

**Mansueto Institute  
for Urban Innovation**

**University  
of Chicago**

# **Environmental Frontiers: Campus**

**Training the Next Generation  
of Leaders in Sustainable  
Urban Development**

2020-2021  
**End of Year Report**

# Faculty Leads



**Elisabeth Moyer**  
Associate Professor of  
Geophysical Sciences



**Sabina Shaikh**  
Director of the Program on Global Environment  
and Senior Lecturer in Environmental and Urban  
Studies in the College

## Overview

Launched in the summer of 2020, EFCampus is a unique research and experiential learning program that brings together University of Chicago (UChicago) faculty, students, and staff to collaborate on innovative strategies to build a more sustainable future on campus and beyond. The program supports teams of undergraduate research assistants who are charged with analyzing campus data, operational systems, and community behaviors to identify actionable recommendations that advance the University's sustainability goals. All projects are aligned with the University's larger sustainability plan, and are closely mentored by University faculty and staff from Facilities Services. EFCampus allows students to contribute to campus sustainability enhancements while giving them the necessary analytical skills and hands-on experience to determine optimal interventions in a complex, multi-faceted setting. The outputs produced by the student teams provide UChicago staff with rigorous quantitative analyses and evidence that can help prioritize opportunities to better manage and conserve energy, water, and other natural resources around the University, and reduce pollution.

In its first year, EFCampus supported 11 undergraduate students working on three projects: laboratory energy analysis, LEED building benchmarking, and water conservation measures. Facilities Services staff identified these projects in consultation with faculty as areas where students could analyze campus utility data to suggest discrete interventions that could achieve savings. When conducting research, students work closely with faculty members and Facilities Services representatives. This provides them with an awareness of operational realities, in addition to the scholarly element of the program. EFCampus also identifies and supports a Graduate Student Project Lead to provide the undergraduate teams day-to-day guidance on their work; ensure they meet identified milestones; review work products for quality and completeness; and act as a liaison to faculty, staff, and community partners. The multiple scales of research management and mentorship provided by graduate students, staff, and faculty ensure both the richness of the undergraduate experience and the viability of implementing their findings. At the end of the 2020-2021 academic year, all projects had completed in-depth quantitative analyses and data visualizations of campus energy and water usage, and produced clearly laid out approaches for achieving conservation in campus labs and water-intensive areas. These findings are now being reviewed for implementation.

The following report outlines the research methods and results of EFCampus during the 2020-2021 academic year. There could not be a more critical time to teach students both the research and technical skills needed to create sustainable practices, organizations, and cities. EFCampus has taken significant strides in delivering an experiential learning model that gives students a scientific and practical understanding of sustainable development, while simultaneously building a coalition of campus stakeholders working together to achieve shared goals for our own ecosystem.

**“We all have the same goal here—students, faculty, Facilities Services and the Office of Sustainability: to make our space more environmentally sustainable and resilient, while being able to translate lessons learned in our backyard to challenges faced globally. This year our students conducted the research needed to identify the important actions we can take at UChicago—and beyond—that will lead us on a path toward sustainable urban development.”**

**- Sabina Shaikh, Faculty Lead, Director of Program on the Global Environment and Senior Lecturer, Environmental and Urban Studies**

# Program Goals

EFCampus is the campus-based component of the Environmental Frontiers Initiative, which creates student-faculty research and educational opportunities at the intersection of environmental sustainability and urbanization. Environmental Frontiers spans the physical sciences and social sciences, complementing existing and emerging course curriculum in Environmental and Urban Studies, Environmental Sciences, and other programs, and serving as a platform for the University of Chicago to advance sustainability through collaboration between faculty, students, and staff. Environmental Frontiers is a partnership between the Mansueto Institute for Urban Innovation, the Program on the Global Environment (PGE), the Center for Robust Decision-making on Climate and Energy Policy (RDCEP), and Facilities Services through the Office of Sustainability at the University of Chicago.



