Stanford University
Department of Civil & Environmental Engineering
2021 Summer Undergraduate Research Program

The Department of Civil & Environmental Engineering is pleased to invite applications for its 2021 undergraduate research program, through funding provided by Stanford's Vice Provost for Undergraduate Education and the School of Engineering. The program supports full-time research appointments over the 2019 summer session. The research awards will be based on a competitive application process. ***Interested students should submit their application and statement of interest, following the guidelines given below, before Feb 28, 2021 at 5:00 pm.*** Decisions regarding awards will be announced by March 15, 2021 via e-mail.

Research Theme: The theme of the undergraduate research program is "Engineering for Sustainability", which can be broadly interpreted within all program areas of civil & environmental engineering and related fields (e.g., architecture, earth sciences, etc.).

Support: The 2021 summer program provides a stipend for the 10 week summer session. The amount of the stipend will be determined by the School of Engineering and the University and will depend, in part, on the anticipated cost of living for the student during the summer period.

Requirements and Restrictions:

- Eligibility is limited to Stanford undergraduates who are working under the supervision of an academic council faculty member in the Department of Civil & Environmental Engineering. Co-terminal master's degree students are eligible only if the bachelor's degree will not be conferred before the end of the research appointment.
- This program is specifically for projects that are conducted under close supervision and collaboration with a member of Stanford's academic council (tenure line faculty). Student-designed projects are funded by the VPUE via a different funding mechanism.
- Students receiving full summer stipends may not register for more than 5 credits of coursework, nor may they work for more than 10 hours per week in addition to their research appointment.
- Students are prohibited from receiving both credit and stipend for any single research activity. This does not, however, preclude students from working on a research project during the summer and then expanding it into a senior thesis during the following academic year.
- The program goals include connecting participants with each other through organized activities in the summer. Therefore, students must participate in organized program activities throughout the summer (provided research is on campus).
- Students must provide final summary reports on their project, complete an on-line evaluation and present the results of their research in early fall quarter at a CEE VPUE conference. Further details on these requirements are provided upon request or at the time a student is accepted to the program.

Application: Prior to submitting an application, students should identify and contact a CEE faculty member who is agreeable to supervise and collaborate a summer research project. Students are encouraged to reference the CEE faculty web pages to learn more about the specific research interests and opportunities of the faculty. *Faculty who have indicated an interest in advising summer*

projects are listed below. ***You may also apply for projects with faculty that are not listed here.*** You may apply to work on more than one project, but please indicate your preference if you do so (i.e., provide your first and second choice, etc).

Applications should include the following in a single PDF document named YOURLASTNAME_VPUE_CEE2021.PDF:
[1] student applicant information (name, pronoun preference, ethnicity / race (not required), major, current year at Stanford (freshman, sophomore, etc.), expected graduation date, current address where you live, e-mail address, student ID number), and confirmation that you will NOT have received your BS or BA before or during summer 2021,
[2] faculty research supervisor name and e-mail address,
[3] brief (500 word max.) statement of your research topic and plans,
[4] copy of your transcript (an unofficial transcript is fine), and
[5] resume or summary of relevant experience.

Applications should be submitted via email submitted to **VPUE_20.kjl9pgtv0b683iwf@u.box.com** before **5 PM on Feb 28, 2021.** Applications received after this date may still be considered, pending availability of funding. **In addition, students must also submit items [1] and [2] through the google form here: https://forms.gle/rZoxwnxrhVxDEoYA8**

Questions about the program should be directed to Professor Alexandria Boehm <aboehm@stanford.edu>.

CEE Summer Undergraduate Research Projects: Students are encouraged to reference the CEE faculty web pages to learn more about the specific research interests and opportunities of the faculty. The following are some examples of faculty who have indicated project topics that they may have available this summer:

Sustainable Natural Environment - Environmental and Water Studies:

Faculty: Alexandria Boehm
Email: aboehm@stanford.edu

Quantification of SARS-CoV-2 RNA in wastewater
We are looking for an undergraduate student to help us with many aspects of this project including data collation, data analysis, GIS, coordinating with stakeholders, and possibly laboratory research.

Faculty: Jenna Davis
Email: jennadavis@stanford.edu

EPIC Initiative (Extreme Poverty, Infrastructure, and Climate)
Sub-Saharan Africa (SSA) is the only world region in which the number of people living in extreme poverty has increased since 1990. SSA is home to 16% of global population, yet more than half of those in extreme poverty live in the region. Lack of access to engineered infrastructure such as roads, water supply and electricity is consistently associated with poverty; however, the causal pathways

that link them are often implied rather than interrogated. The EPIC (Extreme Poverty, Infrastructure, and Climate) initiative is testing hypotheses about the ways in which engineered infrastructure affects poverty dynamics in SSA, with the goal of amplifying poverty alleviation impacts of infrastructure investments. EPIC aims to elaborate the extent to which, the conditions under which, and the pathways by which road and water infrastructure investments affect the well-being of households living in extreme poverty in Uganda. The initiative will also incorporate the effects that a changing climate is likely to have on the links between infrastructure and poverty alleviation. Research assistants will work with secondary household panel and geospatial datasets, assisting with data compilation, manipulation, and analysis. Applicants should have strong GIS and R skills; previous training in inferential and/or spatial statistics is a plus.

