SYRACUSE UNIVERSITY
SYRACUSECOE

LAB TO MARKET | MARKET TO LAB

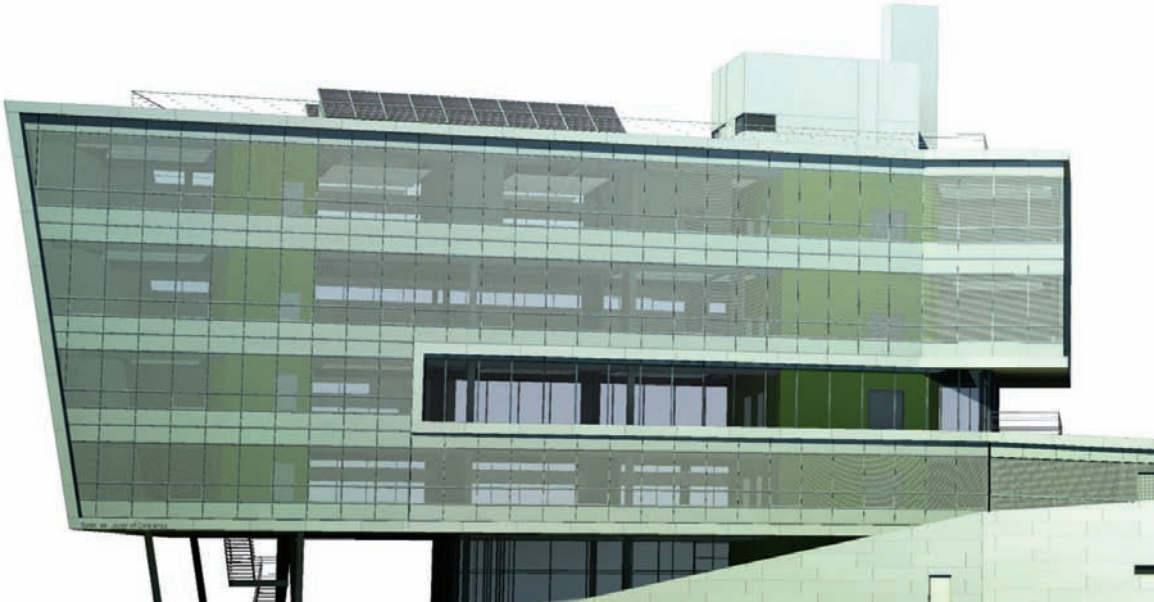
Catalyzing Research and Innovation For a Sustainable and Resilient Future

SyracuseCoE is New York's Center of Excellence for Environmental and Energy Systems.

SyracuseCoE catalyzes research, development, and demonstrations to accelerate innovations for cleaner energy, healthier buildings, and more resilient communities. Led by Syracuse University, SyracuseCoE engages faculty, students, and industry partners to enable a thriving culture of collaboration for innovative research and product development. We take ideas from the lab to the market and bring market needs to the lab for solutions. The result: advanced technologies that conserve natural resources and promote healthy buildings and cleaner, greener communities. SyracuseCoE is one of 10 Centers of Excellence funded by New York State to foster collaboration between the academic research community and the business sector to develop and commercialize new products and technologies. Each CoE focuses on an emerging high-technology field that is important to the economy of New York State. SyracuseCoE initiatives accelerate entrepreneurship and create jobs in the Central New York region and advance New York State's reputation for excellence in environmental and energy systems around the world.

ON THE COVER

Professors Bess Krietemeyer and Amber Bartosh and former School of Architecture student James Amicone demonstrate how users can gesturally interact with an augmented reality wall in the SyracuseCoE Interactive Design and Visualization Lab to view environmental data such as solar radiation for the city of Syracuse, NY.



It began with a bold idea:

develop Central New York as an internationally known innovation hub for environmental and energy systems. The strategy was to foster collaboration between the region's long-standing industry clusters and researchers at area academic institutions on targeted projects in clean energy and green building technologies. **The result: SyracuseCoE.**

Right from the start, SyracuseCoE has provided experiential learning opportunities for students and entrepreneurial endeavors for faculty on real-world cooperative ventures with academic, industry, and government partners from across the country and the around the world.

SyracuseCoE's state-of-the-art LEED Platinum headquarters facility, opened in 2010, provides not only an iconic landmark on the Syracuse landscape, but a living lab to conceive, test, and demonstrate the latest advances in energy-efficient and green building technologies in both real-world and simulated conditions. It's a place where visionary ideas are conceived and brought to life, a physical manifestation of the innovation ecosystem SyracuseCoE has incubated.

And it's more than space and connections. SyracuseCoE is home to expertise in the research enterprise and commercialization that helps ideas become successful products and businesses. Since 2000, SyracuseCoE has funded more than 150 research, development, and demonstration projects, resulting in more than 1,000 jobs created and retained, 58 patents and licenses reported, and eight new start-up companies founded.

And the bold ideas just keep coming—in the lab and in the marketplace. Read about some of them on the following pages: emerging technologies that continue to improve our built environment and the people who bring them to life.

Building Productivity

SyracuseCoE is home to the Willis H. Carrier Total Indoor Environmental Quality (TIEQ) Lab, a one-of-its-kind facility that enabled what climate expert Joe Romm calls "the seminal green building study of our time." The recent groundbreaking study on "The Impact of Green Buildings on Cognitive Function" (COGfx) found participants' cognitive function not only changed in response to the quality of their indoor environment, but also doubled in environments with enhanced green building ventilation.

The COGfx study "explains the great mystery of why better ventilation increases productivity," says Romm, who heralded the findings at the 2015 Greenbuild International Conference and Expo for providing hard data that demonstrates the health and productivity benefits of green buildings.

