



CORNELL ENERGY SYSTEMS INSTITUTE

# THE CESI SOURCE

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## Message from the Director

Welcome to summer, and even more importantly, a return to some semblance of normal! I am very happy to be writing this from my office on campus, where we see more people every day.



The past year has taught us many lessons, including the urgency with which we need to evolve our energy system to adapt to our changing climate. This challenge will require an “all hands on deck” approach with diverse perspectives on fundamental research through commercialization and scaling of promising solutions. I am proud to note that this year CESI has invested in programming across this range; from supporting living-lab projects on campus, and engaging with students and industry during Energy Days, to supporting young innovators in our inaugural entrepreneurship sprint program.

CESI has been busy in our virtual world, and we hope you have had a chance to enjoy some of our programming. In case you did not, this newsletter highlights some of the events and programs with links to more information. The coming year will be an exciting one as we return to in-person operations and continue to explore new ways to connect the energy systems community across Cornell and beyond.

Sincerely,

**C. Lindsay Anderson**  
Interim Director, Cornell Energy Systems Institute

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## SOME HIGHLIGHTS OF 2020-2021

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### Energy Engineering Seminar Series (Fall '20 - Spring '21)

This year our seminar series was fully virtual, which brought some benefits to alums and other Cornell friends that were able to attend. This series also featured two distinguished speakers. **Dr. Steve Zinkle**



in Fall 2020 with a talk titled *Importance of High Performance Materials for Future Nuclear Energy Systems*, and **Dr. Jim Lyons** in Spring 2021 with a talk titled *Clean Tech Investing*.



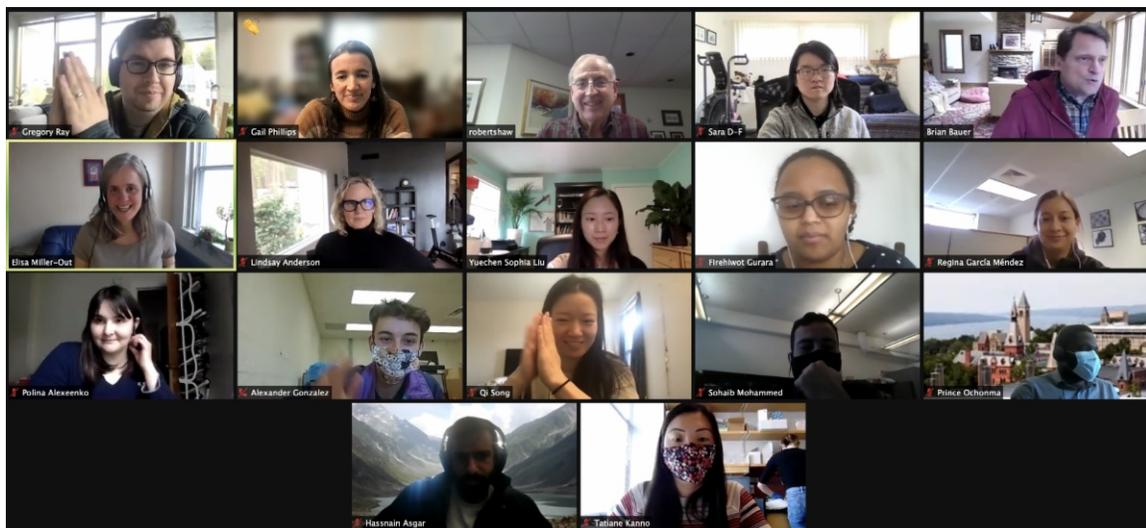
[View a complete list of all 2020 and 2021 speakers.](#)

## Entrepreneurial Foundations and Skills Building Sprint (May '21)

The Entrepreneurial Foundations & Skill Building Sprint was designed and implemented in collaboration with the Center for Regional Economic Advancement (CREA), and engaged faculty, postdocs and grad students affiliated with CESI. The program was a three-part sprint that aimed to explore the skills and entrepreneurial mindset for successfully taking technology from the lab to the market and creating societal value.