**“The results from this year’s research show what can be achieved when student passion is directed at concrete challenges faced by campus operations experts, and paired with quantitative scientific training. The students produced professional-quality work that can have an impact on campus practices. Their visualizations highlight our challenges—for example, University LEED-certified buildings do not outperform non-LEED certified buildings in terms of energy efficiency—and can help us going forward. The laboratory team prototyped a tool that we are continuing to refine and that will be a valuable asset to the university.”**

**Elisabeth Moyer**, Faculty Lead, Associate Professor, Department of Geophysical Sciences



**“EFCampus provided me with a great opportunity to make a tangible impact on UChicago’s campus sustainability. Receiving regular feedback and guidance from faculty, Facilities Services, and our graduate student mentor was unique and invaluable to our research and learning. It was amazing to work with engaged and inquisitive classmates from various disciplines—each brought different skills and talents to our projects. I’ve learned so much about the infrastructure supporting the research and educational mission of the University and am awed by the efforts required to keep the lights on, water running, and heat flowing into our buildings. I plan to continue researching sustainable building design, an interest that was formed during my EFCampus experience,”**

**Dinesh Das Gupta**, EFCampus Research Assistant

# 2020-2021 EFCampus Projects



# Labs Energy Analysis and User Engagement



## Student Research Assistants



**Shopnavo Biswas**  
'22 Mathematics and Economics



**Kimika Padilla**  
'20 Public Policy and Environmental & Urban Studies



**Eric Chen**  
'21 Biological Sciences



**Jasmina Scekcic**  
'22 Mathematics



**Ryan Cutter**  
'21 Environmental Science

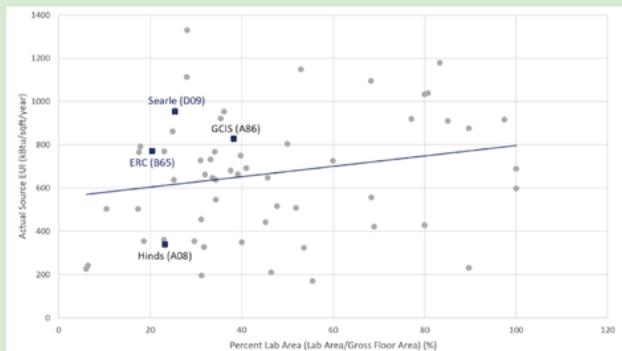
# Background

Though laboratories occupy only 10% of campus building area, they represent 38% of building energy usage. Six of the ten most energy intensive buildings on campus are labs. Because of their heating, cooling, and electricity demands, conducting a more granular analysis of the discrete drivers of energy use across labs was an ideal project for the EFCampus program. Students investigated ways to reduce energy consumption throughout labs on campus, in accordance with the University of Chicago's goals to reduce its greenhouse gas emissions by 50% by 2030.

# Process

The students began by benchmarking UChicago lab building energy use using the International Institute for Sustainable Laboratories Laboratory Benchmarking tool and creating a model for expected energy use based on lab type. Through this process, students were able to highlight three buildings on campus—Searle Chemistry Laboratory, Eckhardt Research Center (ERC), and Gordon Center for Integrative Science (GCIS)—that use energy at higher levels than average. This is driven by a combination of higher ventilation rates, increased fume hood use, settings on ultra-lower temperature (ULT) freezers, and 24/7 operations.

Searle, ERC, and GCIS are energy intensive, even compared to large buildings that are operated 24/7.



Searle (D09), ERC (B65), and GCIS (A86) are **more energy intensive** than the average large lab building (>80,000 sqft) with the same lab area and occupancy hours.<sup>1</sup>

1. Based on building data for 63 U.S. lab buildings with >80,000 sqft gross floor area and 24/7 occupancy hours, downloaded from the International Institute for Sustainable Laboratories' Laboratory Benchmarking Tool.

**Figure 1: Each dot in this graph represents one of 63 lab buildings in the United States with less than 80,000 square foot floor area and 24/7 occupancy. The line of best fit shows the average source energy use intensity (EUI) determined by the percentage of gross floor area taken up by labs. The four labeled dots represent Searle, ERC, GCIS, and Hinds Laboratories at the University of Chicago. The graph concludes that Searle, GCIS, and ERC have a higher-than-average Source EUI compared to their percentage of lab area.**

***Credit: this figure created by Shopnavo Biswas, Eric Chen, and Kimika Padilla.***

Based on the benchmarking done with peer institutions, the students were able to identify opportunities to adjust ventilation rates, fume hood usage, and ULT freezers while still meeting the research needs and safety standards of lab users. The Summer 2020 analysis concluded with the following recommended interventions to decrease excess energy consumption:

## Recommendations

- A** Conduct lab ventilation risk assessments in GCIS (A86), ERC (B65), Searle (D09), and Hinds (A08) to determine if it is safe to reduce minimum ventilation rates to 6 air changes per hour (ACH) occupied, and 4 ACH unoccupied.
- B** Convert fume hoods in Kent (B18) from constant air volume to variable air volume, and expand the “Shut the Sash” program to GCIS (A86).
- C** Provide researchers with additional resources to help them learn about best practices for equipment plug loads, and make informed decisions that save electricity and reduce costs in the lab.
- D** Raise ultra low temperature freezer set points from -80 °C to -70 °C in lab buildings such as GCIS (A86) and Zoology (D05) when possible.