Findings from the COGfx study showed that cognitive performance doubled in conditions that replicated green buildings with enhanced ventilation and in some functional areas—including strategy and information usage—nearly tripled. Just as important, quantitative analysis of that increased productivity found that air quality and cost are no longer a trade-off. According to the study, doubling the ventilation rate in typical office buildings can be reached at an estimated annual energy cost of between $14 and $40 per person, depending on location; this investment can result in improved productivity valued at, on average, $6,500 per person per year.

The COGfx study was led by researchers from the T.H. Chan School of Public Health at Harvard University, in collaboration with faculty members from Upstate Medical University and Syracuse University, and was supported by funding from United Technologies Corporation. Experiments were conducted at the TIEQ Lab in the fall of 2014 and results were published in a series of peer-reviewed papers beginning in fall 2015.

The COGfx study has important implications for the design and operation of environmental systems for office environments. "We spend 90 percent of our time indoors. It's logical that this has an outsized impact on our overall health and well-being, as well as productivity," says Joseph Allen, assistant professor and director of the Healthy Buildings Program at the Center for Health and the Global Environment at the Harvard Chan School.

#THECOGFXSTUDY

8%

Increase in employee decision-making performance when ventilation is doubled.

150x

Increase in employee productivity compared to resulting energy costs.

4

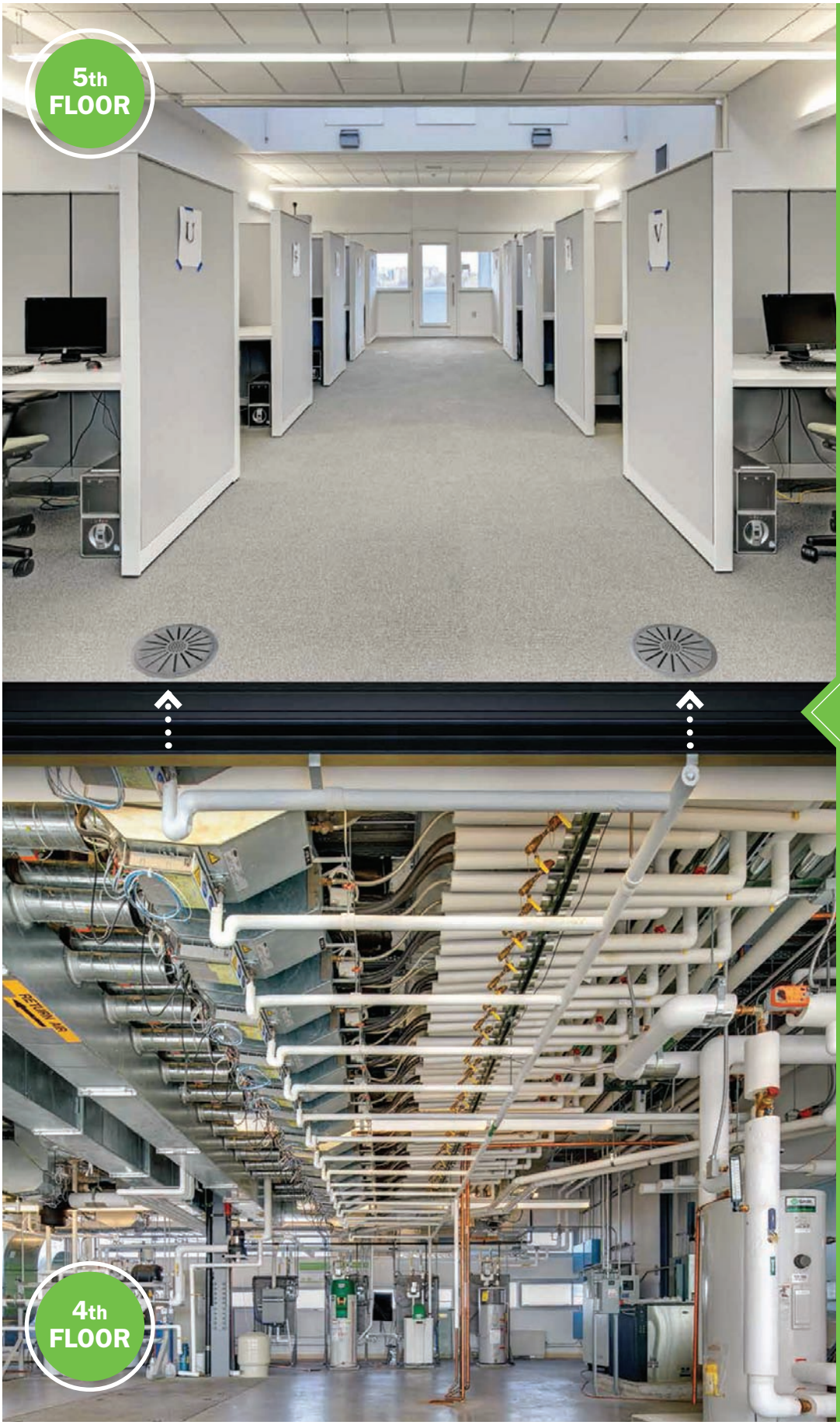
Number of HVAC system strategies utilized: variable air volume; variable air volume with energy recovery ventilator; fan coil unit; and fan coil unit with energy recovery ventilator.

