Facilities & Services

INSIDER

SPECIAL EDITION

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F&S an Active Partner in Collaborative Research on Campus

A MESSAGE FROM THE

Executive Director

As the University of Illinois Urbana-Champaign, and the rest of the world, ramps up to a post-COVID reality, F&S can once again support a campus filled with students, faculty, and staff returning to on-site learning and living. Our mission is to provide and maintain a physical environment, like the Urbana campus' facilities and grounds, conducive to supporting learning, discovery, engagement, and economic development. Simply put, our engineers, architects, energy experts, building service workers, safety and compliance experts, crafts and trades professionals, and, in fact, our entire workforce of more than 1,300 employees, get work done on campus.

But just as importantly, we take part in the academic excellence of the U of I, as well. We are an active partner in research, teaching, and learning.

By helping other researchers in many fields, F&S shows its value to the academic community. This special edition of *INSIDER* will show the reader how we lead and assist efforts to discover more about the world around us.

Academic collaboration is an essential component to the future of F&S, and a major theme emphasized in our ***F&S Strategic Plan 2019-2023: "Foundations for the Future."***

Our expertise, particularly related to energy production and distribution, sustainable grounds and systems, and building technologies, allows professors and instructors on campus to use the campus as a living laboratory, available for curious minds to change the world.

As you read about some academic collaborations, please keep in mind our capacity to enable your research. Our subject matter experts often serve as guest lecturers and provide operational expertise to innovative research efforts. We help students by hosting project-based learning, and have led thousands through tours at facilities like Abbott Power Plant.

You can work with us by filling out a form at **https://forms.illinois.edu/sec/9147937** or reaching out directly to Associate Director Morgan White, or myself.

We welcome your questions and needs in an effort to enable your research!

Cordially,

Dr. Mohamed Attalla, Ph.D., MBA, P.Eng.
Executive Director, Facilities & Services

Dr. Attalla is closely involved with multiple F&S research collaborations, including co-authoring papers. Above, he visits the new instrumented Civil and Environmental Engineering Bridge and, below, he inspects the geothermal energy system at the Campus Instructional Facility.

IN THIS ISSUE

ON THE COVER: *F&S and collaborators outside the Campus Instructional Facility. From left to right: Kassidy Waver, project engineer at Pepper Construction; Dr. Mohamed Attalla, executive director of F&S; Frank Holcomb, senior researcher, U.S. Army Corps of Engineers; Clarence Odom, F&S associate director of project management, Capital Programs; Morgan White, F&S associate director for Sustainability; Dr. Tugce Baser, civil and environmental engineering, University of Illinois Urbana-Champaign; Dr. Andrew Stumpf, Prairie Research Institute, University of Illinois Urbana-Champaign*

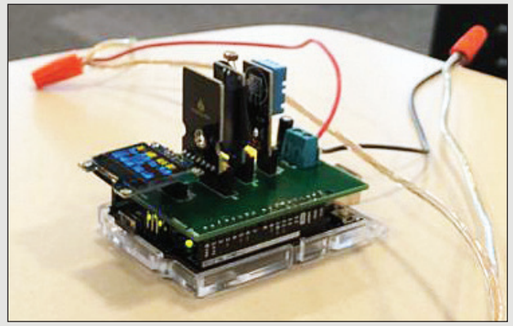
F&S Vital to Building Energy Efficiency Study

Properly and efficiently heating buildings is an instant way to reduce cost, and electrical and thermal energy use. Measuring those savings versus the impact it makes on building occupant satisfaction is an important balance, one that a civil and environmental engineering research team hopes to make easier for building managers now and in the future.

Thanks to F&S, the team, including Dr. Nora El-Gohary, associate professor in civil and environmental engineering, and Ph.D. candidate Nidia Bucarelli (left), was able to make important and informed decisions about conducting the experiments needed.

The research team is leading the effort to install metering devices that collect data that will be used as a baseline for the project. These metering devices, or Arduino (pictured at right), have a printed circuit board (PCB) where sensors read lighting levels, temperature, humidity, and air quality. Each Arduino is essential to the project. So when Bucarelli found it difficult to keep each device on, she reached out.