## Results

Building on the analysis from the summer, in the academic year RAs focused on two pathways to specifically target these improvement opportunities: an Excel-based laboratory design decision-making tool to explore the energy implications of lab equipment purchasing decisions, and an action plan detailing a behavioral change campaign around fume hood usage.

# 1. Laboratory Design Decision Making Tool

One path to reducing energy consumption is to intervene during the design phase of new laboratories, helping researchers focus on opportunities to achieve energy efficiency. To help with this, the RAs developed five principles for designing an energy-efficient laboratory space:

- 1. Optimization of Fume Hoods**
- 2. Dividing Lab Area to Reduce Unnecessary Ventilation**
- 3. Raising ULT Freezer Setpoints**
- 4. Mindful Equipment Purchasing**
- 5. Lighting Choices**

The decision-making tool creates a convenient way to incorporate energy efficiency into lab design or equipment purchasing. With inputs about fume hoods, lighting, and cold storage, the tool produces equipment-specific outputs and creates a final summary comparing the lab's selections to an energy-efficient example. This tool combines the evidence-based recommendations the RAs created with ease of use for new laboratory PIs and Facilities Services. Together, it creates an easy way for the University to increase its sustainability. Additionally, discussions with the Department of Energy's Smart Labs program indicate once this tool is fully developed, it could be valuable to laboratories outside UChicago.



## 2. Behavioral Changes

For this campaign, the RAs also developed four principles for best practices for behavioral change:

1. **Providing Tailored and Specific Feedback**
2. **Implementing a Phased Approach**
3. **Developing Behavioral Norms**
4. **Utilizing Peer Education**

From these principles, and building upon past research supported by Office of Sustainability interns, they recommended a two-part campaign to target high-impact areas.

### Phase 1: “Shut the Sash”

- Focuses on shutting the fume hood sash to reduce energy consumption
- Target GCIS and ERC laboratories
- Reduced estimated energy consumption by 5% for each laboratory building

### Phase 2: “Freezer Challenge”

- Focuses on freezer consolidation and temperature adjustments
- Attempts to reduce cold storage electricity through behavioral changes
- Reduced estimated cold storage electricity use by up to 30%

Based on the Summer benchmarking, the students had determined that encouraging lab users to shut the sash and reduce freezer temperatures would yield the greatest energy savings.

### Future Phase 3: “Lighting Competition”

- Emphasize the role of lighting in excess energy consumption
- Implementing lighting behavioral change would reduce emissions, advancing to the University’s 2030 emissions goal



**We are excited that the results from this collaborative research can be used to advance sustainability at the University. For example, the preliminary calculation tools that were built by the students are being expanded this coming year, and we hope to utilize them in our lab energy efficiency initiatives as part of this new effort.”**

**Alicia Berg**

Assistant Vice President of Campus Planning + Sustainability at the University of Chicago



# Water Reduction Planning



## Student Research Assistants



**Anika Bhat**  
'23 Economics



**Ruby Rorty**  
'22 Economics and  
Environmental & Urban Studies



**Gillian Gagnard**  
'21 Business Economics



**Mark Siedentopf**  
'23 Public Policy and  
Environmental & Urban Studies

# Background

This project aligned with UChicago's goal to reduce water consumption by 15% by 2025. Compared to other peer institutions, UChicago's water consumption falls in the middle overall. Students were tasked with evaluating water conservation efforts that may have worked at other universities and consider how UChicago could implement similar measures.

