*Please submit this completed application, the supplemental budget spreadsheet, and any relevant supporting documentation by the deadline indicated in your Step 1 notification letter to* *Sustainability-Committee@Illinois.edu**.The Working Group Chairs will be in contact with you regarding any questions about the application. If you have any questions about the application process, please contact the SSC at* *Sustainability-Committee@Illinois.edu**.*

# General Information

**Project Name:** Geothermal exchange for greenhouses at UIUC Woody Perennial Polyculture Research Site

**Total Amount Requested from SSC:** $132,550.00

**Project Topic Area(s):** [x] Energy [x] Education [x] Food & Waste

 [x] Land [ ] Water [ ] Transportation

# Contact Information

### Project Lead

Applicant Name: Andrew Stumpf

Unit/Department: Illinois State Geological Survey (ISGS)/Prairie Research Institute (PRI)

Email Address: astumpf@illinois.edu

Phone Number: 217-244-6462

### Financial Contact *(Must be Full-time University of Illinois Staff Member)*

Contact Name: Andrew Stumpf

Unit/Department: Illinois State Geological Survey (ISGS)/Prairie Research Institute (PRI)

Email Address: astumpf@illinois.edu

Phone Number: 217-244-6462

Organization Code: 540075

### Facilities Management Contact *(If Applicable)*

Contact Name: Bruce Branham

Email Address: bbranham@illinois.edu

**Primary Project Team**

|  |  |  |
| --- | --- | --- |
| **Name** | **Department** | **Email** |
| Timothy Stark | Civil & Environmental Engineering | tstark@illinois.edu |
| DoKyoung Lee | Crop Sciences/ACES | leedk@illinois.edu |
| Yu-Feng Lin | ISGS/PRI | yflin@illinois.edu |
| Frank Holcomb (student) | Civil & Environmental Engineering | fholcom2@illinois.edu |

# Project Description

**Please provide a brief background of the project, the goals, and the desired outcomes:**

The proposed project will involve the design, construction, and installation of a geothermal system to heat one greenhouse at the UIUC Woody Perennial Polyculture (WPP) Research Site, located near the southwest corner of Race Street and Windsor Avenue). Water circulated through geothermal piping installed in a series of 150 feet (45 m) deep boreholes will capture the earth's heat (~55°F) and be transported to the surface for heating of the greenhouse. The addition heat directly to the plants through the soil or air heating system will lower propane usage (fossil fuels) and reduce the greenhouse gas emissions; goals outlined in the llinois Climate Action Plan (iCAP). The outcomes and lessons learned from this project will be available for future development of geothermal exchange systems on UIUC campus.

**How will the project improve the sustainability of the Illinois campus and how will the project go above and beyond campus standards?**

The project will help lower overeall propane usage, the primary energy source of greenhouses at WWP. Based on preliminary calculations using UIUC campus energy rates, a ~20% reduction in CO2 emissions is expected.

By fully instrumenting the geothermal system with fiber-optic cables to connect with a distributed temperature sensing system (DTS), conducting a thermogeology characterization in the pilot borehole, and model heat flow in the ground we will obtain a very accurate estimate of heat conduction and losses throughout the geothermal system. This information will be very important in determining the overall efficiency, information that can be used in designing future geothermal exchange systemson UIUC campus. This project advances the work done by Dr. Lin at the UIUC Energy Farm in 2016-2017, by analyzing a working system that has varying seasonal heat loads. Typically, geothermal systems installed in the central US are designed either using, 1) data collected below the ground over just a few days (i.e., industry standard thermal response test [TRT]) or 2) average data from the region. Often, the systems are overdesigned for the energy load required (Rajecki, 2017) and do not take into account the heterogeneity in geology that can significantly impact heat conduction and transport (McDaniel et al., in review).

**Where will the project be located? Will special permissions be required to enact the project on this site? If so, please explain and submit any relevant letters of support with the application.**

The project will be undertaken at the UIUC Woody Perennial Polyculture Research Site, 2711 S Race Street, Urbana, IL 61802 (N40.082288°, W88.212029°; see map). A new high tunnel greenhouse is being built at the site for a biofuel feedstocks–climate change study led by Dr. Lee. The research station is managed by the Department of Crop Sciences, and the site is overseen by Drs. Branham and Lee. No additional permission is necessary because of the involvement of the ACES faculty. The borefield site and trenches for the piping will need to be flagged and nearby utilities located by JULIE and Facilities and Services.

**Other than the project team, who will have a stake in the project? Please list other individuals, groups, or departments affiliated directly or indirectly by the project. This includes any entity providing funding (immediate, future, ongoing, matching, in-kind, etc.) and any entities that will be benefitting from this project. Please attach letters of commitment or support at the end of the application.**

The results of this project could benefit any units on the UIUC campus that are interested in installing geothermal exchange systems. The local community will also benefit as this project expands the usage of this green energy technology. We also anticipate interest from the agricultural sector in Illinois and the Midwest US that may want to use geothermal exchange systems to heat and cool greenhouses. The project also address several obectives of USDA's "High Tunnel System Initiative" <https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/?cid=stelprdb1046250>.