PARTICIPANTS EXPERIENCED:

Significantly better cognitive function

Fewer health symptoms

Better perceived indoor environmental quality

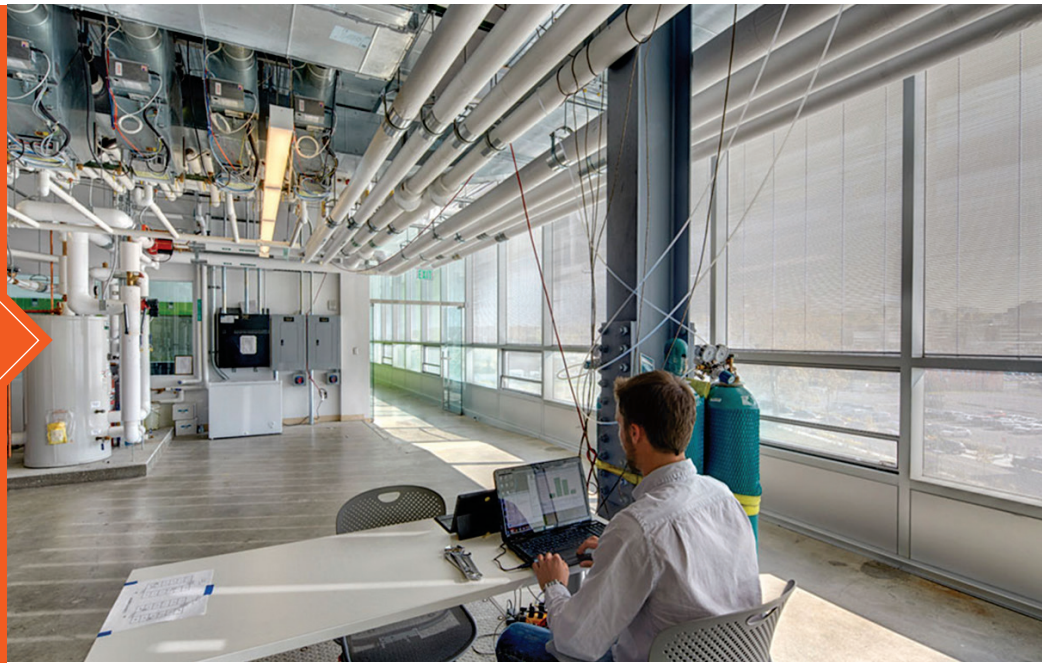


THE PINNACLE OF IEQ TESTING

When SyracuseCoE was conceived, collaborators envisioned pioneering research on indoor environmental quality (IEQ) that would quantify the impacts of IEQ on human health and performance and lead to next-generation technologies to transform the way buildings are heated and cooled.

Drawing on expertise from around the world, the Willis H. Carrier Total Indoor Environmental Quality (TIEQ) Lab was created as the crown jewel of the SyracuseCoE headquarters—a one-of-its-kind facility that enables the study of environmental controls and indoor environment on individuals.

The TIEQ Lab's unique capabilities allow researchers to study how multiple factors—including temperature, humidity, air quality, lighting, and sound—combine to affect human health and performance in built environments. Since 2010, the lab has enabled nearly a dozen major studies, adding to the knowledge base on topics ranging from responsive environmental controls to daylighting to ventilation and the effects of CO2.



Harvard Research Fellow Piers MacNaughton, ScD, collects data during the COGfx study at SyracuseCoE.

The COGfx study was specifically designed to take advantage of the capabilities of the TIEQ Lab. “This study is exactly the kind of pioneering research that we envisioned right from the start,” says Ed Bogucz, SyracuseCoE executive director. “As with many other projects that have been conducted in the TIEQ Lab, the unique capabilities of the facility and the expertise of local researchers familiar with using it attracted collaborators to Central New York.”

The TIEQ Lab consists of two rooms resembling a typical office environment; however, from the floor below, environmental conditions—such as ventilation rate, temperature, humidity, and carbon dioxide concentration—can be controlled with a high degree of precision. “This allowed us to make changes to the indoor environmental quality in the TIEQ Lab while keeping the participants blinded to test conditions,” says Allen.

The COGfx study enlisted 24 professionals from Central New York firms and institutions to relocate to the TIEQ Lab for six days to perform their regular work. Near the end of each workday, they were given a cognitive assessment that evaluated real-world decision-making. Over the course of those six days, the indoor environment was modified to reflect conventional buildings, green buildings, and green buildings with enhanced ventilation.

Not only were participants unaware of changes in environmental conditions, but researchers involved in the cognitive testing were also “blind” to changing conditions as well.

“The double-blind nature of the study strengthens the integrity of our results,” says co-investigator Suresh Santanam, a Syracuse University Professor of engineering and computer science who is an expert in indoor air quality and air pollution control, and director of SU’s Industrial Assessment Center.

Usha Satish, professor of psychiatry and behavioral sciences at Upstate Medical University, led the testing using the Strategic Management Simulation, a highly reliable cognitive testing tool. The computer-based test posed diverse situations based on real-world challenges, allowing users to respond and strategize in their own cognitive style.