"The first thing F&S helped me with was selecting the building. We wanted one on campus and I had certain requirements in regards to size, occupancy levels, and layout, so we spent about two months to find the right building," said Bucarelli. Karl Helmink, associate director for Utilities & Energy Services, energy conservation & retrocommissioning, and Paul Foote, energy efficiency & conservation specialist, consulted with Bucarelli in selecting the Office of Admissions and Records Building as best for the needs of the research.



"Do you know Jerry Buchanan? Well, he's an extraordinary human being."

Bucarelli's experience with electrician sub-foreperson Jerry Buchanan is one she appreciates. She asked for help, and he delivered results: "When I was going to start my device deployment, I had real big issues because I had a problem keeping each device on. But I didn't know how to adjust them since I wasn't an electrician, so I was like, 'Hey Jerry, how do I keep my devices on?' He provided me with a solution. He put together some equipment at his shop to build a power supply. He also gave me some rolls of wires to make my electrical connections and made himself available."

Early in the process Buchanan consulted with the team. He reviewed PCB design before manufacturing, making sure it worked properly once received. Like many F&S employees, Buchanan went the extra mile to support the research team.

"I'm so happy I met him. He was really supportive for me. And now, everything is working fine. I'm so thankful and grateful for him. Without him, I wouldn't be able to deploy my sensors on time."

From l-r, Rob Roman, Clarence Odom, Dr. Tugce Baser, Dr. Mohamed Attalla

Campus Connection

Cold winter nights, accumulated snow and ice, overwhelming heat, wind, and rainstorms can bother any pedestrian on the U of I campus. Soon, individuals on north campus will avoid the weather and move between the Civil and Environmental Engineering (CEE) Building and the Newmark Civil Engineering Laboratory thanks to a new pedestrian bridge.

This bridge allows easy passage three stories up, but it will also have academic relevance for researchers and students in the Grainger College of Engineering. Precise sensors were installed to measure the impacts of various forces above and below ground, allowing engineering students to investigate how the bridge is affected by external influences.

Mini Movements

Have you ever taken a tour at the Willis Tower in Chicago, Golden Gate Bridge in California, or Gateway Arch in St. Louis? You may remember hearing how much those structures sway due to the wind – often measured in feet and occasionally felt or seen with the naked eye. That will not be the case with this new bridge in Urbana.

Those major structures are much more slender and long compared to the new bridge, but sensitive sensors will show minuscule movement, rotation, expansion, contraction, and other dynamic movement from stimuli like wind and heat. For instance, hot days actually make the bridge swell.

"On the Golden Gate Bridge, you can sometimes really feel the movement," said John Popovics, associate head and director of undergraduate studies in the Civil and Environmental Engineering department in the Grainger College of Engineering. "For people who don't know about bridges: they're designed to move. They're generally long and slender. This one on campus is a kind of stout bridge; it's boxy and it's just stiffer. The movement would be measurable, but not necessarily felt."

Three sets of sensors will help faculty and students learn about these natural forces. Weather and wind will be monitored, an accelerometer will identify movement changes in the bridge, and another set where the bridge connects to the buildings will detect joint expansion and contraction.

"With these kind of features, you get something more; you get something additive, especially for a major university," said Popovics. "I expect [instrumented campus structures] to become more common. It's a great opportunity, especially when we can directly benefit our faculty, staff, and students, which we picture this will do."

Added benefits from a construction project are important aspects of the work of F&S project managers, and the more asked of a construction project, the more important a project manager becomes. F&S' Michael Stilger oversees this project, and he recognizes the benefits of this added instrumentation. Stilger seeks to maximize the benefits to campus, while keeping a few guideposts in mind.

"We have to be wary of the project budget and the schedule, along with quality. So those three things are huge," said Stilger. "Managing those three things mean a thousand little tasks to completing on schedule, on budget, and to a satisfied customer."

Under the Bridge, Below the Earth

The bridge connects two buildings high above, and just as importantly, newly cemented foundations go deep underground.

Just like at the Campus Instructional Facility, Dr. Tugce Baser, assistant professor of civil and environmental engineering (CEE), wanted to explore geothermal concepts using this new construction as an opportunity to study the mechanisms of geothermal power directly on-site, in a couple of basement offices and instructional laboratories. The heating and cooling generated by the geothermal piles will directly heat and cool those rooms.

