana Mass Transit District (CUMTD), the U.S. Environmental Protection Agency (EPA) and the Illinois EPA to develop technology for retrofitting public transit buses to reduce diesel emissions in the metropolitan areas of Urbana-Champaign. This project has installed emission-control devices on 50 buses, which capture 90 percent of the diesel soot and 85 percent of hydrocarbon and carbon monoxide gases, clearing the air on campus and around town. The project is the first in Illinois, among the first in the nation. This project will improve ambient air quality and achieve significant health benefits for the public by reducing the number of illnesses, health care costs, and missed work/school days. Also of

importance, this project will increase public understanding of the environmental and economic effectiveness of the demonstrated clean diesel technology.

CUMTD Geothermal HVAC Project: We have also worked with the CUMTD to receive a grant from the U.S. Department of Transportation (DOT) to install a geothermal heating, ventilation and air conditioning (HVAC) system for the 15,000-square-foot CUMTD administration building. Compared to the current HVAC system, the new system will reduce electrical energy usage by 40 percent, cut natural gas usage by 60 percent, and decrease carbon dioxide greenhouse gas emissions by 97 metric tons per year. The reduced emissions will directly improve local air quality and help the CUMTD operate its business at a lower cost. In addition, we have worked with the CUMTD to install 296 kW solar arrays on the roof of CUMTD maintenance building, funded the Illinois Department of Commerce. It generates 350,000-kilowatt hours of electricity annually, which equals to one quarter of the electricity used there.

Ag Engineering Science Building Energy (AESB) Reduction: This project comprised of a thorough energy analysis of the existing AESB via simulation and on-site measurements. Results of the study revealed opportunities for improvements in equipment and operation cycles and protocols that have resulted in a 50 percent reduction in energy consumption (equivalent to \$130k per year) while improving the indoor thermal comfort significantly for occupants.

9) Using observed post construction peak discharges to evaluate a hydrologic and hydraulic design model, Boneyard Creek, Champaign and Urbana, Illinois, by Thomas Over

Boneyard Creek — which drains an urbanized watershed in the cities of Champaign and Urbana, Illinois, including part of the University of Illinois at Urbana-Champaign campus — has historically been prone to flooding. Using the Stormwater Management Model (SWMM), a hydrologic and hydraulic model of Boneyard Creek was developed for the design of the projects making up the first phase of a long-term plan for flood control on Boneyard Creek, and the construction of the projects was completed in May 2003. The U.S. Geological Survey, in cooperation with the Cities of Champaign and Urbana and the Illinois campus, installed and operated stream and rain gages in order to obtain data for evaluation of the design-model simulations. In this study, design-model simulations were evaluated by using observed post construction precipitation and peak-discharge data.

Between May 2003 and September 2008, five high-flow events on Boneyard Creek satisfied the study criterion. The five events were simulated with the design model by using observed

precipitation. The simulations were run with two different values of the parameter controlling the soil moisture at the beginning of the storms and two different ways of spatially distributing the precipitation, making a total of four simulation scenarios. The simulated and observed peak discharges and stages were compared at gaged locations along the creek. The discharge at one of these locations was deemed to be critical for evaluating the design model. The uncertainty of the measured peak discharge was also estimated at the critical location with a method based on linear regression of the stage and discharge relation, an estimate of the uncertainty of the acoustic Doppler velocity meter measurements, and the uncertainty of the stage measurements.

For four of the five events, the simulated peak discharges lie within the 95 percent confidence interval of the observed peak discharges at the critical location; the fifth was just outside the upper end of this interval. For two of the four simulation scenarios, the simulation results for one event at the critical location were numerically unstable in the vicinity of the discharge peak. For the remaining scenarios, the simulated peak discharges over the five events at the critical location differ from the observed peak discharges (simulated minus observed) by an average of 7.7 and -1.5 percent, respectively. The simulated peak discharges over the four events for which all scenarios have numerically stable results at the critical location differs from the observed peak discharges (simulated minus observed) by an average of -6.8, 4.0, -5.4, and 1.5 percent, for the four scenarios, respectively. Overall, the discharge peaks simulated for this study at the critical location are approximately balanced between over-prediction and under-prediction and do not indicate significant model bias or inaccuracy. Additional comparisons were made by using peak stages at the critical location and two additional sites and using peak discharges at one additional site. These comparisons showed the same pattern of differences between observed and simulated values across events but varying biases depending on stream gage and measurement type (discharge or stage). Altogether, the results from this study show no clear evidence that the design model is significantly inaccurate or biased and, therefore, no clear evidence that the modeled flood-control projects in Champaign and on the University of Illinois campus have increased flood stages or discharges downstream in Urbana. More information can be found at <https://pubs.usgs.gov/sir/2011/5176/>.

10) High resolution temperature profiling and thermal analysis for geothermal energy; Thermal response test unit for geothermal pilot, by Yu-Feng Lin

The studies of "High Resolution Temperature Profiling and Thermal Analysis for Geothermal Energy" and "Thermal Response Test Unit for Geothermal Pilot Project" funded by the Student Sustainability Committee (SSC) at the University of Illinois at Urbana-Champaign were conceived to assist the campus community, including the university and nearby cities, to assess the suitability of renewable geothermal heating and cooling as an option for reducing the carbon footprint and greenhouse gas emissions by 2050, a goal of the Illinois Climate Action Plan (iCAP). To further evaluate the benefits of geothermal exchange systems, a Geothermal Research Station was constructed at the Energy Farm located in the south farms district of campus. Here, researchers from the Prairie Research Institute are collecting detailed, continuous information about the earth's thermal properties and temperature profile from a 100-m borehole containing a geothermal loop with fiber optic cables. This state-of-the-art station is capable of monitoring fine resolution temperature (0.01 °C) continuously in both spatial and temporal scales. It provides the only site to perform Distributed Thermal Response Test (DTRT) in our country. Moreover, the data being obtained and analyzed will be the basis for a potential comprehensive assessment of developing large, district-scale geothermal systems on campus to determine overall costs and possible challenges. See more details on High Resolution Temperature Profiling and Thermal Analysis for Geothermal Energy: <http://ssc.sustainability.illinois.edu/?p=1582>

11) Multifunctional woody polycultures at the Illinois Energy Farm, by Sarah Taylor Lovell

The Agroforestry for Food team is studying an alternative option for agriculture in the Midwest, initially targeting areas that are not best suited for row crops. Team members are comparing a variety of systems — mixtures of trees, shrubs, and forage or hay — that yield multiple food (and fuel) products including fruits and nuts. These "Multifunctional Woody Polycultures" offer potential benefits of a more complex mix of permanent species. In addition to providing harvestable products 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 we will measure.

Team members recognize that these systems must be profitable for the farmer, so they are accounting for all costs and income streams to compare with the conventional corn-soybean rotation. They will also explore the potential for alternative agriculture to contribute to healthier rural communities by improving the agricultural landscape and providing job opportunities for residents. The project received 2014 seed funding from the Institute for Sustainability, Energy, and Environment (iSEE), and in spring 2015 the Agroforestry for Food site was established on a 30-acre plot at the Illinois Energy Farm featuring seven different treatments of woody plants replicated four times. Among the more than 12,000 trees and shrubs are chestnuts, currants, hazelnuts, apples, pawpaws, pecans, plums, persimmons, and elderberries.

The forage crop between the rows of nut and berry plants is cut and baled, and the hay is used by the U of I Department of Animal Sciences to feed livestock — providing some income on the farm as the shrubs and trees mature to productivity. More details can be found at <http://sustainability.illinois.edu/agroforestry-for-food-project/>; <http://www.agroforestry4food.com>

12) Partnering with University of Illinois Dining Services to Investigate Food Waste, by Brenna Ellison

Brenna Ellison, Assistant Professor of Agricultural and Consumer Economics, conducted a 13-week audit of food waste in two University of Illinois dining facilities. In the Ikenberry facility, which serves over 2,000 students every day at lunch, the average student was wasting 0.19 pounds, or 3.11 ounces, of food at each meal ± this amount is equivalent to one chicken breast or one piece of pizza wasted per student per meal! In an effort to reduce waste in the Ikenberry facility, Ellison's team posted educational materials to inform students about the extent of food waste in the United States as well as a graph that charted out the weekly food waste from Ikenberry diners. The educational campaign resulted in small reductions in food waste and significantly improved students' beliefs that University Dining Services cares about reducing food waste. Ellison is working with Dining Services to identify other ways to promote food waste reduction in on-campus dining facilities.

These projects show great examples on the integration of research, education and campus sustainability. The investigators of these projects will meet on Oct. 11, 2017 for a workshop on **Using campus as living laboratory: Potentials for research, education and campus**

sustainability. Discussions will focus on how campus sustainability projects help on research and education and on the other hand, how these projects contribute to the realization of campus sustainability objectives. Moreover, the workshop will also invite university administration and faculty to discuss how to integrate campus sustainability with research & education so that these elements can benefit to each other. Through the workshop we call for strengthening the engagement of students, faculty, and staff and communities stakeholders to go beyond our current practices.