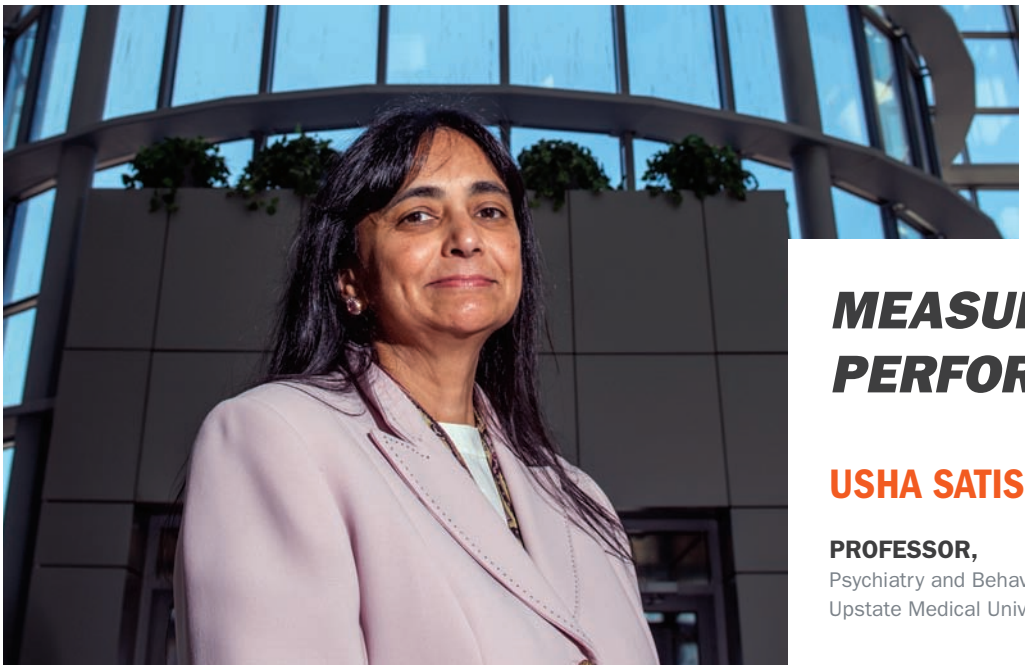
“The simulation scenarios have been validated to replicate people’s daily decision-making,” says Satish.

This study—and the impact its results are expected to bring—is precisely what was anticipated when the lab was conceived.

“Research is a long and costly process,” says Santanam. “It would not have been unusual if it took a decade for published research to have come out of the TIEQ Lab. The impact the lab has made in our knowledge base in a relatively short time is really quite remarkable.”

“We spend 90 percent of our time indoors. It’s logical that this has an outsized impact on our overall health and well-being, as well as productivity.”

JOSEPH ALLEN



MEASURED PERFORMANCE

USHA SATISH, M.P.H., Ph.D.

PROFESSOR,
Psychiatry and Behavioral Sciences,
Upstate Medical University

EXPERTISE: Measuring the impact of environmental conditions on cognitive function.

BACKSTORY: Satish has broad experience using the research tool Strategic Management Simulation (SMS) to study how wide-ranging variables impact cognitive function and real-world productivity, from drugs and alcohol to sleep deprivation to head injuries. In 2006, after completing a study on how various medications for seasonal allergies and rhinitis affect cognitive function, she was sought out by SyracuseCoE to see if her methods might be effective for a forthcoming study on the impact of volatile organic compounds (VOCs) in paint on indoor environments. Satish collaborated on the project, using SMS to evaluate the impact of VOCs on productivity and decision-making and expanded her area of research interest in the process.

SOUND BITE: "Studying the impact of indoor air quality wasn't originally on my radar, but it wasn't out of the realm of imagination either," says Satish. "Whether I'm looking at different levels of alcohol, antihistamines that cause drowsiness, or VOCs—they all have the potential to impact thinking capacity."

SYRACUSECOE CONNECTION: In 2007, SyracuseCoE awarded nearly $300,000 for a two-year project led by Satish in collaboration with researchers at the Lawrence Berkeley National Laboratories to study the implications of low levels of carbon dioxide on people's decision making and perceptions of indoor air quality. In 2009, SyracuseCoE awarded nearly $300,000 for a two-year project led by Satish in collaboration with the Lighting Research Center at Rensselaer Polytechnic Institute to study the impacts of daylighting on human decision making and productivity. Satish was a co-investigator of the 2014 COGfx study, leading the cognitive testing and analysis component. "The SyracuseCoE is a wonderful organization for showcasing the research treasures we have in Upstate New York," she says.

CURRENT PROJECT: Satish is collaborating with Syracuse University engineering professor Jianshun Zhang and King + King Architects to evaluate whether building renovations at Pine Grove Middle School in East Syracuse, New York, impact student learning. Data from SMS taken before and after the renovation under controlled conditions will be used to assess the impact of the built environment on student performance.

Exporting Clean Air to Asia

China's rapid industrialization has come at a cost: The country is afflicted with some of the worst air pollution in the world.

But one Central New York company is improving air quality in China—and throughout Asia—one building at a time.

HealthWay Products manufactures air cleaning and filtration products for homes, businesses, and medical environments. The Pulaski-based company originally developed air cleaners to remove smoke from bars. When legislation banned smoking indoors, the company changed focus, developing proprietary technology to clean air from entire buildings, capturing 99.99 percent of air contaminants.

"The World Health Organization has ranked indoor air quality as a top health concern facing humans," says HealthWay President Vinny Lobdell. "It's beyond smoke and allergens, but ultrafine particles that can cause cardiovascular disease, stroke, and cancer."

HealthWay develops products that clean air at point of use by filtering contaminants generated within a space and at point of entry by cleaning air filtered into a building as part of its HVAC system. Customers include the Cleveland Clinic, Hyatt Hotels, Marriott, Harvard University, Starwood Hotels, Texas Instruments, BMW, Volkswagen, and Crystal Cruises. The company, named to the Inc. 5000 list of fastest growing privately held companies in North America, sells its products in 30 countries.

Asia is the biggest growth market and SyracuseCoE has been an important partner in HealthWay's expansion efforts. In 2013, HealthWay received a $50,000 Commercialization Assistance Program grant from SyracuseCoE to help commercialize and test a disinfecting filtration system specifically for the Asian market. The grant supported the assistance of Syracuse University Professor Jianshun Zhang, who conducted testing of the product.