The drilled shaft foundations of the new bridge are 50 feet underground. There, the relatively constant underground temperature to provide heating and cooling comes at remarkably high efficiencies. The system functions by circulating fluid through heat exchangers in the ground leading to a heat pump in the building.

This project is the subject of a paper co-authored by F&S Executive Director Dr. Mohamed Attalla and Dr. Baser, Michael B. Reiter, and Lydia Kurtz, with the department of civil and environmental engineering. The paper, *Changes in Shaft Resistance and Pore Water Pressures During Heating of an Energy Foundation*, was presented at the International Conference on Energy Geotechnics (ICEGT).

Dr. Tugce Baser, Morgan White, and Dr. Mohamed Attalla at the site of geothermal piles in the foundations of the CEE bridge

"This project will provide an invaluable opportunity for the university to conduct a scalability study from lessons learned during the installation and an excellent basis for a fundamental understanding of the operational response of the energy foundations," Baser said.

During installation, Dr. Baser instrumented the drilled shafts with thermistors to measure temperature profiles within the foundations. The data set from this installation will enable the evaluation of operational thermomechanical properties. Further, the data collected from this project will be used as an input for analyses by students in the graduate level CEE 585 Deep Foundations and CEE 498 Geoenergy Systems courses.

Dr. Attalla said, "The outcomes of this project will be converted into design guidelines for future installation of energy foundations, which will significantly contribute to the sustainability of the campus."

The $240K project is funded jointly by F&S and the Institute for Sustainability, Energy, and the Environment (iSEE), using the Carbon Credit Sales Fund, CEE, and a grant from the Student Sustainability Committee. iSEE also seed-funded Dr. Baser's scalability study as part of the Campus As a Living Laboratory (CALL) program. Her research data gained at the laboratory site will further explore this state-of-the-art approach, inform the campus on the viability of geothermal, and help lead to additional installations on campus.

Through the Illinois Climate Action Plan (iCAP), the U of I has committed to achieving carbon neutrality as soon as possible, and no later than 2050, and geothermal energy is one of several strategies the university is exploring to reduce its environmental impact.

"In order to achieve campus-wide carbon commitments, we have to go beyond renewable power," said Morgan White, F&S academic research lead. "We need renewable thermal energy in buildings at scale. The campus is currently using a little biomass, one solar thermal site, and a few geothermal installations … and the one with greatest opportunity for wide-spread campus infrastructure use that also benefits the UIUC researcher community is geothermal."