# Process

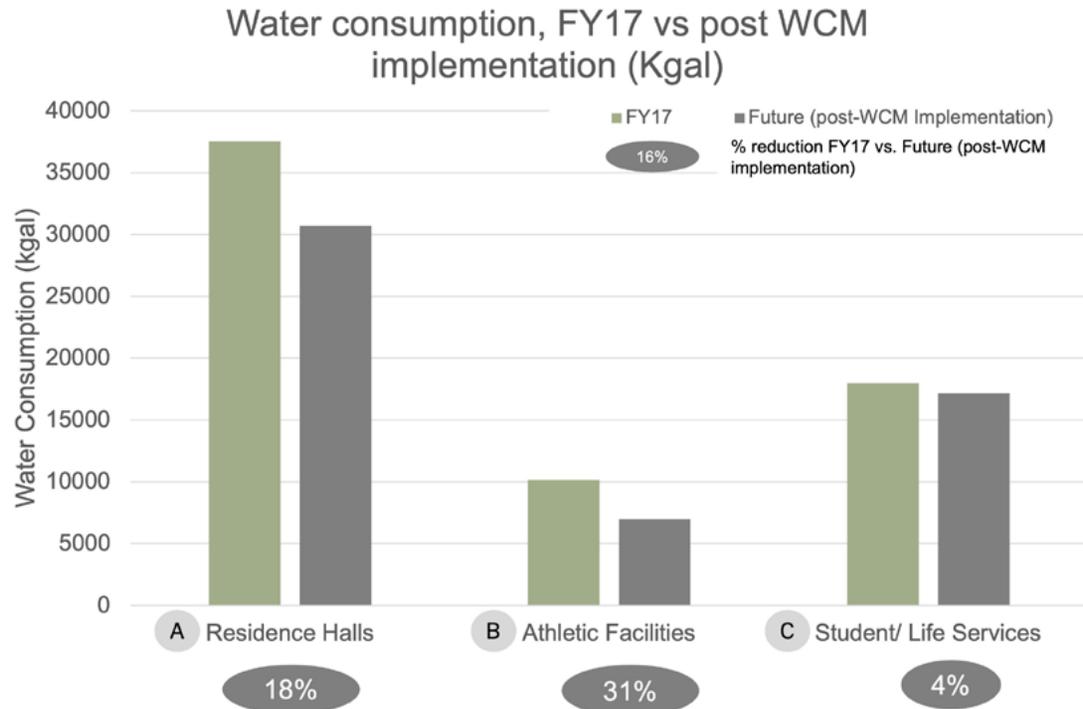
To further explore UChicago's water consumption, the students took a deep dive into three building types: residence halls, athletic facilities, and student/life services. Students found that the order of facilities by total water consumption, using data from FY17, was:

- 1. Residence Halls - 37,500 kgal**
- 2. Student/Life Services - 17,500 kgal**
- 3. Athletic Facilities - 10,000 kgal**

The students predicted that the implementation of their recommended Water Conservation Methods (WCM) would result in a 31% reduction in water consumption for Athletic Facilities, an 18% reduction in Residence Halls, and a 4% reduction in Student/Life Services.



## Water use following water conservation measure implementation



4

Figure 2: This graph compares total water consumption (kgal) for fiscal year 2017 and a future time, post-implementation of the new Water Conservation Methods across three different facility types. The Residence Halls category consists of 7 buildings: Campus North, Max Palevsky, Woodlawn, Renee Granville-Grossman, Burton Judson Courts, International House, and Snell-Hitchcock. The Athletic Facilities category consists of 2 facilities: Ratner Athletic Center and Henry Crown Fieldhouse. The Student/ Life Services category consists of 3 dining hall facilities: Campus North Dining Hall (C26), Campus South Dining Hall (H10), and Bartlett Dining Hall (C04).

*Credit: this figure created by Anika Bhat and Mark Siedentopf.*

## Results

With this evidence, the students created two products to support UChicago's water reduction goals: a financial model and a water reduction plan.



# 1. Financial Model

The financial model assesses important financial indicators of water conservation measures, including:

- water cost avoidance,
- project cost,
- simple payback,
- net present value, and
- internal rate of return.

This tool would aid Facilities Services in pinpointing specific areas to reduce water consumption and the financial impact of those decisions.