6. Summary

Following a review report on campus sustainability programs (Opportunities for education and research, Cai and Shafiee-Jood, 2017), this report reviews the campus sustainability projects conducted on the Illinois campus in Energy, Water, Land & Space, Procurement & Waste, Transportation, Outreach, and Education, i.e., the iCAP projects. Among more than 500 iCAP projects, we identify those that can be particularly useful for sustainability research and education development, especially that which targets external resources.. In particular, we highlight a number of campus facilities and programs that have a great value for developing research and education projects targeting external resources. We then match selected iCAP projects with national grant programs, and preliminary links have already been established online at iCAP portal. Users can use the links to search for iCAP projects, which will allow researchers on campus to identify completed and ongoing efforts that can be incorporated into proposal development for a particular national program. We also provide a list of examples of completed and ongoing research projects that already use the campus as a living laboratory.

Nationwide, some universities have one or more funding sources that are specifically available to provide seed funding for faculty to conduct research projects with the focus of sustainability on campus or in the community. These programs regularly call for proposals, provide mentoring and consultation resources to applicants, and encourage involving more academics in campus sustainability projects. A few examples:

- Harvard University — [Campus Sustainability Innovation Fund](#) for Living Lab
- Ohio State University — [The Campus as a Living Laboratory \(CALL\)](#) program (also [Campus as a Testbed](#))
- [University of Minnesota Living Lab](#)
- University of Washington — [Green Seed Fund](#)

While the iCAP projects, many of which are based on unique facilities/programs on campus, are valuable for research and education development, the realization of many [campus sustainability objectives](#) will need research support. To support this two-fold goal, an iSEE seed funding program for campus sustainability-related projects will be established to provide incentives for faculty to demonstrate progress toward improved sustainability performance. We will leverage this seed money to attract larger external funds that are relevant to iCAP objectives. For approved projects, a considerable amount of funding is expected to be directly applied toward campus sustainability development; research findings can provide scientific support for relevant iCAP objectives; and opportunities can be offered for campus sustainability units (iSEE, F&S, etc.) to enhance ongoing work and for students for improved sustainability education. The proposed seed funding is a win-win solution for research and education using campus as living laboratory — and for campus sustainability promotion. The procedures and criteria for seed funding projects can be found in a document to be released soon by iSEE.

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Appendix I: iCAP projects that can be used for research and education development (colors represent categories of similar projects of each theme)

Table A1. iCAP projects with the theme of Education

<u>Education</u>	Description	Keywords
<u>Develop Sustainability Learning Outcomes</u>	The learning outcomes for campus sustainability coursework were developed by the Sustainability Education Task Force, a committee of faculty, staff and students from diverse units across campus, which was appointed by the Chancellor and Provost.	learning outcomes, education
<u>Sustainability Literacy Assessment</u>	Sustainability is included in our campus Senior Survey.	Literacy assessment, senior survey, behavior, awareness, evaluation
<u>Provide incentives for sustainability education</u>	A preliminary set of learning outcomes requiring each graduating student to obtain a core competency on sustainability has been identified.	incentive, sustainability education, learning, course plans
<u>Sustainability Immersive Experience</u>	One of the 2015 iCAP suggestions. Students will conduct research on real-world problems related to sustainability at the campus level, in their communities or the national/global level.	immersive experience, student participation, social, economic and environment
<u>Prairie Project Instructional Workshop</u>	The Prairie Project was a faculty development workshop on the University of Illinois campus that is meant to prepare faculty to teach about sustainability and introduce sustainability issues into their existing coursework.	faculty training, sustainability workshops
<u>CEE 398 Project Based Learning (PBL)</u>	The primary objective of this project-based learning course is to develop critical thinking and engineering problem solving skills by exploring and proposing sustainable solutions to current civil and environmental engineering problems facing the University of Illinois campus community.	examples of sustainability course, group projects, communication, learning
<u>CEE 598 SUS with Barbara Minsker</u>	In this course, students will explore fundamental concepts of sustainability and resilience in urban systems through case studies.	examples of sustainability course, resilience, urban systems, consulting

Table A1 (Continued) iCAP projects with the theme of Education

NRES 285: Sustainability Metrics and Evaluation Techniques	A course to teach students how to evaluate the holistic impacts of various sustainability projects.	examples of sustainability course, evaluation, impact analysis
Sustainable Studies in the Humanities	An interdisciplinary course load that connects physical and technical sciences with economics, policy, and social science.	sustainability courses, humanities, interdisciplinary,
Inventory of Sustainability Courses	An inventory of sustainability-, energy-, and environment-related and -focused courses. It is available on the iSEE website.	Sustainability Courses inventory
Development of Experiential Learning Sites	Development of long-term experiential learning sites that will integrate research, education, engagement, and operations through hands-on learning on campus, regionally, and globally.	experiential learning sites, international, sustainability courses, learning sites
Independent Student Projects	Part of the 2015 iCAP.	Independent study for undergraduates, research
Sustainability Minor	The Sustainability, Energy, and Environment Fellows Program (SEE FP) is a campuswide undergraduate minor that prepares students for careers in the corporate sector, non-profit organizations, government agencies and environmental advocacy groups.	undergraduate minor in sustainability, interdisciplinary
Student Sustainability Educators Program	Student sustainability educator programs are peer-to-peer learning or training opportunities.	student associations, peer learning, training
Sustainability Living Learning Community (SLLC)	SLLC welcomes students to live and learn about diverse aspects of sustainability in a variety of ways: academically, organically, and experientially.	learning, student associations, experience, dialogue
Student Sustainability Committee (SSC)	With the ultimate goal of making the University of Illinois at Urbana-Champaign a leader in campus sustainability, SSC reviews, recommends, and funds projects that increase environmental stewardship, inspire change, and impact students.	student associations, organization, planning, management

Table A2 iCAP projects with the theme of Energy

<u>Energy</u>	Description	Keywords
<u>Energy Dashboard Project</u>	Provides clearly visible understandable information data and information to students and staff of selected University buildings describing energy consumption rate.	monitoring, energy saving, building scale, campus scale, data visualization, awareness
<u>Presentations with Energy Liaisons</u>	The goal is to use the Energy Liaisons and various campus sustainability committees as grassroots contacts for initiatives such as energy conservation, hopes to effect behaviour change on campus.	energy saving, communication, behaviour, community, education
<u>Energy Conservation Incentive Program (ECIP) Awards</u>	ECIP is an intensive program to encourage departments on campus to conserve energy.	energy saving, behaviour, incentives
<u>Energy Use Policy</u>	The campus implements an energy policy that in the short term (until 2012), aggressively reduced energy consumption and improve energy efficiency, and in the long term will proactively increase our use of renewable energy to power our campus.	energy saving, policy, history, path
<u>Building Level Energy Consumption Report</u>	This project aims to create a building level energy consumption report with information about each specific building.	energy saving , building level study, monitoring, behaviour
<u>Illini Lights Out</u>	Engages student volunteers to turn lights out in key campus buildings, to conserve energy and raise awareness.	energy saving, behaviour, community involvement, awareness
<u>Kill-a-Watt Monitors at Libraries</u>	There are three Kill-a-Watt monitors that SSC bought for the Student Weatherization Program.	energy saving, monitoring, behaviour, awareness
<u>Eco-Olympics</u>	ECO-OLYMPICS is an energy competition between residence halls on campus.	energy saving, behaviour, competition, incentives
<u>Green Your Dorm</u>	An effort to help students realize the impact they have and how they can change their living in simple ways to be more sustainable in the long term.	energy saving, behaviour, competition, incentives
<u>Fume Hood Shut the Sash Campaign</u>	A program to educate users of variable air volume chemical fume hoods (VAV CFH) to encourage lowering the sash when not in use, but after background studies are performed.	energy saving, cost saving, emissions, efficiency