Heat Rising at Campus Instructional Facility

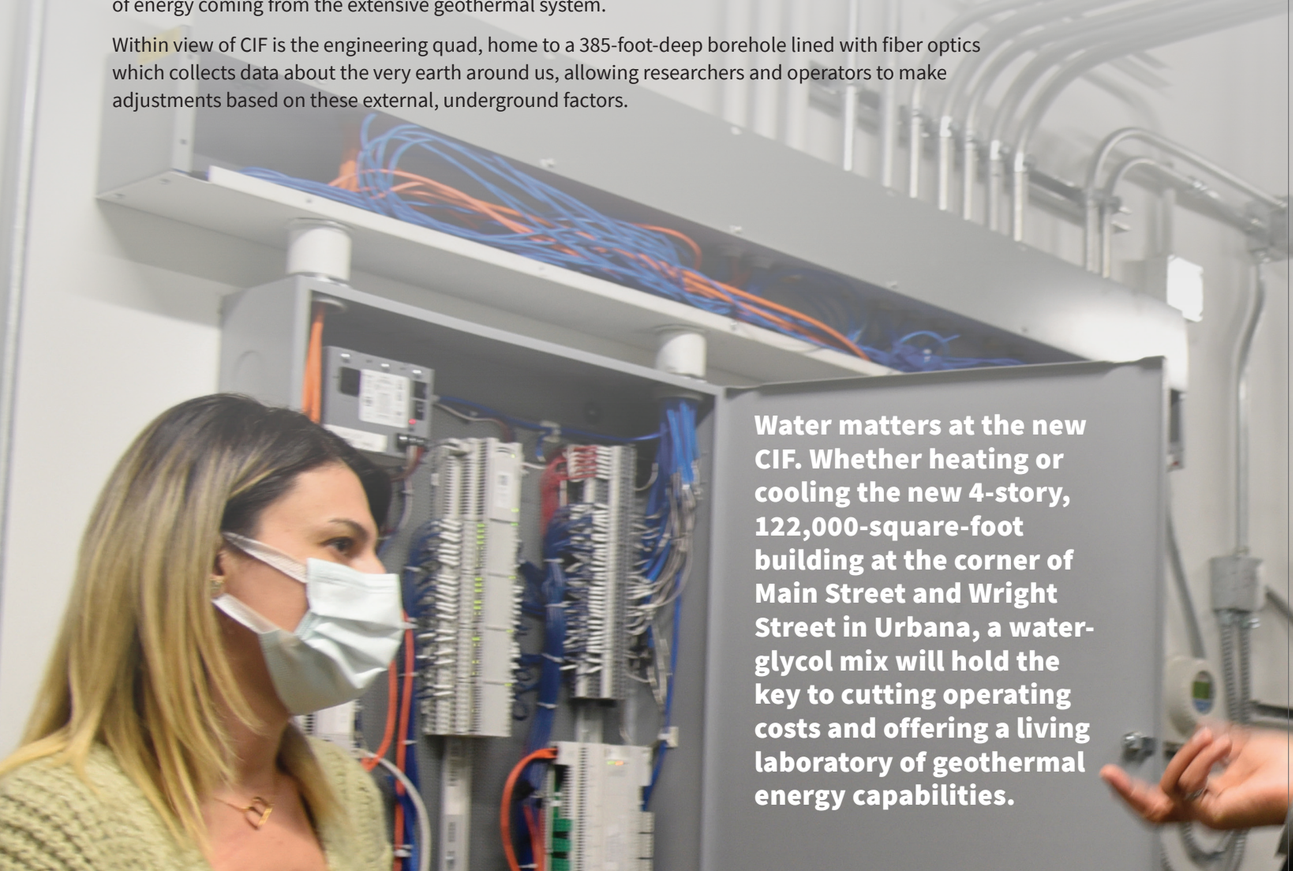
The concept is easy: the temperature underground is more consistent throughout the year than air temperature. Geothermal plumbing in the ground uses liquid to move heat and make the building temperature comfortable year-round. In the summer the heat is pulled out of the building and in the winter the heat is pulled into the building. By using a geothermal system, savings to the building's heating and cooling systems could reach 30 percent against standard utility use.

"Geothermal energy building systems have a tremendous future, and the technology at Campus Instructional Facility (CIF) is a fantastic example of how F&S works with campus to add to the academic capabilities of this campus," said Dr. Tugce Baser, assistant professor of civil and environmental engineering (CEE). "My class, specifically, will look at data coming from how efficiently the liquid is heated and cooled, which is then used to heat and cool the building itself."

Clarence Odom, F&S associate director of project management, Capital Programs, with the geothermal power system in the basement of CIF

During the planning for construction, F&S' Dr. Mohamed Attalla, Clarence Odom, and Morgan White ensured the site would become a working and living laboratory for data from the heating and cooling system. Basement work areas, labs, and offices now actually host the direct physical lines of energy coming from the extensive geothermal system.

Within view of CIF is the engineering quad, home to a 385-foot-deep borehole lined with fiber optics which collects data about the very earth around us, allowing researchers and operators to make adjustments based on these external, underground factors.



Water matters at the new CIF. Whether heating or cooling the new 4-story, 122,000-square-foot building at the corner of Main Street and Wright Street in Urbana, a water-glycol mix will hold the key to cutting operating costs and offering a living laboratory of geothermal energy capabilities.

Illinois Geothermal Coalition

Part of using geothermal power relied on buy-in from other organizations on campus and in the community. To jumpstart the process, F&S worked with campus researchers to create the Illinois Geothermal Coalition (IGC).

As a founding member, F&S worked with the IGC to increase geothermal awareness when developing new infrastructure on campus. It is thanks to the IGC for the development of geothermal energy use at CIF.