**Please indicate how this project will involve or impact students. What role will students play in the project?**

Undergraduate students will be involved in the design and installation of the geothermal exchange system. The students will work with scientists and engineers from the ISGS and the Civil and Environment Department to characterize the thermogeology, install the fiber-optic cable system and monitor thermal profile, and model heat transport in the pilot borehole.

We plan to include this site in a "Living Laboratory" that will be proposed to iSEE. The laboratory will be allow students and their professors/instructors to use the sites and data for coursework, independent studies, and innovative experiments.

# Financial Information

*In addition to the below questions, please submit the supplemental budget spreadsheet available on the Student Sustainability Committee website. Submission of both documents by the submission deadline is required for consideration of your project.*

**Have you applied for funding from SSC before? If so, for what project?**

No

**If this project is implemented, will there be any ongoing funding required? What is the strategy for supporting the project in order to cover replacement, operation, or renewal costs?

Please note that SSC provides funding on a case by case basis annually and should not be considered as an ongoing source of funding.**

No ongoing funding required. The ISGS and WPP will maintain the station after SSC funding cycle.

**Please include any other sources of funding that have been obtained or applied for. Please attach any relevant letters of support as needed in a separate document.**

None

# Environmental, Economic, and Awareness Impacts

*In addition to the below questions, please indicate specific measurable impacts as applicable on the supplemental budget spreadsheet.*

**Which aspects of sustainability does your project address, and how? Does the project fit within any of the iCAP goals? If so, how does the project go beyond the university status quo standards and policies.**

The proposed project will provide important information about the thermal geology and heat transport in the subsurface that is critical for desiging efficient geothermal exchange systems. This project extends these systems into the agricultural sector, specifically biofuel feedstock production.

The project will contribute significantly on reaching the following iCAP goals:

\* Energy Utilization: 30% improvement from FY08 baseline

\* Energy Emissions: 30% reduction from FY08 baseline

\* Agriculture Emissions: 30% reduction from FY08 baseline

\* Education & Outreach: provide immersive sustainability learning opportunities

\* Build connections by bringing together scholars from across campus to encourage collaboration and to enhance research endeavors.

**How will the environmental impacts of your project be measured in the near and long term? What specific monitoring and evaluation processes will you be using to track outcomes and progress?**

The propane usage for high tunnel greenhouses can be compared with the consumption at the WPP. The reduction in fuel usage can be converted to determine the reduction in CO2 emissions. Any campus unit can use this information to calculate the energy saving rate from one or more potential ground source heat pumps. The initiation, progress of utilizing geothermal energy will be the long-term impact from the project.

**What is the plan for publicizing the project on campus? In addition to SSC, where will information about this project be reported?**

We will disseminate, widely, news about this application of a geothermal technology. We expect interest from researchers at UIUC and other universities, agricultural groups and stakeholders (e.g., UIUC Extension and Farm Bureau), and private companies. We plan to write articles in scientific and trade journals, newspapers, and brochures, report project progress and energy efficiency results on PRI and iSEE websites, and present information about the project at conferences, workshops, and public lectures.

**What are your specific, measurable outreach goals? How will these be measured?**

The introduction and analysis of geothermal energy for greenhouse heating will have interest from a broad spectrum of the sustainability community. We will work with the Geothermal Assocation of Illinois and the national Geothermal Exchange Organization to track new installations of geothermal systems for greenhouses. We will track user views/citations of our websites and publications through online tracking systems. We will document on PRI/iSEE websites requests from UI campus and the community about our project.

**Do you have any additional comments or relevant information to aid in evaluation of this application?**

References:

McDaniel, A., J. Tinjum, D. Hart, Y-F. Lin, A. Stumpf, L. Thomas in review. Distributed thermal response test to analyze thermal properties in heterogeneous lithology. Geothermics.

Ralecki, R. 2017. Geothermal service is simple and straightforward. The News, October 9. <https://www.achrnews.com/articles/135799-geothermal-service-is-simple-and-straightforward>

Attached documents:

- Site map of WPP and location of greenhouse

- Email from UIUC Facilities & Services support of this project

Additional Information:

During our project development we learned more about the existing geothermal system at the WPP. It is a horizontal geothermal loop installed in the long, west to east ditch located just south of the office building (see map). The geothermal system is currently being used to heat and cool the office building and cold storage room. Although running fine, Facilities & Services staff have determined it is leaking fluid, which requires them to refill the loop annually. Because of the uncertainity in lifespan of the system, we decided to forego connecting the greenhouse to it.