Table A2 (Continued). iCAP projects with the theme of Energy

Convert Fume Hoods from CAV to VAV	The iCAP calls for converting all existing constant air volume chemical fume hoods to variable air volume chemical fume hoods with energy recovery. Studies were conducted to assess the impacts of this strategy on energy saving.	energy saving, cost saving, emissions, efficiency
Weatherization of Small Campus Buildings	Students conduct energy assessments of campus buildings for the purposes of weatherization.	energy saving, behaviour, building level study, evaluation
Update Building Maintenance Procedures to Support Long-Term Energy Savings	The University of Illinois has begun to renovate its buildings with sustainability in mind. The F&S Building Maintenance team is working to incorporate the operations changes identified by the Retrocommissioning Teams.	energy saving, maintenance, efficiency, retrocommissioning, cost saving
AFMFA Energy Conservation Projects	The Deferred Maintenance Program covers numerous large projects on campus. It often contributes to energy conservation projects on campus, and clear information about individual projects is regularly updated on the Deferred Maintenance Website.	energy saving, maintenance, cost saving
Pipe Insulation	The Maintenance Division has funded two full-time insulators to continuously insulate pipes of all types throughout campus.	energy saving, maintenance, cost saving
Main Library Steam Reduction Project	This project was to reduce the need for burning coal to fulfil the campus steam energy demand, by reducing the steam load at the Main Library.	energy saving, building level study, steam reduction, retrocommissioning, maintenance
Plant Sciences Window Shades	The Energy Shade Curtain Systems provide shading and heat retention. Curtains are driven open and closed by a motorized (gear drive) system governed by commands from a controller.	energy saving, technology, control systems
Reduce Active Fume Hoods	The iCAP recommends removal of 25 percent of CFHs on campus over the first five years resulting in a total removal of 432 CFHs for a theoretical annual; it is recommended that before any action to remove or alter large quantities of CFHs, a detailed survey of each CFH on campus be conducted to determine what, if any alterations can be made and calculate the associated cost and energy savings associated with it.	energy saving, cost saving, emissions, efficiency
Lighting Conservation Projects	The campus is in the process of retrofitting older T12 fluorescent lighting fixtures by replacing them with more energy-efficient T8 (or T5) fixtures and electronic ballasts.	energy saving, lights, efficiency
LED Campus	The University has delivered on a pledge to become the first major research university to commit to becoming an LED Campus.	energy saving, LED, retrofitting efficiency, technology

Table A2 (Continued). iCAP projects with the theme of Education

TBH Lighting Project	In order to reduce energy use associated with lighting and cooling within the building, occupancy sensors, daylight sensors, and lighting timers will be installed.	control systems, energy saving, efficiency, retrofitting, lights , technology
Vending Machine Sensors	The primary contract for vending machines on our campus is systematically replacing old beverage machines with new machines that have lighting sensors.	control systems, energy saving, efficiency, retrofitting, lights , technology, monitoring , operations
Occupancy and Daylight Sensors	Occupancy Sensors provide automatic ON/OFF switching of lighting loads to enhance convenience, security and long-term energy savings.	control systems, energy saving, efficiency, retrofitting, lights , technology, monitoring , operations
Energy Services Conservation Projects	This follows one of the 2015 iCAP objectives: Strengthen centralized conservation efforts focusing on building systems to achieve a 30% reduction in total campus building energy use by FY20. This includes meeting LED Campus commitments.	energy saving, retrocommissioning, efficiency, cost saving, planning, contracts, maintenance, iCAP objective
SAIC projects	A recent evaluation of potential energy conservation measures on campus was performed by the international consulting firm Science Applications International Corporation.	energy saving, evaluation, planning, campus level study, historical data
Smart Grid for Campus	By incorporating direct digital controls at many levels of the electrical grid, campus will be able to shave the energy demand as needed during peak times.	energy saving, monitoring, control systems, technology, smart grid, DDC
Retrocommissioning (RCx)	This project involves an analysis of a building's Heating, Ventilation, and Air Conditioning systems as well as their maintenance program. The purpose of this group is to restore the most favourable operating conditions while optimizing energy conservation, sustainability, and client comfort satisfaction.	energy saving, retrocommissioning, efficiency, cost saving, maintenance
Energy Recovery Wheels	Air-to-air heat recovery systems are required by the university's Facilities Standards for new capital projects. As a part of the LEED certification and deferred maintenance process, heat recovery wheels have been installed in multiple facilities on campus.	energy saving, technology, LEED, energy recovery
Vet Med ESCO	The Vet Med ESCO project will provide innovative energy efficiency and technology, demonstrable energy savings, and long-term financing solutions for modernization of our facilities and energy infrastructure.	energy saving, efficiency, cost savings, retrofitting, technology, building scale
Oak Street Chiller Plant ESCO	It is expected this project will install new equipment and make operational revisions for energy savings in chilled water production for the campus' central chilled water system.	energy saving, efficiency, cost savings, technology, building scale

Table A2 (Continued). iCAP projects with the theme of Energy

Thermal Energy Storage (TES) Tank	Energy storage allows campus to use energy when costs are low at night and store the energy in the water until it is needed during the day. The University of Illinois at Urbana-Champaign built a Thermal Energy Storage (TES) tank for the Campus Chilled Water System (CCWS).	energy saving, efficiency, cost savings, technology, facility
ECE Net-Zero Energy Building	With the new ECE building the University is determined to achieve LEED platinum certification, and is striving for a net-zero energy design that will enable the building to supply all of its own energy. From a vast array of photovoltaic cells, to a chilled beam system to cool and heat the classroom tower, ECE will accomplish a major campus addition with maximum space and minimal carbon footprint.	energy saving, renewable energy, LEED, net-zero energy, solar
Consolidate Servers with Virtualization	Virtual machines save on power and space by consolidating physical machines.	energy saving, campus scale, technology,
Chip PC Thin Client	Thin client computing devices and servers have low power consumption and increased lifetime as compared to ordinary desktop computers.	energy saving, campus scale, technology,
ECE Rooftop Solar PVs	The new ECE building is designed to include Solar Panels on its roof. The panels will provide about 11% of the building's energy needs.	renewable energy, solar, building scale, rooftop
Install Solar PVs on NCPD	The College of Engineering looked to other locations where arrays might be installed to generate the additional energy needed for the ECE building to meet its goals. Located one block away from the ECE site is the North Campus Parking Deck (NCPD).	renewable energy, solar, building scale
Solar Farm	The University signed a 10-year power purchase agreement with Phoenix Solar to purchase all electricity produced by the Solar Farm and deliver it directly to the campus grid.	renewable energy, solar, facility, energy farm, PPA, data
Rooftop Solar Potential	One potential method for achieving the 2015 iCAP goal for on-campus solar is to retrofit existing campus buildings with rooftop solar. As of 2016, the financial payback for solar photovoltaics is not strong enough to easily justify the up-front costs, so alternative funding solutions are needed.	renewable energy, solar, building scale, rooftop, retrofitting
BIF Rooftop Solar PVs	The Business Instructional Facility was the first production rooftop solar PV array installed on a campus building.	renewable energy, solar, building scale, rooftop, retrofitting

Table A2 (Continued). iCAP projects with the theme of Energy

Ground Mounted Solar PVs BRC Research Test Bed	Illinois Center for a Smarter Electric Grid's research mission is to support the continuing development of the Smart Grid through research that tests and validates the trustworthiness of new components and systems that will be required to realize the full potential of the Smart Grid, and renewable energy systems such as wind and solar are critical to realizing this vision.	renewable energy, control systems, solar, wind, smart grid
Idea Garden Solar PVs	The Master Gardeners are interested in adding rooftop solar PVs to the garden shed to the east of the Idea Garden in the Arboretum.	renewable energy, solar, rooftop
KCPA Rooftop Solar Feasibility Study	This feasibility study considered the potential placement of a photovoltaic array on the roof of Krannert Center for the Performing Arts (KCPA).	renewable energy, solar, building scale, rooftop
Solar Panels on Everitt Lab	To power an electric vehicle charging station at the Sustainable Student Farm, this project will install rooftop solar on the Fruit Farm Admin building.	renewable energy, solar, rooftop, electric vehicles
Solar PVs on Fruit Farm Admin Building	There are eight photovoltaic (PV) panels on the roof of Everitt Laboratory used by the Power and Energy System Group to conduct research.	renewable energy, solar, building scale, rooftop
Speech and Hearing Rooftop Solar PVs	The Student Sustainability Committee has funded the design and installation of a small solar PV array on the Speech and Hearing Building. This particular location was chosen due to its viability, visibility, and location near the heart of campus.	renewable energy, solar, building scale, rooftop
Uni High Gym Rooftop Solar PVs	University Laboratory High School (Uni) received grant funding from Illinois Clean Energy Fund (ICECF) through its K-12 Solar Schools Program, to install a 1 kwh dc solar array on the gym roof.	renewable energy, solar, building scale, rooftop
Wassaja Hall Rooftop Solar PVs	A 30 kW solar PV array was installed on December 14, 2015 on the east side of the roof.	renewable energy, solar, building scale, rooftop
SSC Solar Feasibility Study	SSC commissioned a solar photovoltaic study to determine viable buildings for the installation of solar arrays.	renewable energy, solar, building scale, rooftop
Solar Thermal at ARC	The 24-panel, gravity fed solar-thermal system on the roof of the ARC preheats domestic cold water prior to its introduction into the steam-powered heat exchanger for domestic hot water, which significantly reduces steam usage for domestic hot water during normal operating periods.	renewable energy, solar, building scale, rooftop
Rooftop Wind Vertical Turbines on PPSB	The Physical Plant Service Building (PPSB) is uniquely positioned parallel to the Stadium, with a long, flat roof. As a highly visible rooftop, this building may be an opportunity to test out verticals rooftop wind turbines. These turbines could be designed and built in cooperation with faculty and students on campus.	renewable energy, wind, facility, rooftop, building scale