"The development and deployment of the Illinois Geothermal Coalition is what is helping draw focus from other parts of campus and those in the community about the present and future use of geothermal as a means of energy production and as a research topic as more efforts are made to make buildings more sustainable," said Morgan White, associate director for Sustainability.

Founding members:

- The Illinois Water Resources Center
- University of Illinois Facilities & Services
- The Prairie Research Institute
- The Institute for Sustainability, Energy, and Environment
- The Geothermal Exchange Organization (GeoExchange)
- Department of Civil & Environmental Engineering
- *Affiliate members: Geothermal Alliance of Illinois; International Ground Source Heat Pump Association*

In photo below, l-r, Dr. Tugce Baser, Clarence Odom, Dr. Mohamed Attalla, Dr. Andrew Stumpf

Findings at the Farm

A team of researchers will be measuring the impact of natural vegetation at the Solar Farm 2.0 grounds. Below the 31,122 bi-facial solar panels lie 54 acres perfect for pollinator-friendly plantings.

But how exactly does one calculate the plants' effectiveness? How about: count the bugs.

Ben Campbell, an energy engineer at the University of Illinois Chicago, is part of a research effort that will do exactly that, and more. Their research will also address other matters at Solar Farm 2.0, including how the pollinator plants affect the efficiency of the solar panels' power production, and how quickly and strongly the pollinator plantings grow. Additionally, F&S Utilities & Energy Services are a support team member for the research project which will study the economic and ecological benefits of planting native and other flowering plants under and around solar arrays.

In order to count the bugs, a few times a year researchers will catch flying insects over the course of a day. The insects they collect will be taken to the Bee Research Facility on the Urbana campus where they will be identified and archived, under the guidance of Dr. Adam Dolezal.

This might seem standard practice for a new test site with new plantings. What may surprise the reader is another research question: where and how many birds and bats will come around for feeding time?

"The research is driven by the solar industry's questions about the colocation of solar power production and pollinator habitat," said Campbell. "Our research seeks to understand what scale of habitat is necessary to have measurable impacts on pollinator, bird, and bat populations at utility-scale solar facilities, in addition to benefits in terms of increased power production or lifecycle costs of managing vegetation. We are excited to have the opportunity to test these questions in our own backyard at Solar Farm 2.0."

Using acoustic and ultrasonic recorders, the team will record bird and bat abundance and diversity, respectively, over time, measuring wildlife elements until at least 2023.

Once fully grown, pollinator-friendly plantings at Solar Farm 2.0 should look similar to those at this central Minnesota array. Credit: Natural Resource Service.

The research project, led by Iris Caldwell at the Energy Resources Center at University of Illinois Chicago, is funded by the U.S. Department of Energy Solar Energy Technology Office. Her research team consists of the University of Illinois Urbana-Champaign, UIC, the Argonne National Laboratory, and the National Renewable Energy Laboratory. Six solar facility test sites have been selected for field research across Illinois, Indiana, Michigan, and Wisconsin. This includes the 12 MW Solar Farm 2.0 facility at UIUC. In partnership with F&S and Sol Systems (the site operator) the research team will evaluate the effects of the pollinator plantings on photovoltaic and ecological performance and compare operational costs with facilities that use conventional ground cover (usually turf grass). In addition, Solar Farm 1.0 may be used as a control site for comparison for performance and pollinator observation.

Pictured above, l to r: Morgan White, associate director of Sustainability; Dr. Mohamed Attalla, executive director of F&S; Rob Roman, director of Utilities & Energy Services