At the Building Energy and Environmental Systems (BEES) Laboratory in the College of Engineering and Computer Science at Syracuse University, Zhang simulated air pollution to evaluate the filter's performance in cleaning air "breathed in" by building HVAC systems in China.

"That grant was very important in helping us get that product to market," says Lobdell. Installations include BMW corporate headquarters in China, the Saudi Ministry of Health, and hotels throughout Asia.

Lobdell says that product—the 2000 SC—is now the cornerstone of the company's commercial line. In 2015, HealthWay purchased an additional facility in Pulaski to accommodate its manufacture, as well as to bring back other products the company was manufacturing in China, adding approximately 20 jobs to the Central New York region.

"We're really grateful to have an organization like the SyracuseCoE locally," says Lobdell. "Syracuse has become a hub for innovation in indoor air quality because of their efforts, and they continue to help us grow."

"We're really grateful to have an organization like the SyracuseCoE locally. Syracuse has become a hub for innovation in indoor air quality because of their efforts, and they continue to help us grow."

VINNY LOBDELL

HealthWay Disinfecting Filtration System units are packaged for export to China.

99.9%

Amount of harmful microorganisms captured by HealthWay's patented Disinfecting Filtration System

"The World Health Organization has ranked indoor air quality as a top health concern facing humans. It's beyond smoke and allergens, but ultrafine particles that can cause cardiovascular disease, stroke, and cancer."

VINNY LOBDELL

Saving Energy Through Precision Comfort

Heating, ventilation, and air conditioning (HVAC) systems for buildings have traditionally been "one-size-fits-all"—a single thermostat controlling the temperature in an office or classroom. But occupants aren't "one-size-fits-all" in terms of comfort—with this approach, at least 20 percent of occupants are typically dissatisfied with the temperature they experience.

With support from SyracuseCoE, faculty and students at Syracuse University and their collaborators have been working for years to transform HVAC systems through the development of personalized environmental control systems (PECS), that would allow individual occupants to adjust heat and cooling to their own level of comfort. The PECS vision took a big leap forward with the award of a $3.2 million grant from the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E), and companion awards of $319,000 from NYSTAR, and $400,000 from NYSERDA.

The new project responds to an ARPA-E vision for saving energy nationally by localizing thermal management on an individual level while changing the set points for thermostats for large spaces to 66 degrees in winter and 79 degrees in summer (from 70 degrees and 75 degrees respectively). The approach promises to save more than 15 percent of energy used for HVAC nationally, while simultaneously improving occupant comfort and indoor air quality.

NYSTAR Distinguished Professor H. Ezzat Khalifa leads the Syracuse University team that is developing a near-range micro-environmental control system. The system will provide local cooling and heating via a box about the size of medium-tower computer that will fit under an individual's desk. The unit has a high-efficiency micro-vapor compression system with a tiny scroll compressor and an evaporator embedded in a phase-change material. This material will store the cooling or heating produced by the micro-vapor compression system at night, releasing during the day to make occupants more comfortable.

"Buildings consume nearly 40 percent of the energy used in the United States and other industrialized countries," says Khalifa. "Ultimately this transformative technology will create a much more affordable and energy-efficient way to ensure individual occupant comfort."

In addition to researchers at Syracuse University and SyracuseCoE, the three-year project includes partners United Technologies Research Center, Air Innovations, Bush Technical LLC, and Cornell University. The SU team was one of 11 funded nationally. This is the first ARPA-E grant awarded to Syracuse University. SyracuseCoE aided the project team in the development of the proposal and is a key player in the execution of the research, including bringing the technology to market.

"We see a great future for personal environmental control. By reducing the control point to each user, we only condition areas that need conditioning, and to the specific needs of that individual," says Michael Wetzel, president and CEO of Air Innovations. "Not only will this program reduce future energy costs, but it allows individual choice of comfort settings."

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MICHAEL WETZEL

Professor H. Ezzat Khalifa and SyracuseCoE intern Bryan Morris, a Syracuse University engineering undergraduate student, check on the progress of the PECS project in the mechanical space at SyracuseCoE headquarters.

EPHESUS LIGHTING

Lighting a Bright Future

A shift to LED lighting is saving sports teams millions of dollars and improving fan experiences, in large part using products developed and manufactured by Central New York's Ephesus Lighting. Since 2013, Ephesus lighting has been installed at more than 100 sports venues across the United States and Canada, saving an estimated 45-million kilowatts of energy and eliminating 34,000 tons of CO2 from being emitted into the atmosphere.

Ephesus developed an ultra-high performance LED technology with a patented lens design that is 75 percent more energy-efficient than the metal halide lights traditionally used at stadiums, providing fuller illumination and casting fewer shadows. And at much less cost—the average arena installation reduces energy costs by up to 85 percent, bringing a return on investment in less than five years.

Since entering the sports LED market, Ephesus' revenue has grown an average of more than 300 percent in each of the last three years. "We wouldn't be where we are today without SyracuseCoE," says Joe Casper, who founded the company in 2010 with his wife, Amy.

The Caspers had worked for advanced technology companies across the United States, including Lockheed Martin in Syracuse and Motorola. They returned to Central New York with a vision to translate their combined expertise in semiconductor design and production to develop new energy-efficient technologies in LED lighting. Casper sought out Ed Bogucz at SyracuseCoE, who in turn connected the Caspers to a broad array of resources, including business incubation, potential research and development collaborators, and other services to develop, test, and commercialize their innovative, energy-efficient lighting products.