Table A2 (Continued). iCAP projects with the theme of Energy

Geothermal at Allerton Park	Funded by SSC and the Department of Commerce and Economic Opportunity, the installation of a geothermal system will reduce the park's and the University's dependence on fossil fuels.	renewable energy, geothermal, park
ISTC Geothermal Loop	To investigate the possibility of installing an open-loop geothermal system at the Illinois Sustainable Technology Center. Based on the results of the first phase, it turned out that there was not enough flow rate, no more funding was granted, and project was cancelled.	renewable energy, geothermal
Geothermal Test Well	The main objective is to provide comprehensive scientific data and analysis to help our community on evaluating the potential of using ground source heat pump system in a large scale as part of campus green energy policy.	renewable energy, geothermal
Methane Capture on Campus	One of the strategies listed in the iCAP to reduce agricultural emissions is to install a methane capture process for additional energy generation by 2020, with a pilot project by 2015. The University will implement a pilot methane capture project at the South Farms by 2015.	methane capture, agriculture, facility
Anaerobic Digester at Beef and Sheep Study	This project will provide a study to investigate the feasibility of installing an Anaerobic Methane Digester in the area of the University's South Farms to capture renewable energy from beef, sheep and/or dairy cow waste. The study will assess the possibility of an on-site digester at one site, with one digester system of animal waste.	methane capture, facility
Biomass use on Campus	The Center for Advanced BioEnergy Research (CABER) focuses on bioenergy systems research, and F&S Energy Services is reviewing options for integrating biomass fuel sources into campus energy production.	renewable energy, bioenergy, biomass fuel
Biogasification	The University is working on biogasification in collaboration with the City of Rantoul.	renewable energy, bioenergy, biogas, technology, community development
Biomass co-firing pilot at Abbott Power Plant	Plans are progressing to add a new energy source at Abbott Power Plant – biomass fuel made from plants – following the Illinois Environmental Protection Agency 2012 decision to grant a test-fire permit.	renewable energy, bioenergy, agriculture, facility, technology
Biomass use at the Energy Farm	This project is looking to convert the existing (and future) biomass from the Energy Farm into power and heat for the on-site Energy Farm facility.	renewable energy, bioenergy, agriculture, technology

Table A2 (Continued). iCAP projects with the theme of Energy

Vet Med Miscanthus CHP Boiler	<p>Envisioned to use the energy crops grown on the Energy Farm to provide power to the Veterinary Medicine building complex. It would also allow researchers to do test burns of various energy crops grown on campus. After many discussions and evaluations, campus decided that this project would not meet the goals set.</p>	<p>renewable energy, bioenergy, technology, boiler</p>
Green Allerton Wood-fired Boiler	<p>An Outdoor Wood-fired Boiler system was funded to replace a natural gas heating system at Allerton Park. By replacing the previous system, CO₂ emissions will be eliminated and there will be a substantial cost savings.</p>	<p>renewable energy, bioenergy, technology, campus property, Allerton Park</p>
PPA for National Petascale Computing Facility	<p>This project follows on the 2015 iCAP objectives: Offset all emissions from the National Petascale Computing Facility (and other successor facilities) by the conclusion of the current period of National Science Foundation support. At present, renewable energy certificates (RECs) are the most cost effective means of reducing the emissions from NPCF.</p>	<p>renewable energy, offsets, PPA</p>
Wind Power Purchase Agreement (PPA)	<p>From November 2016 through October 2026, the Urbana campus will receive a percentage-based portion of the wind-generated electricity and associated environmental attributes from the Rail Splitter Wind Farm located north of Lincoln, Ill.</p>	<p>renewable energy, wind, PPA, campus energy use, community collaboration</p>
Stop Burning Coal at Abbott Power Plant	<p>The Abbott Power Plant capital plan will include elimination of significant investment to extend the life of the coal plant and implementation of a plan to convert the plant to burn biomass.</p>	<p>coal, carbon footprint, power plant</p>
Carbon Capture	<p>The Illinois Sustainable Technology Center will explore methods to capture carbon dioxide from the gas- and coal-fired Abbott Power Plant. The ultimate goal is to reduce CO₂ emissions and developing industrial markets that would reuse the recovered CO₂. The Department of Energy is funding the \$1.3 million engineering and planning phase, representing the DOE's first sponsorship of a large-scale research and development project for the capture of CO₂ emissions.</p>	<p>carbon capture, carbon footprint</p>
Explore Options for 100 Percent Clean Campus Energy	<p>Following one of the objectives of 2015 iCAP, The Energy Generation, Purchasing, and Distribution SWATeam has formed consultation groups centered on each of the most promising clean energy technologies. Input from these consultation groups can inform the development of recommendations for moving to 100% clean campus energy.</p>	<p>community collaboration, planning, evaluation</p>

Table A3 iCAP projects with the theme of Transportation

<u>Transport</u>	Description	Keywords
<u>Reduce Cars (Vehicle Miles Travelled) on Campus</u>	In order to have a sizable impact on transportation emissions, campus will need a multifaceted program that encourages and educates the entire University community on active transportation options.	reduce VMT, behaviour, planning, community
<u>Discourage Vehicles on Campus</u>	The University seeks to provide healthy, efficient, economic, and sustainable forms of transportation for students, employees, and campus visitors.	reduce VMT, behaviour, planning, community
<u>Parking Master Plan</u>	The Campus Master Plan includes future plans for Parking facilities.	Parking Master Plan, campus master plan
<u>Traffic Calming</u>	The University is implementing traffic calming techniques on campus to encourage the use of alternative transportation modes, and to make the campus safer for pedestrians, cyclists, and persons with disabilities.	behaviour, planning
<u>Encourage Ride-Sharing</u>	By sharing a ride with even one more person, via carpool or vanpool, the emissions from trips are cut in half (one vehicle going 15 miles, compared with two vehicles going 15 miles each).	reduce VMT, behaviour, planning
<u>Encourage Active Transportation</u>	The University can be a leader in Active Transportation by encouraging students, employees, and visitors to get out of the car-centric mentality.	reduce VMT, behaviour, planning
<u>Increase Bicycle Use</u>	In order to increase ridership and the safety of all roadway users, the University recognizes that it must take a number of steps to improve both the culture and infrastructure around cycling on campus	iCAP objective, bicycle, behaviour
<u>Bicycle Education</u>	The University is working with the communities to provide bicycle safety training, awareness events, and lessons in maintaining a bicycle.	bicycle, education, behaviour, safety
<u>Campus Bike Center</u>	The Campus Bicycle Center — a collaboration between the University of Illinois and The Bike Project of Urbana-Champaign — is dedicated to empowering individuals with knowledge about how to repair and maintain bicycles and encouraging mode-shift away from single-occupancy vehicles.	bicycle, education, facility, administration
<u>Encourage Bicycle Use</u>	The University is also working to encourage new riders to try bicycling as a method of transportation	bicycle, incentives, behaviour

Table A3 (Continued). iCAP projects with the theme of Transportation

Bike Sharing	The University is exploring options for making communal bicycles available to students and potentially to the general public.	bicycle, incentives, behaviour
C-U Bike to Work Day	In 2010, Champaign-Urbana hosted the first annual C-U Bike to Work (and School) Day on May 4. The University is also a partner organization for this event.	bicycle, education, incentive, community development
Incentives for Biking	Implementing programs to incentivize people to ride a bike.	bicycle, education, incentive, community development
Engineer for Bikes	Bicycle lanes, paths, parking and repair stations all help to make the campus more bicycle-friendly, and encourages campus users to travel and commute by bike.	bicycle, engineering, parking, facility
2014 Campus Bike Plan	The University of Illinois at Urbana-Champaign has completed and approved the 2014 Campus Bike Plan, a master plan to direct our efforts for future bicycle infrastructure improvements and program development.	bicycle, planning, evaluation, campus level, urban planning
Collect Cyclist Feedback	F&S Transportation Demand Management's (TDM) latest initiative to improve efforts to make the Urbana campus more bicycle friendly is a "Campus Bicycle Feedback Form" that will allow anyone to share their suggestions for bicycle-related improvements on campus.	bicycle, planning, evaluation, community
Improve Reporting and Metrics for Bicycles	There are many metrics that the University needs to evaluate the success of bicycle programming efforts. The University aims to improve and increase the rate of reporting on bike thefts and crashes to better understand changing trends for safety and security of bicycles on campus.	bicycle, planning, evaluation, monitoring
Support High Speed Rail Plans for Illinois	The University supports efforts of the Midwest High Speed Rail Association to bring highspeed rail to Champaign-Urbana. It would greatly decrease transportation emissions, and it would also increase economic development in this area.	public transportation, regional planning, high speed train,
Increase Walking	It is a healthy and fun mode of travel, which can be enjoyed alone or with friends and colleagues.	Walking, health, behaviour, incentive,