## 2. Water Reduction Methods

The comprehensive Water Reduction Methods plan is designed to explore the details of campus water consumption and areas of improvement. It is composed of three tenets corresponding to the three biggest campus facilities with improvement potential:

- Residence Halls
  - Annual Behavioral Change Competition
    - Motivating students to adopt more water-efficient behaviors, such as shorter shower and sink durations
    - Savings: 739 gal/year
  - Replacing Fixtures
    - Most significant method of reducing water consumption
    - Savings: 6,000 gal/year
- Athletic Facilities
  - Replacing Fixtures in Ratner Athletic Center and Henry Crown Fieldhouse
    - Most significant method of reducing water consumption
    - Savings: 2,500 gal/year
  - Installing Shower Times in Ratner
    - Attempting to promote behavioral changes and shorter showers
    - Savings: 300 gal/year
  - Installing New Equipment Systems for Washers in Ratner and Crown
    - Upgrading laundry equipment for increased water conservation
    - Savings: 400 gal/year
- Student Life and Services
  - Replacing Fixtures in Student Bathrooms for Three Dining Halls: Bartlett, Campus North, and Campus South
    - Savings: 800 gal/year

The student research team predicted that the Water Reduction Plan would help the University meet water reduction goals, improve their social impact, and increase student engagement and pro-environmental behavior. The plan would also save the University approximately 11,000 gallons of water a year in direct water cost savings. This water reduction plan will be used by Facilities Services staff to create a comprehensive campus water conservation plan to be implemented over the next three to five years.



# LEED Building Models



## Student Research Assistants



**Dinesh DasGupta**  
'21 Public Policy



**Jasmina Scekic**  
'22 Mathematics



**Lily Mansfield**  
'21 Physics and Statistics



**Mark Siedentopf**  
'23 Public Policy and  
Environmental & Urban Studies

# Background

LEED, or Leadership in Energy and Design, is a widely-used building certification system aimed at identifying buildings with high sustainability. However, in data from the University of Chicago and the City of Chicago at large, LEED buildings have shown no considerable difference from non-LEED buildings. With this benchmark, the RAs wanted to further explore the areas of improvement for LEED buildings, including their “Operations + Management” certification system.