The pilot, which took place virtually from May 3-10, prioritized the participation from groups historically under-represented in the energy field. A diverse group of fourteen participants from different schools across the CoE and CALS successfully completed the program. Sessions included presentations from CREA team members Brian Bauer, Elisa Miller-Out, and Gregory Ray, together with young and experienced entrepreneurs.

We are currently evaluating to offer this program again in the near future. If you are interested in participating, please email [Gail Phillips](#)



## Cornell Energy Systems Club Energy Days (April '21)

Energy Days 2021 was a virtual event this year, hosted by the Energy Systems Club and CESI on April 21& 22. The event included keynote speakers, panel discussions, poster presentations and networking sessions. You can read more about Energy Days 2021 [here](#).

### Day 1

- Keynote: [Mary Ann Piette, LBNL](#)
- The Cornell Climate Action Plan (CCAP) Panel Discussion
- Poster Session
- Energy Trivia

### Day 2

- Keynote: [Bri-Mathias Hodge, NREL](#)
- Industry Perspectives Panel
- CCAP Student Discussion

## UPCOMING IN FALL 2021

### Energy Engineering Seminar Series

[The Energy Engineering Seminar Series, Fall Semester, 2021](#)

A list of featured speakers will be available on the [CESI webpage](#) in the coming months.

Through the weekly Energy Engineering Seminar, CESI provides a mechanism for students in and outside of Cornell to receive up-to-date knowledge about energy systems science and technology, across the full spectrum of energy areas. Seminar speakers will be practicing engineers and executives from industry and government, as well as Cornell faculty members from a variety of departments. A discussion session with the external speaker will immediately follow the seminar.

To receive our weekly seminar announcements please email [Polly Marion](#).

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## Post Doctoral Fellowship Program

The CESI Post-doctoral Fellowships are high-profile fellowships designed to attract the best and brightest young researchers in energy science, engineering, and materials to Cornell. The goal is to create a cohort of independent scholars pursuing frontier research in energy. Fellows will work in partnership with Cornell faculty sponsors on projects consistent with the CESI mission. The CESI fellowships are two-year appointments and provide up to 50% of the cost associated with sponsoring a postdoctoral scientist at Cornell, with the faculty advisors providing the other 50%.

Applications for the 2022 Post-Doctoral Fellowship Program will open in fall 2021.

[More information](#)

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## 2019-2021 POST-DOCTORAL FELLOW PROFILES

We are proud to highlight our 2019-2021 fellowship winners who took time to share a bit about their experiences with us.

Congratulations to Shuangyan and Alexa!

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### Shuangyan Lang

CO-ADVISED BY DR. HÉCTOR D. ABRUÑA, DR. LYNDEN ARCHER AND DR. JIN SUNTIVICH



**Q: What initially attracted you to Cornell and/or CESI for your postdoctoral research?**

A: It is the top academic environment. This is a valuable opportunity for me to work with world-class researchers over here.

**Q: What have been the main findings of your research?**

A: The fundamental mechanism and kinetics of lithium–sulfur redox *via operando* techniques.

**Q: How has CESI supported your work?**

A: CESI provides funding programs as well as advanced facilities to support my research.

**Q: What are your next steps/future plans?**

A: I am planning to continue my research in Prof. Abruña's group, mainly focused on *operando* investigation of advanced energy storage systems.

**Q: What advice would you give to incoming CESI PostDoc fellows?**

A: Keep deep thinking, hardwork, optimistic and discussion with your advisors and collaborators.

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### Alexa Schmitz

CO-ADVISED BY DR. BUZ BARSTOW AND DR. ESTEBAN GAZEL

**Q: What initially attracted you to Cornell and/or CESI for your**



#### postdoctoral research?

A: I have always been interested in applying biology to sustainable energy, and this research is a great opportunity to do so. Becoming part of CESI has not only supported me in this work, but it has given me an identity as an energy scientist I look forward to solidifying throughout the rest of my career.