Table A3 (Continued). iCAP projects with the theme of Transportation

Walkability Study	<p>By working with volunteers to perform walking audits, the Wellness Center is collecting detailed comments and notes about walking around campus. This information will be shared with Facilities and Services and incorporated into project prioritization for sidewalk improvements.</p>	<p>Walking, community, campus services, planning</p>
Multimodal Corridor Enhancement Project (MCORE)	<p>Improve mobility in our community’s core through a federal Transportation Investment Generating Economic Recovery (TIGER) grant. The goal of MCORE is to provide a balance between all modes of transportation. MCORE will encourage sustainable development that is located and designed to be compact and contiguous to existing developments.</p>	<p>Infrastructure, community development, urban planning, maintenance</p>
Multi-Modal Transportation Study	<p>A consultant was hired in 2007 to review the campus multi-modal transportation and make recommendations for improved campus safety. Many of the recommendation have already been implemented and study was a helpful source in the transportation section of the 2010 iCAP.</p>	<p>Infrastructure, community development, urban planning, safety</p>
Install Public Use Electric Vehicle (EV) Charging Stations	<p>Electric vehicle (EV) charging stations can encourage low-emission vehicles by providing the supporting infrastructure.</p>	<p>transportation, EVs, energy, emission, facility</p>
Develop Scenarios for Converting the UI Fleet to Renewable Fuels	<p>One of the iCAP 2015 objectives to develop scenarios for complete conversion of the campus fleet to renewable fuels.</p>	<p>iCAP objective, fleet, emission reduction, renewables, planning</p>
Use Electric Vehicles (EV) on Campus	<p>Electric vehicles are a focus of the University’s continuing efforts in reducing fossil fuel emissions.</p>	<p>fleet, EV, emission reduction, renewables</p>

Table A4. iCAP projects with the theme of Land and Space

<u>Campus Land and Space</u>	Description	Keywords
<u>Carbon Sequestration</u>	One of the objectives of 2015 iCAP. The first half of this objective aims to determine the sequestration value of existing plants. For the second half of this objective of finding locations for additional planting.	ICAP objective, carbon sequestration, agroforestry, inventory, survey
<u>Incorporate Sustainability Principles into Campus Master Plan</u>	F&S is working with the University Office of Capital Programs and Real Estate Services on updating the Campus Master Plan in 2017, putting more emphasize on the Net Zero Growth Policy.	Campus master plan, sustainability, planning
<u>Sustainable Agricultural Practices</u>	Areas that need improvement include reductions in food waste and the energy required for food processing, preparation, and transportation.	Agricultural emission reduction, watershed management, land use, organic agriculture, animal production, food waste, incentives
<u>Assess and Reduce Agricultural GHG Emissions</u>	One of the 2015 iCAP objectives. This assessment should include the identification or development of an agricultural emissions calculator.	Agricultural emission reduction, watershed management, land use, organic agriculture, evaluation, planning, GHG reduction
<u>Orchard Downs Community Gardens</u>	Community gardens built on the farmlands at Orchard Downs are available to use for growing their own food.	community collaboration
<u>Sustainable Student Farm</u>	In addition, the farm acts as a living laboratory to connect students, community members, and the state at large with regional, small-scale food systems. We plan to broaden our focus to include the research, education, and outreach missions of the University.	local food, postharvest loss prevention, farming, community outreach, education

Table A4 (Continued). iCAP projects with the theme of Land and Space

Woody Perennial Polyculture (WPP) Research Site	To create a research farm in which the arrangement of plants is similar to that of the climate's natural ecosystem, but uses plants that are more practical for human consumption. This research site is the first attempt at a large-scale WPP system in a temperate environment.	local food, ecosystem, agroforestry, couple human natural systems, farming, sustainable agriculture, education
Sustainable Landscapes Plan	The campus landscapes are continuously improved and maintained in a more sustainable manner with guidance from the Campus Landscape Architect at F&S.	Campus Landscape Architect, campus trees, planning, maintenance
Committee on Natural Areas	The role of CNA is to provide and facilitate long-term research and teaching opportunities on University-owned properties. Sites are managed to protect both the integrity of the ecological systems and the biological research that takes place on them.	Campus Landscape, campus trees
Burrill/ Morrill Walkway	This project is meant to transform the walkway between Burrill and Morrill Halls into a sustainable and multifunctional landscape. Also in order to curb the rainwater collection problems of the water, a rain garden has been proposed to be added to the center of the walkway.	native plants, recreation, water use, rain gardens, sustainable landscape
Native Plants at Arboretum	Not only does the Arboretum serve as a beautiful area for the public to enjoy, but as a "living laboratory" for University students studying plants sciences and fine and applied arts.	native plants, recreation, education, sustainable habitat
Small Prairie at Natural Resources Building	The Natural Resources Building is the site of another native species planting project, both in front of the building and behind it on Pennsylvania Avenue. This project is funded by the Student Sustainability Project.	native species, insect pollinators, woodland wildflowers
The Illinois Path	Illinois Path is a vision to transform the Military Axis from its current use into a landscape that incorporates prairie, savanna, a wet prairie swale, and woodland.	Prairie ecosystem, environmental, educational, socio-ecological, and economical.
Vet Med Prairies	A tallgrass prairie garden that mimics the natural Illinois prairie landscape of Illinois was planted on the Vet Med Campus.	native plants, prairie
Woodland Plants at NRB	To improve the biodiversity and aesthetics at the front of the Natural Resources Building, volunteers planted sections of native woodland flowers.	native plants, restoration

Table 4 (Continued). iCAP projects with the theme of Land and Space

Support Pollinators	The F&S Landscape Architect is working with campus stakeholders and subject matter experts to develop sustainable landscape solutions that support pollinator populations.	pollinator population, native plants, ecosystem restoration, sustainable landscapes
Low Mow Zones	Facilities & Services established “ <i>Low Mow Zones</i> ” in 2010 to support sustainability, increase pollinator support, and decrease maintenance costs.	native species preservation, ecosystem restoration
Tree Campus USA	Campus is recognized as a Tree Campus USA, as of 2015. This program recognizes college and university campuses that effectively manage their campus trees, develop connectivity with the community beyond campus borders, and strive to engage their student population utilizing service learning opportunities centered on campus and community, forestry efforts.	forestry, behavior, nature, community involvement
Maintain or Reduce Gross Square Footage	The Net Zero Space Growth Policy was enacted to halt the growth in gross square footage of campus buildings; to support the goal of reducing the campus footprint over time through more efficient space utilization; to fulfill the commitment under the 2010 Illinois Climate Action Plan to enact a "no net increase in space" policy and to reduce energy usage through conservation measures	Net Zero Space Growth, footprint
Space Marketplace	The campus will implement a freeze on new buildings and building additions once current planned projects are completed.	Net Zero Space/Energy Growth,
Facility Standards	The University of Illinois at Urbana-Champaign Facilities Standards shall be applied for all remodeling and new construction at the University of Illinois at Urbana-Champaign	energy management, sustainability, environmental impact, standards, policy
Green Roof on Art & Design	The green roof program is among the campus projects for green infrastructure. Some buildings in the university have a green roof, which can be used for both research and education	green roof, energy saving, stormwater, environmental aspirations, beauty, LEED
Green Roof on Forbes Natural History Building		
Green Roof on Foreign Language Building		
Green Roof on KCPA		
Green Roof on NCEL addition		
Green Roof on the Business Instructional Facility (BIF)		

Table A4 (Continued). iCAP projects with the theme of Land and Space

Bousfield Hall: LEED Platinum	<p>The University has adopted LEED Gold certification as a part of their design standards on all new construction. Facilities & Services tracks LEED status for new buildings and major reconstruction.</p>	<p>energy saving, green building, technology, cost saving, waste reduction, LEED</p>
Business Instructional Facility: LEED Platinum		
Huff Hall, Khan Annex: LEED Silver		
Ikenberry Dining Hall: LEED Silver		
Illinois Fire Service Institute: LEED Silver		
Illinois Natural History Survey: LEED Silver		
Lincoln Hall Renovation: LEED Platinum		
NCSA Petascale: LEED Gold		
Nugent Hall: LEED Silver		
Yeh Student Center: LEED Silver		

Table A5. iCAP projects with the theme of Water

<u>Water</u>	Description	Keywords
<u>Stormwater Management Program</u>	One of the 2015 iCAP objectives: Investigate the water quality impacts of stormwater runoff and potential ways to reduce stormwater pollutant discharges by FY18.	iCAP objective, campus stormwater management, pollution control
<u>Porous Asphalt Parking Lot C9</u>	Porous asphalt used in parking lot C9 to reduce stormwater runoff.	stormwater, green infrastructure, facility
<u>Hartley Garden Renovation</u>	The Hartley Garden is declining and a renovation proposal is being put together which includes all elements of the garden, especially the irrigation system which is antiquated and wastes large amounts of potable water. Also, using/collecting grey water and/ or rainwater for irrigation is being considered.	property, green infrastructure, water reuse, irrigation, greywater
<u>Red Oak Rain Garden</u>	This garden is beautiful and smart. It addresses flooding in an innovative way — by planting an attractive landscape feature that captures and filters stormwater; It uses water as a resource instead of allowing it to rush into storm sewers and flood downstream.	stormwater, green infrastructure, facility, landscape sustainability
<u>Rainwater Capture Systems</u>	The capture of rainwater to use as irrigation or other purposes would reduce stormwater volume and usage of potable water on campus.	Green infrastructure, water reuse, irrigation
<u>Inventory and Benchmark Existing Landscape Performance</u>	The campus could complete an inventory and evaluation of existing landscape performance and compare it with high-performance landscapes.	stormwater, landscape, evaluation, benchmark, inventory
<u>Reduce Nitrates from Agricultural Stormwater</u>	One of the 2015 iCAP objectives: Reduce nitrates in agricultural runoff and subsurface drainage by 50% from the FY15 baseline by FY22.	iCAP objective, water quality, nutrient management, agriculture, water pollution