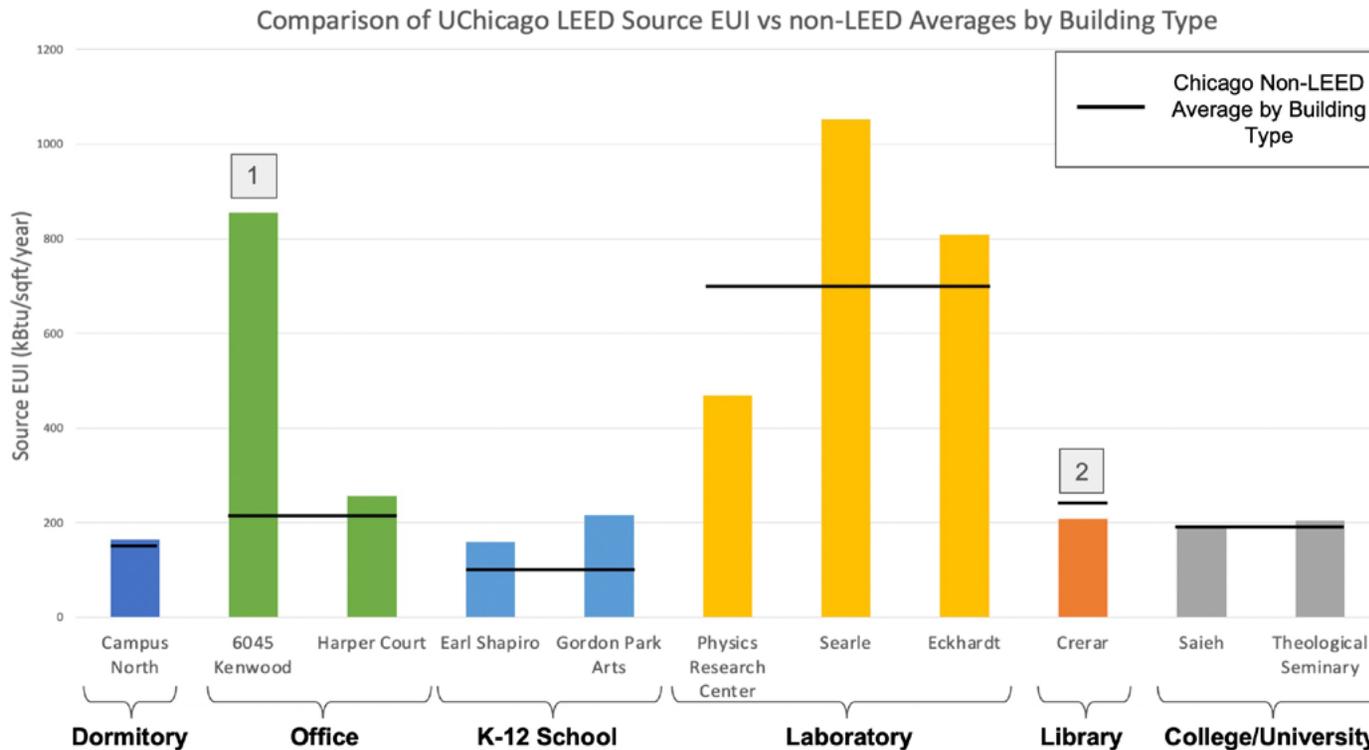
# Process

To study performance, the LEED team analyzed building energy performance across several types of buildings, including:

- Campus North residence halls
- Logan and Gordon Parks art centers
- Michelson, Searle, and Eckhart labs
- Saieh Hall, the Theological Seminary, and Facilities Services buildings

This data showed that UChicago LEED buildings use more energy than the Chicago non-LEED average.

- On average, UChicago LEED buildings used 39% more energy than their hypothetical non-LEED equivalent and 70% more than their LEED proposed energy usage.
- Excluding Logan Arts Center and Michelson Laboratory as outliers, the RAs observed that UChicago LEED buildings use 14% more energy than their hypothetical non-LEED equivalent and 42% more energy than their LEED proposed energy usage.
- One of the LEED certification systems, Operations + Management specifically, did not lead to significant energy reductions compared to the non-LEED average.



**Figure 3:** This graph compares the Source EUI, or the energy use intensity, across UChicago LEED-Certified buildings and non-LEED building averages in City of Chicago buildings (designated by the black horizontal line). Two points in the graph have been identified: Point 1 identifies the office building 6045 Kenwood, which has a higher-than-average Source EUI due to its data center, rare for office buildings. Point 2 identifies Crerar Library and points out its good performance, given its energy-intensive computer equipment. In general, UChicago LEED-Certified buildings underperform due to three reasons: the comparison of unique, mixed-use university buildings to buildings with few uses may be misleading; issues with construction, operation, and/or occupant behavior lead to worse performance than intended; the type of LEED certification pursued by the University is ineffective.

*Credit: this figure created by Dinesh DasGupta, Lily Mansfield, Jasmina Scekcic, and Mark Siedentopf.*

**Call Out: What is Source EUI?**

*Energy use intensity (EUI) is a common metric for comparing energy performance. EUI is calculated by dividing total energy use by square footage. Site energy is the amount of energy used onsite by a building. Source energy includes generation and transportation energy from production to final use. The LEED team used EnergyStar national conversion factors to convert site energy use to source energy use.*

# Results

With this knowledge, the RAs created a comprehensive Sustainability Checklist for new buildings that combines the best aspects of several certification systems, including a Passive House Recommendation. In addition, researchers created several other recommendations for actions to increase LEED efficiency.

## 1. Passive House Recommendation

A passive house is a building designed to maintain indoor thermal comfort using mostly “passive” means to heat and cool air. Their design and construction can apply not just to single-family homes, but also to residence halls, office buildings, schools, and more, and are certified by the Passive House Institute (PHI), which models energy performance based on every square inch of a particular building. Passive house-designed buildings can use 60%-80% less source energy and approximately 90% less heating and cooling energy, compared to standard buildings<sup>1</sup>. The Passive House certification is attractive in part due to less operations and maintenance upkeep compared to LEED certification, and the LEED team suggests that all new projects explore constructing to Passive House standards as guiding principles with architects and building engineers during the design phase.

## 2. Other Recommendations

In addition to Passive House certification, RAs also created three specific recommendations to address sustainability concerns:

1. More focus on other areas of sustainability, including:
  - Renewable Energy
  - Changing Materials and Resources To More Sustainable Options
  - Pursuing non-LEED Building Constructions and Certification Systems
2. Increasing University engagement through more data access and opportunities for student involvement with sustainability.
3. Further investigations of other peer institutions' sustainability; specifically, their sustainability initiatives and programs; in the hopes of developing partnerships.