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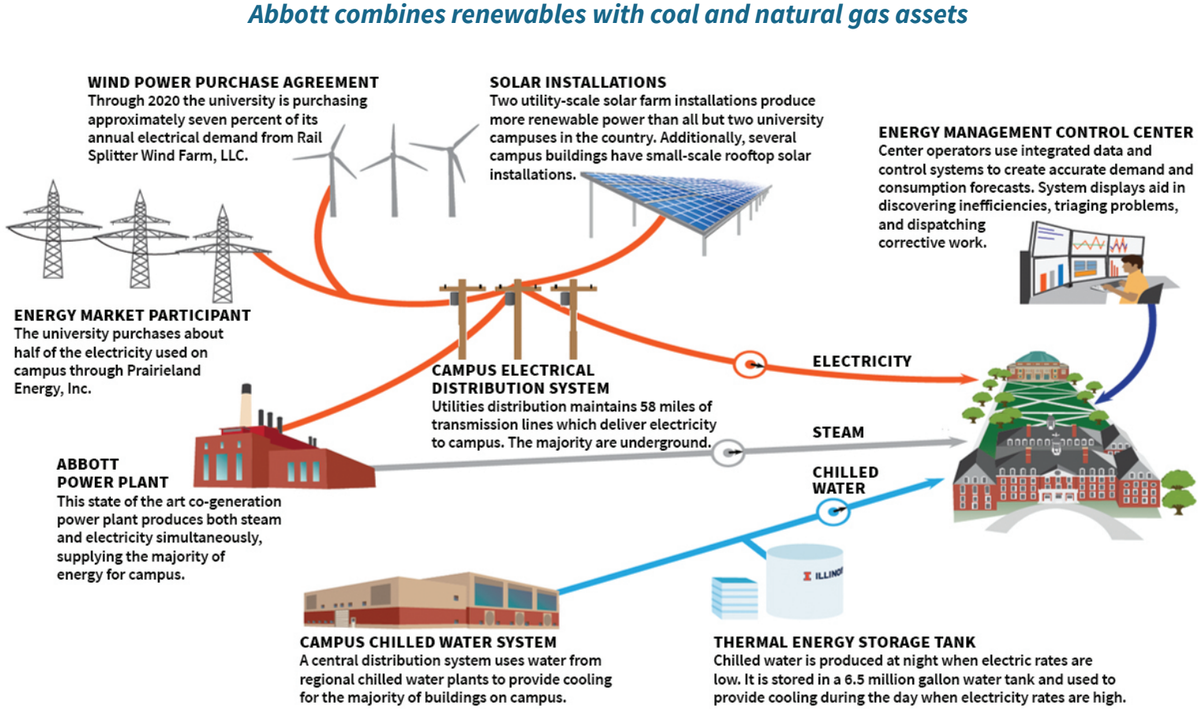
~ Ben Campbell, energy engineer, University of Illinois Chicago

Abbott Produces Power... and Data

In March 2021, Dr. Mohamed Attalla, executive director of F&S, presented a paper at the 15th International Conference on Greenhouse Gas Control Technologies (GHGT-15) on the vital role of Abbott Power Plant on campus, not just as an energy generation facility, but as a place that embraces current and future research collaborations.

Abbott Power Plant and University of Illinois Grid

Abbott combines renewables with coal and natural gas assets



From l-r, Dr. Yongqi Lu, Illinois Sustainable Technology Center; Dr. Mohamed Attalla, F&S executive director; and Mike Larson, F&S associate director of utilities production in front of the newly built carbon capture research equipment, built and installed by F&S experts.

Dr. Attalla was a co-Principal Investigator for *Enabling Technology Maturation in Carbon Capture: The Role of a University Based Power Plant as a Test Facility*, along with others from F&S and researchers with the Illinois Sustainable Technology Center. The research team included Dr. Kevin O'Brien, Dr. Yongqi Lu, Stephanie Brownstein, and Jim Dexter from the Illinois Sustainable Technology Center, as well as Morgan White, Rob Roman, and Mike Larson from F&S.

How Abbott generates power makes it not just important to the rest of campus as a cogeneration operator (producing heat and power); its location on campus and relation to renewable campus assets allow Abbott to be the destination for multiple testing technologies. The site's Technology Readiness Level (TRL), a metric used to determine how well a site can host an academic study, is high enough for multiple cases – the range of TRL is measured from 1 to 11. As noted in the paper, Abbott has "gained a reputation amongst power plants within the state and region as a 'test bed' for emission reduction technologies."

In one study, Abbott hosted testing of a transformational biphasic solvent CO2 absorption process. In that process, the site's TRL increased from 1 to 5. The site can host a wide range of TRLs of technologies.