Table A5. (Continued). iCAP projects with the theme of Water

Construct Tile-Drainage Wetlands	One of the most promising management practices for the removal of nitrates and the elimination of nitrous oxide from agricultural surface waters is the establishment of constructed tile-drainage wetlands.	water quality, nutrient, drainage, constructed wetlands, tile drainage, GHG emissions, water management
Clean up campus	Preventing trash on surface streets is an ongoing goal in keeping storm drains, and water ways everywhere, clean. The University will continue its efforts to educate citizens about the harmful effects of littering on our waterways.	Behavior, pollution control, community involvement, awareness, education
Storm Drain Murals	Using drawing to raise awareness about the water quality impacts: the project's goal is to increase understanding and education and inspire people to keep our waterways clean and healthy.	Behavior, pollution control, stormwater, community awareness
Reduce Potable Water Usage	Reduce potable water usage and its associated emissions from a fiscal year 2008 baseline: 20 percent by 2015; 30 percent by 2020; 40 percent by 2025.	Behavior, drinking water, pollution control
Install Low Flow Fixtures throughout Campus	The UI plumbing fixtures are being upgraded to low-flow fixtures.	water use, facility, water conservation
Green Nozzles	The "Green Nozzle" is a highly efficient pre-rinse spray valve that will save approximately 545 therms of natural gas annually due to a reduction in hot water usage.	water use, technology, facility
Campus Rec Water Conservation Incentives	To reduce the water consumption of Campus Recreation patrons without interfering with the service they receive, mainly via upgrading equipment.	water use, technology, facility, incentives, water conservation
Connect Raw Water System	To connect the Raw Water System to a raw water source by 2020. This is another way to utilize non-potable water sources.	Water use, non-potable
Pipe Leakage Assessment	In order to achieve the next potable water conservation goal of reducing use by 40 percent from 2008 to 2025 the University has begun to look at the 63 miles of water distribution lines which provide potable water to the campus.	Water use, water distribution system, water saving, surveying

Table A5. (Continued). iCAP projects with the theme of Water

Reduce Cooling Tower and Chiller Plant Water Use	Following one of the 2015 iCAP objectives, ISTC' study benchmarked water use in cooling towers and proposed five action items to improve water efficiency of cooling towers.	Water use, water save, cooling, efficiency, monitoring, plant study
Turner Greenhouse water cooling systems	The Turner Hall greenhouses can use a new and improved system for cooling that reduces the water usage.	Water use, cooling, monitoring
University Housing Trayless Dining	All campus dining halls have a trayless dining program, in which trays are not available in dining halls, to save water.	water saving, policy
Water Audit / Inventory	Follows one of the 2015 iCAP objectives to perform water audits and determine upper limits of water demand by end use.	iCAP objective, water demand, water use, behavior, water audit, inventory, monitoring
Obtain and Publicize Water Data	Following one of the 2015 iCAP objectives, the campus should obtain and publicize the usage, costs, and quality of water for campus.	Water use monitoring, data, water saving, community awareness
Charge for "true cost of water"	The university is discussing whether to include "true cost of water" charges with the energy billing program as one of the water strategies.	water use, cost, LCA, incentive, recycling
Conduct True Cost of Water Study for Chiller Plants	Due to the large water use of these towers, a 'True Cost of Water Study' was performed on with goals of benchmarking water use in cooling towers and generating ideas for improving water use efficiency.	water use, cost, LCA, water save, recycling
Use of Non-Potable Water	The projects under this category follow one of the iCAP objectives to "implement at least four pilot projects to showcase the potential of water and/or stormwater reuse by FY20."	water/stormwater reuse, greywater
BIF Greywater Pipe System	Although the building is fed from the potable water supply, there is separate piping for the urinals and water closets in the building, which can be used if greywater system becomes available.	water use, water save, recycling, greywater
State Laws for Non-Potable Water	Before utilizing such sources, the University must conduct research to understand how non-potable water may be used within the constraints of the Illinois state laws.	water reuse, recycling, policy

Table A6. iCAP projects with the theme of Outreach

<u>Outreach</u>	Description	Keywords
<u>Green Observer</u>	The Green Observer is the only environmental publication at the University of Illinois, written and published by students. The website is http://greenobserver.net/ .	media, outreach, leadership, education, communication, reporting, awareness
<u>ActGreen</u>	ActGreen is a green business organization composed of University of Illinois Urbana-Champaign students, professors, and administrators. Their mission is to increase undergraduate business students' understanding of the connection between environmental issues and their business area of interest.	green business practices, empowerment, support
<u>Beyond Oil Campaign</u>	The Beyond Oil Campaign began in Fall 2012 with the aim of reducing use of oil on the University of Illinois campus, since oil dependence has harmful economic, political, and environmental effects.	media, outreach, public participation, oil dependence reduction, renewables, communication, outreach, awareness
<u>Illinois Biodiesel Initiative (IBI)</u>	IBI is a RSO with the mission to produce biodiesel and soap from waste vegetable oil collected from campus dining halls. This project is to help IBI rebuild its production up to the previous levels at the ISTC. The IBI goal is to become self-funding. The RSO also worked on an educational component and created a class.	outreach, renewable energy, public, transportation, recycling, technology, waste to energy, student run
<u>Solar Decathlon</u>	The Solar Decathlon is a bi-annual international competition hosted by the Department of Energy and the US Green Building Council (USGBC). The University team has shown a commitment to education of the public about how solar power and sustainable design are feasible and attractive options.	outreach, renewable energy, public, solar, competition
<u>Students for Environmental Concerns (SECS)</u>	The Illinois campus' oldest and largest environmental group is a Registered Student Organization.	environment, leadership, student association, communication, awareness, activism, planning, organization

Table A6. (Continued). iCAP projects with the theme of Outreach

USGBC Student Chapter	USGBC Students is a Registered Student Organization and a member society of the Engineering Council of the University of Illinois at Urbana-Champaign.	environment, leadership, student association, LEED, energy saving, cost efficient, green buildings
Student Sustainability Leadership Council (SSLC)	The Student Sustainability Leadership Council (SSLC) is iSEE's finger on the pulse of student-led initiatives in sustainability. It is also the bridge between iSEE and the student body, serving as a two-way conduit of information and concerns about campus sustainability issues.	leadership, student association, organizations, community, collaboration, planning, awareness,
ISTC Sustainability Seminars	The Illinois Sustainable Technology Center (ISTC) presents an annual year-long series of seminars, usually one or two per month, presented by researchers, policy makers, and corporate executives on various topics related to Sustainability, Energy, and the Environment.	research, public/academic events, discussion, awareness
Certified Green Office Program (CGOP)	Initiative to engage the University community in a campuswide commitment to sustainability.	campus teams, green communities, awareness, outreach, community engagement, incentives
Certified Green Lab Program	A Certified Green Labs Program, to match and augment the Certified Green Office Program .	campus teams, green communities, labs, outreach, community engagement, incentives
DIA Green Team	This team is looking at options for improving sustainability practices within the Division of Intercollegiate Athletics (DIA) and opportunities to incorporate sustainability into major DIA events.	campus teams, green communities, community engagement, sports
Energy Liaisons	Departments and colleges across campus have designated energy liaisons to promote energy conservation practices.	campus teams, green communities, energy , behavior, awareness, education, management
Sustainable Electronics Campus Consortium	The Sustainable Electronics Initiative (SEI) and its host agency, the Illinois Sustainable Technology Center (ISTC), are coordinating meetings of individuals interested in fostering research, education, and policy related to sustainable electronics on the campus.	campus teams, green communities, energy, education, policy, support, management, collaboration