Faculty: Mark Z. Jacobson
Email: jacobson@stanford.edu

Transitioning cities, states, and countries to 100% clean, renewable energy
This project involves the gathering and analysis of data used in roadmaps to transition all energy (electricity, transport, buildings, industry) in cities, states, and countries to 100% clean, renewable energy. Most work involves spreadsheet analysis and graphics development. The plans will be an extension of those developed here https://web.stanford.edu/group/efmh/jacobson/Articles/I/WWS-50-USState-plans.html . The roadmaps will serve as a benefit to policymakers, experts, and the general public.

Faculty: Richard Luthy
Email: luthy@stanford.edu

Non-potable water reuse for irrigation on the Stanford Campus This work would assist with pilot testing of a water reuse system and measurement of water quality through various steps. The work would take place at the Codiga Resource Recovery Center and Y2E2. The work is appropriate for students interested in water resources, and environmental science and engineering. Procedures would be taught but basic chem lab experience is desired.

Stormwater management to prevent sediment contamination. This work would assist with lab testing of engineered media to treat contaminants in stormwater runoff. The work would take place at Y2E2. The work is appropriate for students interested in water resources, and environmental science and engineering. Procedures would be taught but basic chem lab experience is desired.

Stormwater capture to augment water supply. This work would help plan for a field test in Los Angeles to treat stormwater prior to recharge of groundwater. The work is appropriate for students interested in water resources, and environmental engineering and science. Procedures will be taught, but basic chem lab experience is desired. The work will take place in Y2E2 if UGs are allowed to work in the labs this summer.

Assessment of hydrophilic organic contaminants in a stormwater detention pond. This work would assist studies in Redwood City on examination of the inputs and levels of hydrophilic organic compounds in a stormwater detention pond. The work will compare different sampling methods for

trace levels of pesticides and other compounds. The work is appropriate for students interested in water resources, and environmental engineering and science. Procedures will be taught, but basic chem lab experience is desired. The work will take place in Y2E2 if UGs are allowed to work in the labs this summer.

Sustainable Built Environment – Structures and Construction :

Faculty: Sarah Billington
Email: billington@stanford.edu

Hybrid Physical+Digital Spaces for Enhanced Human Wellbeing
We may not often think about it, but we are constantly influenced by the built environment that surrounds us in our daily lives. And as engineers, we get the chance to shape the buildings and infrastructures around us! Our interdisciplinary research team is developing methods to quantify the impact of various design decisions on wellbeing first in controlled lab conditions and, second, in the real offices of our corporate partners, through beta design implementations. Summer research responsibilities will include collecting and analyzing data from various experiments in our office and lab set-ups. Additional responsibilities may include assisting with planning future lab experiments and designing deployable design implementations for field testing.

Faculty: Michael Lepech
Email: mlepech@stanford.edu

Advancing Sustainable Building Materials: the GFRP Composite Façade System of the San Francisco Museum of Modern Art (SFMOMA)
The adoption of fossil-based hydrocarbon polymer composites has been successful in both the automotive and plane industries. Our team endeavors on advancing the application of GFRP composite in civil infrastructure and building construction industry to reduce the environmental impacts of buildings throughout their life cycle. The method we are using is to create a multiphysics computational model to predict environmentally-accelerated aging and damage. Students can expect to develop an add-on code to our framework using data collected from existing literature and public urban data. No prior coursework is required but a basic understanding of Solid Mechanics and some experience with Matlab will help you hit the ground running.

Evaluation of a Biopolymer-Bound Soil Composite for 3-D Printing. The researcher will work alongside a PhD candidate in exploring the fresh properties of a biopolymer-bound soil composite (BSC)—an exciting new class of sustainable construction materials. Specifically, the researcher will assist in designing and conducting experiments that measure the BSC's strength gain and desiccation level over time. The researcher will also use COMSOL—a finite element analysis software—to model the desiccation process observed in the laboratory. The researcher will participate in weekly research meetings and present their work to the Lepech Research Group. The exploration into a novel construction material will provide the researcher an in-depth understanding of the strength and rheological properties required for 3-D printable materials in the construction industry. Additionally, the student will gain experience in technical communication and critical thinking in a space with open-ended problems.

Students considered for this position should have successfully completed CEE 101A or an equivalent course.

Faculty: Rishee Jain
Email: rishee.jain@stanford.edu

Understanding the Role of Land Use and Urban Form in the Energy Efficiency and Decarbonization. In order to achieve California's aggressive 2050 GHG goals, there is a need for an additional 61-74% reduction in GHG emissions below forecasted 2030 levels. Buildings in California are responsible for a quarter of total emissions, making urban energy efficiency and decarbonization of the built environment a critical lever to achieve the state's GHG goals.

Two emergent and disruptive energy trends have direct implications for how energy efficiency is understood in cities – (1) the integration of distributed energy resources (DERs) such as solar energy and battery storage into the built environment, and (2) the rise of electric mobility which interacts with the built environment and potentially acts as "mobile batteries" for peak load management. These trends necessitate a better understanding of the balance between in-boundary and out-boundary urban energy flows as well as the techno-economic feasibility of urban energy self-sufficiency. At the same time, the land use patterns of our cities have profound impacts on energy use in buildings and transportation, and will thus influence the integration of DERs and electric vehicles into the grid.

This project will address these gaps in understanding through the development of a novel efficiency framework and benchmarking protocol for urban energy efficiency, offering ways to compare the performance of SVCE's thirteen communities in the clean energy transition. In addition, understanding the relationship between land use change and energy efficiency can allow SVCE to partner with its communities to offer pathways to decarbonization through land use and zoning regulations.