In 2012, Ephesus won a Commercialization Assistance Program award from SyracuseCoE that enabled the company to develop its own patented LED chip using gallium nitride on diamond. Subsequently, Ephesus developed an LED light for sports arenas that was installed at the historic War Memorial Arena at The Oncenter, home of the Syracuse Crunch of the American Hockey League.

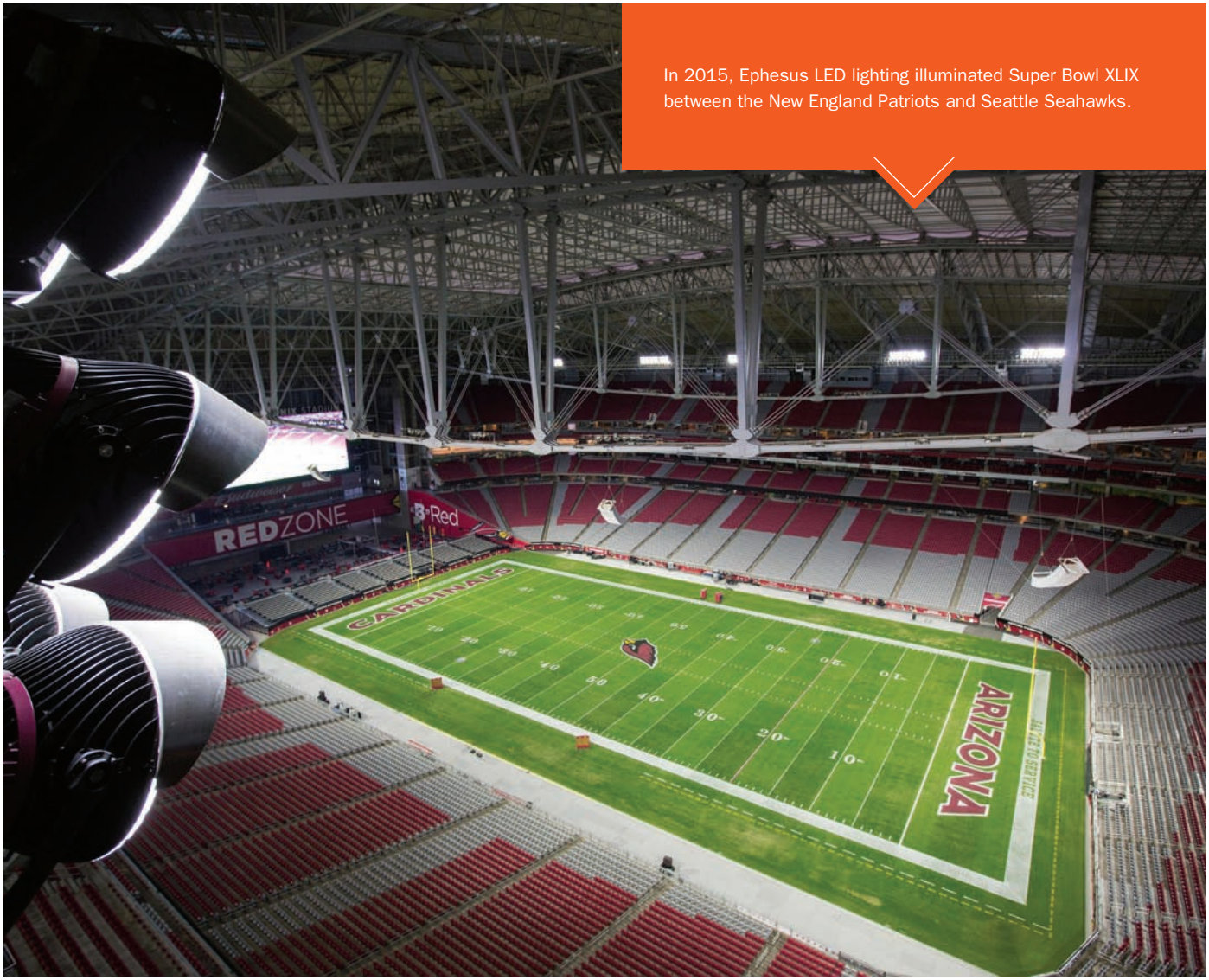
In 2014, Ephesus developed a next-generation light suitable for large stadiums; the performance of the first prototype was tested successfully at SyracuseCoE headquarters in May. The first installation of the new light was the University of Phoenix Stadium, which hosted the Super Bowl in February 2015. That exposure led to a jump in sales. "Every new venue will be built with LED," says Casper, adding that stadium and arena lighting is just one aspect of business. Ephesus has also developed lighting for industrial and commercial use and for broadcasting. And that's just the beginning.

"The intellectual collisions that happen at SyracuseCoE spawn a lot of new ideas," says Casper.

In October 2015, Ephesus Lighting was purchased by Eaton Corporation, a global technology leader in power management solutions.

"We wouldn't be where we are today without SyracuseCoE."

JOE CASPER



In 2015, Ephesus LED lighting illuminated Super Bowl XLIX between the New England Patriots and Seattle Seahawks.

SyracuseCoE served as the testbed for Ephesus' first outdoor stadium prototype LED fixture, providing performance data needed to scale up production. The fixtures are now installed at stadiums around the U.S. and Canada.

AM-TEC ANALYSIS AND DESIGN CENTER

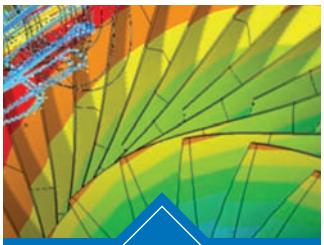
Virtual Production

In a lab on the third floor at SyracuseCoE headquarters, a group of Syracuse University graduate students works on a prototype for a heat exchanger that transfers heat with a low-pressure draw. Later that afternoon, another team will work on a structural analysis of a low-vibration cryorefrigeration system in an attempt to find ways to reduce the vibration level even further.