Table A6. (Continued). iCAP projects with the theme of Outreach

Contribute to a Regional Climate Action Plan	In coordination with the Chancellor’s Office work with representatives from Champaign, Urbana, Savoy, MTD, and the Regional Planning commission to evaluate the potential for a region-wide Climate Action Plan.	iCAP objectives, climate planning, regional scale
Mapping Sustainability	This project is meant to map the sustainability related programs, facilities and organizations in the Champaign-Urbana Area.	outreach, campus efforts, community, planning, education, awareness, information
Big Ten & Friends Sustainability	Since 2009, operational, administrative, and sustainability staff and faculty from the Big Ten and several additional schools have been meeting on a semi-annual basis to discuss environmental stewardship and sustainability issues.	regional network, regional universities, collaboration, planning
Champaign County Sustainability Network (CCNet)	Champaign County Sustainability Network (CCNet) is a volunteer-led organization that hosts open discussions in the community.	regional network, local, planning, community, collaboration, awareness, education
IGBA Transportation Technical Advisory Group	The Illinois Green Business Association (IGBA) is a 501(c)3 non-profit organization that assists businesses in reducing their ecological foot-print through green certification.	regional network, energy, transportation, green business, footprint reduction, standards, monitoring
Sustainability Practitioners at RPC	Champaign County Sustainability Practitioners is an informal intergovernmental committee that facilitates coordination of local sustainability initiatives that span political boundaries. iSEE meets regularly with CCSP to discuss mutual interests.	coordination, management, collaboration, planning, county level
Green My Crib	Green My Crib is a competition between sorority houses to see which chapter can make their house the most sustainable.	regional network, community development, environment, competition, energy saving, recycling, incentives
Illinois Green Office Challenge	The Illinois Green Office Challenge is an impact-driven program that encourages friendly competition among offices/office buildings to adopt sustainable practices.	regional network, community development, environment, competition, incentives, energy saving
Solar Urbana-Champaign	The University is helping to promote and encourage participation in the Solar Urbana-Champaign program: solar group buy in Champaign County.	regional network, community development, renewable energy, solar, outreach, collaboration, innovative

Table A6 (Continued). iCAP projects with the theme of Outreach

Urbana-Champaign Energy Star Challenge	The Urbana-Champaign Energy Star Challenge invites commercial building owners and managers to benchmark their energy use, then track and improve energy use throughout the year, all with US EPA’s free online tool, Energy Star Portfolio Manager.	regional network, community development, monitoring, energy saving, management, incentives, cost saving
Resilience Commitment Efforts	The Resilience Commitment is focused on climate adaptation and community capacity-building to deal with a changing climate and resulting extremes.	regulation, community, capacity building, adaptation, resilience, climate change, planning, evaluation
Campus Sustainability Week	This was created to raise awareness of the University’s sustainability projects, celebrate the successes of those projects, and motivate more progress on the sustainability front.	public events, outreach, community participation, awareness, motivation, education, event
Earth Week	Earth Week activities are coordinated by Students for Environmental Concerns (SECS) and co-sponsored by iSEE.	public events, outreach, community participation, awareness, education, community, event
iSEE Congress	Annual campus conference on a major sustainability grand world challenge.	public events, outreach, community participation, collaboration, dialogue
iCAP Working Group (iWG)	It is made up of representatives from major stakeholder groups across campus, and it has been tasked with a) reviewing Sustainability Working Advisory Team recommendations and transmitting them to the affected units or the Sustainability Council, as appropriate; and b) initiating a process for revising the iCAP.	Communications, institutions, leadership, evaluation, planning
Institute for Sustainability, Energy, and Environment (iSEE)	The institute will serve as a research and educational hub for environmental and sustainability initiatives for the entire campus community.	Communications, institutions, leadership, communication, outreach, education, awareness, research
Sustainability Council	The Sustainability Council was established in 2008 as part of our campus’ implementation of the American College and University President’s Climate Commitment, and was intended to help lead sustainability efforts on campus and provide strategic direction and oversight of the iCAP.	Communications, institutions, leadership, direction, oversight, planning, evaluation

Table A7. iCAP projects with the theme of Waste and Procurement

<u>Zero Waste</u>	Description	Keywords
RecycleMania	The University of Illinois at Urbana-Champaign is participating in RecycleMania in 2014 and 2015 with Game Day Events .	RecycleMania, education, competition, waste reduction, behavior
Skip the Bag Campaign	The Student Sustainability Committee funded an effort to decrease the use of single use plastic bags at the Illini Union Bookstore.	reduce use of plastic bags, behavior
Water Fountain Retrofit	Retrofit campus water fountains with water filling stations, in the form of glass filler attachments by which users can easily fill reusable water containers.	Water Fountain Retrofit, reduce bottle water, bottle recycling, reuse, behavior, facility
Establish a Net Zero Waste Plan and Policy	The mission of this study is to assist campus in achieving its waste management goals.	iCAP objective, net zero waste, policy, GHG emissions, planning, evaluation
Measure waste levels in dumpsters	This pilot program will install wireless sensors in the dumpsters for a certain area on campus. The depth of the trash in the dumpsters will be shared online with the F&S personnel, which will allow data analysis of waste generation sites for the first time on campus at the large scale level.	Waste measure, monitoring, wireless sensors, data analysis
Use Landfills with Methane-capture Technology	One of the 2015 iCAP objectives: Utilize landfills with methane capture.	GHG emission capture, landfill, iCAP objective, technology
Waste Stream Characterization Study Phase 1	The objective of the assessments is to characterize the waste generated from a Lab building, a classroom building and a housing building. The primary goal of the waste stream characterization study is to provide the Illinois campus with an accurate and precise baseline measurement of the solid waste generated at each facility type.	waste characterization assessment, measurement, monitoring, building level study, waste audit, zero waste, evaluation
Waste Stream Characterization Study Phase 2		waste characterization assessment, measurement, monitoring, building level study, waste audit, zero waste, evaluation

Table A7 (Continued). iCAP projects with the theme of Waste and Procurement

Increase Recycling Rates	There are many recycling opportunities in this community, so individuals can choose to responsibly handle their waste materials.	iCAP objective, recycling, waste reduction
Styrecycle: Expanded polystyrene (EPS) recycling program	The University of Illinois at Urbana-Champaign now recycles expanded polystyrene (EPS), more commonly known by its brand name Styrofoam.	waste recycling, waste reduction
Enviropures	EnviroPure is a food waste elimination system that is a self-contained unit that can be continually fed food waste and dispose the waste.	food waste reduction, facilities, technology
Food Donation	Prepared and unserved foods are donated to charity organizations	food waste reduction, behavior, regulation, community
Vermicompost	The aim of this project is to collect food waste from the university dining halls, decompose the food waste into organic fertilizer on the Student Farm in a self-contained vermicomposting unit, and uses the fertilizer to grow transplants for the Student Farm.	food waste treatment, vermicomposting, fertilizer
Illini Gadget Garage	NEED CORRECT STUFF HERE!!!!	collaborative repair, community, e-waste, waste reduction
Support the YMCA Dump and Run	As students move-out, hundreds of volunteers help collect the reusable materials for resale after summer break.	community organizing, reuse
Adopt Environmental Indicators to Guide Purchasing Standards	Use carbon and other environmental indicators for purchasing to avoid environmentally irresponsible products and corporations. These indicators should be incorporated into the campus sustainable purchasing policies.	indicators, planning, evaluation, policy
Full-Cost Accounting and Life-Cycle Analysis	Implement full-cost accounting and life-cycle analysis structures for major purchases and categories with a cost threshold to be determined	LCA, economics, evaluation, planning, policy
Sustainable Food Practices	Although increasing local food purchases were the primary food procurement initiative outlined in the Illinois Climate Action Plan (iCAP), there are several other sustainable aspects the University has tried to increase in their food purchases.	Sustainable Food Practices, responsible farming, local sourcing, footprint, technology, recycling
Food Purchases from Local Sources	By committing to exceed the state local food procurement standards and, therefore, making more than 30 percent of food purchases from local (within 100 miles) by 2015, the University will support local farmers as well as saving energy associated with food transport.	iCAP objective, local food, responsible purchasing, agriculture, local sourcing, agriculture, energy saving, transport reduction

Table A8. iCAP projects with the theme of Research

<u>Research</u>	Description	Keywords
<u>Inventory Sustainability Research</u>	This inventory revealed more than 120 faculty conducting research in the arena of sustainability. Eventually, this inventory will be posted online to enable both the public to identify experts and for faculty to locate partners on potential research projects.	inventory, faculty research, capacity development
<u>Illinois Center for Transportation (ICT) Sustainability Research Program with IDOT</u>	As part of a long-term commitment to sustainable practices, IDOT is partnering with the Illinois Center for Transportation (ICT) at the University of Illinois at Urbana-Champaign.	sustainability research, local collaborators, sponsors, transportation
<u>Center for Advanced Bioenergy Research (CABER)</u>	The Center for Advanced BioEnergy Research (CABER) works to provide a campus outreach, teaching and research on bioenergy systems, which are essentially renewable energy systems created from biological sources.	sustainability research, local collaborators, sponsors, renewable energy, bioenergy
<u>Center of Advanced Materials for the Purification of Water with Systems (WaterCAMPWS)</u>	The Center of Advanced Materials for the Purification of Water with Systems (WaterCAMPWS) is a center at the University focusing on the development of new materials and systems to purify water safely, economically, and sustainably for human use.	sustainability research, local collaborators, water supply, environment, materials, water purification
<u>Energy Biosciences Institute</u>	The goal of EBI is to research and develop a plan to create an economically and environmentally sustainable biofuels industry without negative impacts on food production.	sustainability research, local collaborators, sponsors, bioenergy, renewable energy
<u>Illinois Sustainable Technology Center (ISTC) research</u>	The Illinois Sustainable Technology Center (ISTC) mission is to be at the forefront of environmental and energy research and innovative technological advances that protect natural resources and reduce waste.	sustainability research, local collaborators, waste management, energy
<u>Institute for the Sustainability of Intensively Managed Landscapes (ISIML)</u>	ISIML is an institute at the University of Illinois that focuses on the interaction between water, carbon, and energy cycle dynamics to predict the impact factors in climate change of surrounding ecosystems.	sustainability research, local groups, Intensively Managed Landscapes