#### Q: What have been the main findings of your research?

A: Through the creation of a whole-genome knockout collection in *Gluconobacter oxydans*, I have identified several genes important for this bacteria's ability to bioleach rare earth elements. Additionally, disrupting certain genes has resulted in up to an 18% increase in rare earth bioleaching. Overall, these results have provided a clear path towards exceptionally improving rare earth bioleaching, and thus a more sustainable and environmentally conscious method for mining and recovering rare earth metals.

#### Q: How has CESI supported your work?

A: Most practically through funding - this has left us more resources to be able to tackle our research with the most effective methods. In a lab as new as the Barstow Lab (only a year old when I started), this was an invaluable help to get us off the ground running. Additionally, I have made many valuable connections with other energy researchers I know will remain beyond my time at Cornell.

#### A: What are your next steps/future plans?

Q: As my CESI fellowship comes to an end, I plan to continue my work in the Barstow Lab improving *G. oxydans*' rare earth bioleaching. With the help of CESI, I have also become interested in entrepreneurship, and in partnership with colleagues from my lab, I hope to be able to take some of our technology to market in the near future.

#### Q: What advice would you give to incoming CESI PostDoc fellows?

A: Keep in touch! Both with previous fellows, and with your colleagues in CESI. The research under the CESI umbrella is both diverse but at the same time so inter-related. I hope the program continues to grow with more and more opportunities for synergistic discussions and collaboration!

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## PROJECT HIGHLIGHT: EARTH SOURCE HEAT

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### Update on Cornell's Earth Source Heat

by Jeff Tester with inputs from many other Geothermal Team members

By evaluating the direct use of geothermal energy using Earth Source Heat (ESH) technology to provide geothermal baseload heating for the campus, Cornell is taking an important step to reach its goal of carbon neutrality by 2035. While geothermal has an essential role in Cornell's decarbonizing strategy, successfully demonstrating ESH for heating our campus of 30,000 students, faculty, and staff may be even more important. Sixteen states in the U.S. have set aggressive goals to decarbonize their energy footprint by 80% or more by 2050. Meeting these goals presents a significant challenge, particularly for heating-dominated states where between 20 and 40% of their carbon footprint results from burning natural gas, fuel oil and propane for space and water heating in residential and commercial buildings, and for providing low-temperature industrial process heat. Most federal and state energy policies and incentives currently focus on promoting renewable solar PV and wind power for generating electricity and electrifying land transportation – often ignoring the need for decarbonizing the supply of thermal energy for heating. Some states are beginning to introduce incentives to promote the use of geothermal heat pumps powered by renewable electricity, which take advantage of stable ground temperatures found at shallow depths from a just a few feet below the surface to about 500 ft. Geothermal heat pumps are about 50 to 100% more efficient than air-source heat pumps whose performance can vary widely depending on ambient air temperatures. As a result, geothermal units require less electricity to operate, resulting in lower operating costs, but they cost more to install than air-source units.