They're working in the Analysis and Design Center, a NYSERDA funded resource created to assist firms in Central New York's thermal and environmental control cluster accelerate development of innovative products. Under the supervision of faculty members from Syracuse University's College of Engineering and Computer Science, these students are helping solve real-world problems for AM-TEC companies such as Cryomech, a world leader in cryorefrigeration and helium recovery systems.

"As a small company, we have limited manpower," says Chao Wang, Ph.D., director of research and development at Cryomech. "Collaborating with the resources at Syracuse University and SyracuseCoE gives us research and development capabilities we just don't have on our own."

That's where the Analysis and Design Center comes in. The center provides AM-TEC companies with assistance from a team of specially trained students from Syracuse University's College of Engineering and Computer Science, who work under the supervision of faculty members. The students perform analysis and design using software for computational fluid dynamics or finite-element analysis.



The goal of the AM-TEC Analysis and Design Center is to help companies introduce products to market faster by assisting firms with product design challenges.

In addition to helping AM-TEC manufacturers develop new products, the Analysis and Design Center also benefits the students who are engaged. "By getting to work on problems not 'well-posed' in classroom homework or an exam, students have to make their own assumptions to solve the problem," says Thong Dang, professor of mechanical and aerospace engineering at Syracuse University.

One of those students is Pratik Manandhar, a master's student in mechanical and aerospace engineering at Syracuse University, who has worked on projects for Ekostinger and Kohilo Wind. "Working in the Analysis and Design Center has provided me with an excellent opportunity to work hands-on in a professional environment and gain practical experience in implementing classroom knowledge to solve real-life problems," he says. "In addition, attending meetings and interacting with company professionals has also helped me learn how to communicate effectively and will help me make a smooth transition from academia to industry."

"Working in the Analysis and Design Center has provided me with an excellent opportunity to work hands-on in a professional environment and gain practical experience in implementing classroom knowledge to solve real-life problems."

PRATIK MANANDHAR

During summer 2016, seven engineering students from Syracuse and Clarkson universities participated in NYSERDA-supported engineering internships with six AM-TEC firms, getting valuable experience applying their education to manufacturers' analysis and design production needs and by working with the specially trained SU faculty and graduate students at the Analysis and Design Center.

WHAT IS AM-TEC?

THE ADVANCED MANUFACTURING FOR THERMAL AND ENVIRONMENTAL CONTROLS SYSTEMS (AM-TEC) project is a four-year, $3.2-million regional initiative that provides a broad range of targeted economic development assistance to small, medium, and large manufacturers and suppliers of thermal and environmental control (TEC) equipment in Central New York.

AM-TEC is led by SyracuseCoE in partnership with CenterState Corporation for Economic Opportunity, Manufacturers Association of Central New York, NYSTAR, Technology Development Organization of Central New York, SUNY College of Environmental Science and Forestry, and the Small Business Development Center at Onondaga Community College.

AM·TEC
ADVANCED MANUFACTURING
THERMAL AND ENVIRONMENTAL CONTROLS

SUNY-ESF BIOFUELS PILOT PLANT

Commercializing Renewable Energy

For 30 years, researchers at SyracuseCoE academic Partner SUNY College of Environmental Science and Forestry (ESF) have studied new forms of renewable energy. In the Department of Paper and Bioprocess Engineering, researchers use sugars derived from willow biomass to create biofuels with very low greenhouse gas emissions that will replace their fossil fuel counterparts.

That research moved from the lab bench to production scale with the opening of the SUNY-ESF Biofuels Pilot Plant at SyracuseCoE in 2015. "We want to make the same portfolio of products you can make from fossil fuels," says Art Stipanovic, ESF professor of chemistry and director of the Pilot Plant.

The new facility is a small-scale, commercial grade pilot plant that allows researchers to scale up the size of their production significantly, so that they can develop and demonstrate processes that will evolve into full-scale commercial production.

"Equipment like this is hard to find," adds Thomas Amidon, professor and chair of paper and bioprocess engineering at ESF. "It's too small for most manufacturers but too big for almost anywhere else. You'd rarely find this on a college campus."

The Pilot Plant includes a 1000-Liter fermenter that creates an optimal environment for microorganisms to convert wood-based sugars to fuels such as ethanol and butanol, and a 30-gallon-per-hour distillation column to distill the biofuels produced in the fermenter to high purity fuels suitable for testing in engines.

The facility provides a more robust learning and research environment in a real-world setting. "The goal is to move science into a technology and then into a commercial business," says Amidon.

That's already happening.

New companies that have originated from ESF's research include Avatar Sustainable Technologies, founded by Bhavin Bhayani, Ph.D., and Bandaru V. Ramarao, professor of paper and bioprocess engineering at ESF and director of the Empire State Paper Research Insitute.

It was during an internship at a paper mill while an ESF doctoral student that Bhayani had his aha moment. "There was a tremendous amount of paper waste that was already beaten and pulped," he says.

Bhayani saw this cellulosic waste as a readymade option for producing the sugars needed for fermentation to biofuels.

He and Ramarao, his doctoral advisor, received NYSERDA funding to develop and demonstrate the concept on a lab scale. Bhayani also won $10,000 from SyracuseCoE in Syracuse University's RvD IDEA student competition in 2013; the award served as a catalyst to start Avatar Sustainable Technologies to commercialize its proprietary technology for producing fermentable sugars for bioproducts industries.