While testing the effectiveness of aerosol mitigation, the research team found that certain concentration levels and individual sizes of particulates in the air do not necessitate a pre-treatment system. Another study will use a "mixed-salt process" (MSP) to capture CO2 from entering the earth's atmosphere.

Abbott has a wide range of advantages to hosting multiple academic collaborations.

"The reputation of Abbott as a non-biased evaluator of technologies, its ability to aid in workforce development and education, along with its outreach to the local community enables the plant to further the education of the future workforce and to educate stakeholders on future trends in the power industry," the paper concluded.

Abbott will continue to be home to not just production, but act as a home for varying levels of academic investigation.

Abbott has "gained a reputation amongst power plants within the state and region as a 'test bed' for emission reduction technologies."

~ From paper presented at the 15th International Conference on Greenhouse Gas Control Technologies

Facilities & Services
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

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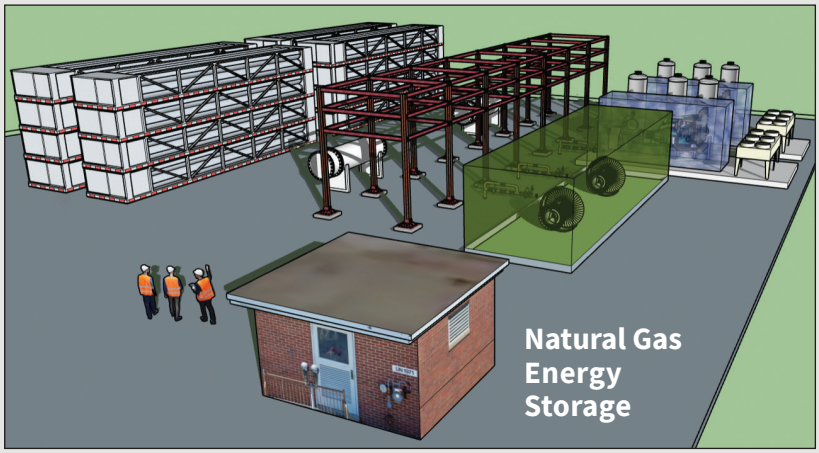
Saving Air Now for Energy Later

F&S' power production on campus is really great due to the incredible array of production services on campus with the two solar farms, the off-campus wind power purchase agreement, and at Abbott Power Plant. The Abbott combined heat and power facility provides both electric and thermal energy across campus. It has existed for over 80 years, and has a long history of supporting research collaborations. It's also at the forefront of integrating renewable energy options into the energy operations, exploring and incorporating clean energy in addition to the existing use of fossil fuel.

Now, three studies hosted by F&S facilities will look for important data related to the storage of fuel like compressed air, natural gas, and hydrogen.



3-D rendering of proposed on-site natural gas energy storage facility at or near Abbott Power Plant

The Prairie Research Institute (PRI), the Illinois Sustainable Technology Center (ISTC) and F&S will help lead three multi-disciplinary teams studying systems of energy storage to increase the reliability of solar and wind farms, and integrating it with Abbott's fossil fuel production. This work is funded by grant awards won through the Department of Energy, with Dr. Mohamed Attalla, F&S executive director, named as a co-Principal Investigator on each.

Compressed air energy systems, for example, can store output from renewable energy sources as a means to keep fossil-fueled electrical systems loaded when electricity demand is low and as a reliable backup. Eventually, F&S will store compressed air and use it to rotate the turbine generators when doing so would be beneficial to university power production operations based on market conditions.

Studies looking into the storage of hydrogen and natural gas will also use Abbott data to evaluate integration of energy storage systems, as production facilities look to multiple types of fuel in order to improve cost and effectiveness in a variety of climates and economic realities. The PRI teams at the Illinois Sustainable Technology Center (ISTC) and the Illinois State Geological Survey (ISGS) play a vital role.

"This work offers a unique approach with high potential for development of a clean and sustainable energy system that will have broad application. We recognize the important role that our colleagues at PRI have had through their research and industrial partners have had in developing world-recognized projects, and we look forward to their continued contribution toward advancing this important technology," said Attalla.

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Questions, ideas, or comments? Email fscustomerrelations@illinois.edu.

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