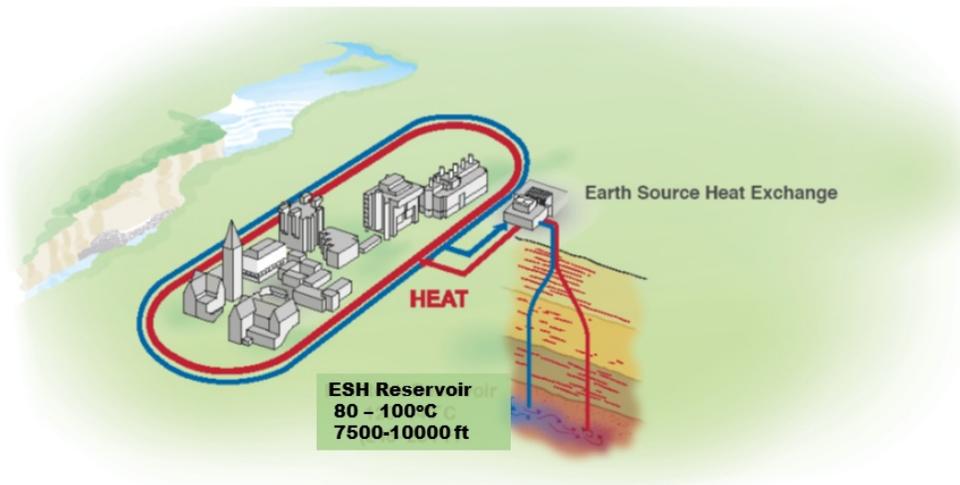
Systems making direct use of geothermal energy stored in deeper rock at higher temperatures (80 to 100°C) operate at even higher efficiencies than geothermal heat pumps. There are many examples of direct use in district heating systems in European countries and China. Although the US has lagged far behind other countries, direct use has enormous potential in the northern tier of the US for providing decarbonizing heating. Full-scale demonstrations are essential to catalyze adoption and deployment.

A successful Cornell ESH demonstration (see *conceptual diagram below*) will serve as an example for rural and urban communities in New York State and in other heating-dominated regions. This fall Cornell will take a big step toward achieving its goal of using geothermal for heating the campus. In October, we plan to begin drilling our first geothermal well, to a depth of about 10000 ft (3 km). It is called the Cornell University Borehole Observatory (CUBO).

Although CUBO is not intended for heat production, it will allow researchers to more precisely understand the geologic conditions beneath Ithaca needed to lower the technical risks for developing full-scale ESH reservoirs. In addition, CUBO will provide a high resolution, subsurface monitoring system, to ensure that the methods used to extract heat from the earth would not create unacceptable risks or unintended impacts. Cornell is committed to studying and addressing these issues in a thorough and transparent manner, developing best practices that will increase performance and lower costs while minimizing risk for our campus and for others who might implement this technology to sustainably meet their heating needs.

Prior research indicates that suitable subsurface temperatures, in the range 70 to 100°C, are expected at 2.5 to 3 km depths. Techno-economic analysis suggests that integrating ESH into Cornell's existing district energy infrastructure by employing centralized heat pumps would provide heat for the campus at a levelized competitive cost of about \$5/MMBtu. By conducting numerous tests in CUBO using core and cuttings analysis, geophysical logging, and formation testing, we will be able to determine earth stresses and mechanical rock parameters that will allow us to evaluate target formations that can provide acceptable fluid flow rates and reservoir lifetimes.

[Learn more about Earth Source Heat](#)



**Cornell  
Engineering**

## ENERGY SYSTEMS CLUB

### Club Mission:

To foster communication and collaboration among Cornell faculty, graduate students, and undergraduate students in the energy field. To foster discussion surrounding relevant modern and future issues related to energy. Develop a student-faculty-alumni network within the greater energy community on and off-campus, especially with commercial entities that have not been traditionally represented at previous Cornell recruitment events.



For more information, please contact the Energy Systems Club President [Jeff Sward](#).

# ACADEMICS

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CESI is excited to partner with Systems Engineering to offer the Master of Engineering in Energy Systems! This exciting new program brings together energy and systems content from across the college. More information is provided below.

## Energy Systems M.Eng. Specialization

Together with the Cornell Energy Systems Institute (CESI), the Cornell Systems Engineering program has created a new on-campus and distance learning Energy Systems Specialization in our MEng (Systems) Degree. This degree and specialization is dedicated to helping you develop as a leader who will create complete solutions that are sustainable, responsible, and socially achievable. With the broad range of stakeholders' needs, technology, and societal impacts energy is truly a systems problem. As a world leader in Systems Engineering professional education & research, Cornell is ready to stand with you to make a difference.