**“ I appreciate the opportunity to have a learning experience on campus that wasn’t just in the classroom. I hope this same opportunity continues to be provided for more students because it really is so great.”**

**Mark Siedentopf**, EFCampus Research Assistant

## Conclusion

Combining hands-on research, experiential learning, and an extensive mentorship network, the EFCampus program creates a rich opportunity for students to enhance their academic and professional capabilities, all while providing Facilities Services and the University with practical and targeted recommendations for how to improve campus sustainability. Together, students, faculty, and Facilities Services staff are working to help achieve the University’s sustainability goals.

The EFCampus program has an exciting future ahead. During Summer 2021, research assistants will continue to work on Laboratory Energy analysis to develop further recommendations for the university to meet its GHG emissions reduction goals. In addition, a new project has been launched to explore Campus Tree ecosystems services, where researchers will explore the many benefits from different tree species in urban forests, with the ultimate goal of optimizing ecosystem services to advance the University’s sustainability goals.



# Special Thanks

The EFCampus program would not be possible without the support, enthusiasm, and efforts of many partners. We are grateful to all those who have dedicated their time and thinking to make this program a success.

## Program Sponsors:

- **Melina Hale**, Vice Provost and William Rainey Harper Professor in Organismal Biology and Anatomy and the College
- **Luis Bettencourt**, Inaugural Director of the Mansueto Institute for Urban Innovation
- **Alicia Berg**, Assistant Vice President for Campus Planning + Sustainability

## Project Mentors:

### LEED and Labs

- **Elisabeth Moyer**, Associate Professor of Geophysical Sciences
- **Adam D'Ambrosio**, Senior Director, Energy Services and Sustainability, Facilities Services
- **Sara Popenhagen**, Sustainability Manager, Facilities Services
- **Ryan Hoff**, Campus Energy Manager, Facilities Services

### Water Conservation

- **Sabina Shaikh**, Director of the Program on Global Environment and Senior Lecturer in Environmental and Urban Studies in the College
- **Sara Popenhagen**, Sustainability Manager, Facilities Services
- **Alfredo Izguerra**, Energy Engineer, Facilities Services

## Strategic Advisors:

- **Brian Bozell**, Energy & Utilities Manager, Facilities Services
- **Anne Dodge**, Executive Director, Mansueto Institute for Urban Innovation
- **Joseph Kanabrocki**, Associate Vice President for Research Safety, Office of Research Safety
- **James Novack**, Data Analyst, Facilities Services
- **Emily Padston**, Executive Director, Center for Robust Decision-making on Climate and Energy Policy (RDCEP)
- **James Passalano**, Director of Design and Construction, Department of Physical Sciences
- **Diana Petty**, Associate Director, Mansueto Institute for Urban Innovation
- **David Tooley**, Facility Engineer, UChicago Medicine

## Graduate Student Project Leads

- **Kriti Bhardwaj**, '20 Master's of Public Policy, Harris School
- **Annalise McGrail**, '21 Master's of Business Administration, Booth School

# Financial Report

EFCampus is financially supported by a coalition of campus partners: the Program on the Global Environment (PGE), the Center for Robust Decision-making on Climate and Energy Policy (RDCEP), the Crown Family through a gift to the Office of Sustainability, the Mansueto Institute for Urban Innovation, and the College. All funds go to compensating undergraduate and graduate Research Assistants under the program. We are grateful for the generosity of all supporters in making this collaboration possible.

<b>Funding Source</b>	<b>Allocation</b>	<b>Summer 2020</b>	<b>Academic Year 2020-21</b>	<b>Total</b>
<b>Moyer Research Funds (RDCEP)</b>	1.5 undergrad RAs	\$7,875		<b>\$7,875</b>
<b>Facilities Services Office of Sustainability</b>	1.5 undergrad RAs + .5 graduate RA 20-21	\$7,875	\$2,000	<b>\$9,875</b>
<b>Shaikh Research Funds (PGE)</b>	.5 of summer graduate RA	\$4,600		<b>\$4,600</b>
<b>Mansueto Institute</b>	3 summer undergrad RAs + .5 summer graduate RA + .5 graduate RA 20-21	\$20,350	\$2,000	<b>\$22,350</b>
<b>College Curricular Innovation Funds 2020-2021</b>	Academic year undergraduate RAs		\$27,000	<b>\$27,000</b>
<b>Total Income</b>				<b>\$71,700</b>