Appendix II: [Student Sustainability Committee \(SSC\) Projects](#)

The [Student Sustainability Committee \(SSC\)](#) is a student-led campus committee which is responsible for the distribution of two student fees: the Sustainable Campus Environment Fee and the Cleaner Energy Technologies Fee. SSC allocates more than \$1.1 million per year to fund projects that improve campus sustainability in areas ranging from renewable energy to energy conservation to waste reduction and beyond, specifically with a focus on direct student impact (iCAP, 2015). We reviewed all the funded projects by SSC (most of the SSC projects are already listed in the iCAP portal) from 2009-2010 to 2015-2016 in seven categories (Education, Energy, Food, Land, Transportation, Waste, and Water) and identified those with research or educational potential. In the following (Tables A10-A16) we provide a summary of the total grants awarded to projects each year and the amount of grants awarded to the projects with research or educational potential.

Table A10. Grants allocated to projects with research and educational potential (R and T): Education category

FY Accepted	Total (\$)	R and T Projects (\$)	Percentage
2009-2010	0	0	-
2010-2011	0	0	-
2011-2012	0	0	-
2012-2013	10,000	0	0.0
2013-2014	0	0	-
2014-2015	35,795	35,795	100.0
2015-2016	72,989	0	0.0

Table A11. Grants allocated to projects with research and educational potential (R and T): Energy category

FY Accepted	Total (\$)	R and T Projects (\$)	Percentage
2009-2010	0	0	-
2010-2011	156,750	0	0.0
2011-2012	271,200	0	0.0
2012-2013	635,501	0	0.0
2013-2014	861,968	0	0.0
2014-2015	764,633	8,570	1.1
2015-2016	169,557	62,325	36.8

Table A12. Grants allocated to projects with research and educational potential (R and T): Food category

FY Accepted	Total (\$)	R and T Projects (\$)	Percentage
2009-2010	25,000	0	0.0
2010-2011	55,000	0	0.0
2011-2012	40,000	0	0.0
2012-2013	302,550	125,050	41.3
2013-2014	387,000	0	0.0
2014-2015	51,530	0	0.0
2015-2016	279,593	254,648	91.1

Table A9. Grants allocated to projects with research and educational potential (R and T): Land category

FY Accepted	Total (\$)	R and T Projects (\$)	Percentage
2009-2010	10,000	0	0.0
2010-2011	0	0	-
2011-2012	0	0	-
2012-2013	192,582	68,416	35.5
2013-2014	83,628	79,620	95.2
2014-2015	20,000	20,000	100.0
2015-2016	54,925	54,925	100.0

Table A10. Grants allocated to projects with research and educational potential (R and T):

Transportation category

FY Accepted	Total (\$)	R and T Projects (\$)	Percentage
2009-2010	10,600	0	0.0
2010-2011	0	0	-
2011-2012	39,872	0	0.0
2012-2013	281,546	0	0.0
2013-2014	104,130	52,930	50.8
2014-2015	107,095	86,795	81.0
2015-2016	46,638	46,638	100.0

Table A11. Money allocated to projects with research and educational potential (R and T): Waste category

FY Accepted	Total (\$)	R and T Projects (\$)	Percentage
2009-2010	0	0	-
2010-2011	0	0	-
2011-2012	0	0	-
2012-2013	0	0	-
2013-2014	77,920	0	0.0
2014-2015	252,305	33,718	13.4
2015-2016	133,021	28,011	21.1

Table A12. Grants allocated to projects with research and educational potential (R and T): Water category

FY Accepted	Total (\$)	R and T Projects (\$)	Percentage
2009-2010	74,500	63,900	85.8
2010-2011	0	0	-
2011-2012	0	0	-
2012-2013	15,160	0	0.0
2013-2014	0	0	-
2014-2015	117,142	0	0.0
2015-2016	0	5,816	-

Appendix III: Introduction of some facilities/programs

1. Solar Decathlon

[Solar Decathlon](#) is a bi-annual international competition hosted by the Department of Energy and the U.S. Green Building Council (USGBC). Competitors design, build, and present a completely solar-powered house on the National Mall in Washington, D.C. The [Illinois Solar Decathlon](#) team seeks to lead innovation in design and technology to advance toward an environmentally sustainable future. SSC funded the project several times ([Link 1](#), [Link 2](#)). For more information, visit the [University of Illinois Solar Decathlon website](#). For our existing homes, we ensure their continual usage as a research and outreach platform as they provide significant potential for educational demonstration and future research.



Figure A1. 2007, 2009, 2011, and 2013 homes (source: <http://solardecathlon.illinois.edu/>)

2. [Solar Farm](#)

In November 2012, the University Of Illinois Board Of Trustees approved construction of a 20.8-acre solar farm on campus. Phoenix Solar South Farms LLC was hired by the University in 2015 to design, build, and operate the facility at the Windsor Road site. The Solar Farm will produce an estimated 7.86 million kilowatt-hours (kWh) annually or approximately 2% of the FY15 electrical demand for the Urbana campus making this site one of the largest university solar arrays in the country. The University signed a 10-year power purchase agreement with Phoenix Solar to purchase all electricity produced by the Solar Farm and deliver it directly to the campus grid. [Solar farm real-time data](#) is a potentially valuable source for research, particularly to develop short-term forecast the solar energy generation and to study the impacts of weather condition on solar power. For more information visit the F&S Solar Farm [website](#).



Figure A2. Aerial photo of the Solar Farm (Source: <http://www.fs.illinois.edu>)

3. [Illinois Biodiesel Initiative](#)

Biodiesel is a renewable, clean-burning diesel replacement that can be made from a diverse mix of feedstocks including recycled cooking oil, soybean oil, and animal fats. On campus, a registered student organization is dedicated to creating such fuel called [The Illinois Biodiesel Initiative](#) (IBI). Their primary mission is to produce biodiesel and soap from waste vegetable oil (WVO) collected from campus dining halls in an effort to reduce emissions and promote sustainability on campus. Agreements are already in place with Campus Fleet and Campus Dining for the sale of biodiesel and soap, respectively. In addition to the club, the team working on this project found that an education component would be very beneficial to spreading their overarching goals of sustainability across the campus. Because of that, they created a class that students from all disciplines can take and piloted it this semester. The objective of the class competent is to educate students on the project and hopefully increase student and campus involvement in sustainability. For more information, refer to the SSC entries for the IBI ([Link 1](#), [Link 2](#)) or the iSEE feature story ([Link 3](#)).



Figure A3. Oil containers from the dining hall, and the reactor that converts the waste into a final product of usable fuel. (source: <http://ssc.sustainability.illinois.edu/?p=1760>)

4. [Geothermal Test Well](#)

Geothermal heating is one option to reduce University of Illinois' existing reliance on coal-fired steam heating for many buildings, but there is a lack of information about the feasibility of

geothermal systems on campus. This project conducts a series of high-detail observations of the geothermal profile of campus and analyze the data. In particular, this project will collect data over an entire calendar year to identify impacts of seasonal heating and cooling on the subsurface. In addition to a high-resolution temperature profile with depth, we can analyze the drilling mobilization cost and the cost of construction per foot of depth of the installed vertical loop. The results of the study will help identify the costs and possible challenges associated with adding a significant amount of geothermal heating systems to campus. (for more details, see the [project blog](#) and the [SSC entry](#)).



Figure A4. Geothermal test well in Energy Farm

5. Woody Perennial Polyculture Research Site

The Woody Perennial Polyculture (WPP) Research Site at the University of Illinois is working to create a research farm in which the arrangement of plants is similar to that of the climate's natural

ecosystem, but uses plants that are more practical for human consumption (see [WWP entry](#) on the SSC website). This research site is the first attempt at a large-scale WPP system in a temperate environment. The main objective of this research is to show that the WPP system is a sustainable and economically advantageous alternative to the corn-soybean rotation that is commonly used on farms across the Midwest. Beyond the quantitative research garnered by the site, the WPP Research Site benefits the Illinois campus by:

- producing local foods to be utilized in the dining halls;
- restoring degraded land on UI property with sustainable agriculture processes;
- educating students and the greater Central Illinois community about sustainability issues; and
- reducing the carbon footprint of the campus by sequestering carbon in the trees and soil as well as reducing N₂O emission from fertilizer use.



Figure A5. WPP research site at the Illinois Energy Farm