[More information](#)

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## Energy Economics and Engineering

The specialization in Energy Economics and Engineering (EEE) brings together faculty and students from various personal and academic backgrounds to focus on potential careers in energy-related technology, management, and public policy. Course work explores current and evolving energy systems.

[More information](#)

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## Sustainable Energy Systems Minors

Cornell offers both [undergraduate](#) and [graduate](#) students the option to minor in Sustainable Energy Systems.

These minors offer students a wide array of coursework spanning multiple colleges within the University. The breadth of concentrations and options make this minor something that students can focus in on their area of interest, or inversely gain exposure to a variety of areas within sustainable energy.

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# FACILITIES UPDATE

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The [Cornell Energy Systems Institute \(CESI\) laboratory](#), a 4,000 square foot, 24/7 facility, in Kimball Hall designed to support materials innovation and sustainable energy solutions that support the mission of the institute. The laboratory is available on a fee-for-service basis to anyone, with priority given to CESI stakeholders. The CESI laboratory provides an innovative platform for individuals taking new material from concept to prototype. The lab boasts unique capabilities for materials synthesis (1 wet lab, 3 gloveboxes, 10 general equipment), physical characterization and material structure-property-processing analysis (21 analytical instrument), and energy storage studies (3 application instruments).

Current research projects supported by the CESI facility include, but are not limited to; carbon capture and conversion, electrochemical energy storage in batteries & fuel cells, photonic and photovoltaics, biophysics studies and hydrogels for biomedicine and drug delivery. The open lab encourages partnerships internal to Cornell and between companies and the university.

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**Three new testing capabilities were introduced to the CESI facility in 2020-2021:**



### Nano ITC by TA Instruments

The Nano ITC is designed to provide maximum sensitivity and flexibility for the study of biomolecular binding via isothermal titration calorimetry technology.

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### Autopore IV 9500 by Micromeritics

The mercury porosimetry analysis technique is based on the intrusion of mercury into a porous structure under stringently controlled pressures, the AutoPore IV Mercury Porosimeter can determine a broader pore size (3 nm to 360 mm) distribution more quickly and accurately than other methods.



### XFA 500 thermal conductivity tester by LINSEIS

The XFA 500 uses programmable laser energy pulse irradiation on back of the sample, the resulting temperature rise of the surface of the sample is measured by a very sensitive high speed IR detector. Both, thermal diffusivity and specific heat can be determined from the temperature vs. time data.

For more information on our facilities please contact [Jiefu Yin](#)

## MEET THE TEAM

CESI has seen some big changes this year! To bring you up to date, below you can read about the awesome CESI team that makes it all happen.

### **Gail Phillips,** Project Associate

Gail Philips joined the team in March 2021 directly supporting Director Lindsay Anderson and the activities across CESI. Gail also works with the Strategic Partnerships team at the Atkinson Center for Sustainability.

### **Jiefu Yin, PhD,** Laboratory Manager

Jiefu Yin joined CESI as the Laboratory Manager in 2018. He earned his PhD in Chemistry, with a focus on electrochemistry and rechargeable batteries, in the research group of Dr. Ester Takeuchi at Stony Brook University. In CESI, Jiefu is responsible for instrumental maintenance, user training, and the development of new technology & test ability for the facility.

### **Polly Marion,** Administrative Assistant

Polly Marion is an Administrative Assistant in CBE for Professor Jeff Tester. In May 2021, Polly took on the role of providing administrative support for CESI. Specifically, Polly will support the Energy Engineering Seminar Series in Fall 2021.

### **Brittney Snyder,** Administrative Assistant

Brittney Snyder is an Administrative Assistant in CBE. She began providing support for CESI in August 2020, and will continue to manage the communications and marketing for CESI.

The CESI Source is an internal newsletter brought to you by the Cornell Energy Systems Institute.

[energy.cornell.edu](http://energy.cornell.edu)

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