"Different biofuels and bio-plastics require different qualities of sugar. We're working with people in academia, at the paper mills, and biofuels companies to make sure our processes are in alignment with their requirements," he says.

In addition to continued use of the ESF Pilot Plant, SyracuseCoE provides the firm with office space, funding through a $25,000 Innovation Fund award, and guidance in commercialization.

"It would be very difficult to do this without the support of SyracuseCoE," Bhayani says.

"The goal is to move science into a technology and then into a commercial business."

THOMAS AMIDON

The SUNY-ESF Biofuels Pilot Plant at SyracuseCoE is a key facility in the production of next-generation bio-based fuels derived from renewable resources such as locally grown woody feedstocks including planation-grown willow, switchgrass, and forest-based biomass. The facility includes a 1000-liter fermenter in which microorganisms will convert wood-based sugars to fuels such as ethanol and butanol and a 30-gallon-per-hour distillation column to distill biofuels produced in the fermenter to high-purity fuels suitable for testing in actual engines.

Designing Cities for Comfort

TAREK RAKHA, Ph.D.

ASSISTANT PROFESSOR,
School of Architecture,
Syracuse University

FACULTY FELLOW,
SyracuseCoE

EXPERTISE: Modeling urban energy flows and human-powered mobility; daylighting and energy in building technology applications; the use of unmanned drones for building performance inspections.

RESEARCH PROBLEM: Designing cities for pedestrian comfort. Rakha's work on sustainable urban mobility looks at how weather conditions and the built environment influence walking and biking in urban communities. "It's about planning for thermal and visual comfort under predictable conditions, such as cold winters and hot summers," says Rakha.

BACKSTORY: Rakha's doctoral dissertation from MIT focused on comfortable and walkable cities. He was also part of a research team that developed a citywide building energy model for Boston, which estimated the gas and electricity demand of every building in Boston.

SYRACUSECOE CONNECTION: Rakha was attracted to Syracuse University, in part, because of the resources available through SyracuseCoE. "I was excited about the kind of support I could get here that I couldn't get anywhere else," says Rakha. That includes networking, access to industry partners, lab space to develop research activities, and assistance with grant proposals. Prior to the official start of his faculty position, SyracuseCoE helped Rakha submit a proposal in response to a solicitation from NYSERDA. The proposal was funded, supporting a study of sustainable transportation alternatives in Syracuse. Subsequently, SyracuseCoE assisted Rakha develop a proposal to SageGlass for a study of daylighting and energy in buildings; he also is using space in the SyracuseCoE lab wing to test his drone with various sensors.

LAB TO MARKET: Rakha's NYSERDA-funded study examines the walkability and bikeability of downtown Syracuse, including outdoor thermal comfort, as well as sharing economy technologies in the City of Syracuse (e.g., bike and car sharing), and public transit and regional relationships between Syracuse and Central New York. "SyracuseCoE has relationships with all the relevant stakeholders so whatever outcomes we present from our feasibility study will directly link to each of them," says Rakha.

"I was excited about the kind of support I could get here that I couldn't get anywhere else."

TAREK RAKHA

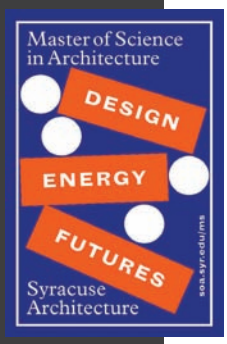
The Feasibility Assessment of Sustainable Transportation (FAST: Syracuse) project studies the feasibility of achieving reductions in greenhouse gas (GHG) emissions in the City of Syracuse via interventions that are designed to increase walking and biking, shared vehicles, and the use of public transportation.

DESIGN | ENERGY | FUTURES

THE SYRACUSE UNIVERSITY SCHOOL OF ARCHITECTURE has launched a post-professional master's program, Design | Energy | Futures, that focuses on energy and the built environment, with research and design projects ranging across many scales—from urban design to high-performance buildings. SyracuseCoE is supporting the three-semester program, which is intended for individuals with a professional degree in architecture, landscape architecture, urban design, or urban planning. The program will pair students to work on the research projects of affiliated faculty members, which include Tarek Rakha and Bess Krietemeyer.

"Both the educational and professional landscapes of architecture are in the midst of exciting changes," says School of Architecture graduate chair Brian Lonsway. "Our new Design | Energy | Futures M.S. degree helps move us to the forefront of these changes, especially as we look towards preparing students for the increasingly complex and multidisciplinary project of architecture."

Ed Bogucz, executive director of SyracuseCoE, serves on the program's international advisory board. "The new program is symbiotic with the goals of SyracuseCoE," says Bogucz. "Our synergy will undoubtedly provide mutual benefit."



Interacting with the Built Environment

BESS KRIETEMEYER, Ph.D.

ASSISTANT PROFESSOR,
School of Architecture,
Syracuse University

FACULTY FELLOW,
SyracuseCoE

EXPERTISE: Emerging material technologies, human interaction, and computational simulations influencing the design of sustainable built environments.

BACKSTORY: As a doctoral student at Rensselaer Polytechnic Institute, Krietemeyer was part of a team that developed an innovative facade system installed at the SyracuseCoE headquarters as a demonstration project. After she joined the faculty of the Syracuse University School of Architecture, she turned to SyracuseCoE as a natural partner for assistance with developing her own research projects.

SYRACUSECOE CONNECTION: Krietemeyer leads the Interactive Design and Visualization Lab at SyracuseCoE, where she conducts interdisciplinary research on advanced building technologies and human interaction using immersive simulation techniques. “The lab is intended to support different systems being tested in the building,” she says. “A lot of the work I do explores reactive facade systems that respond to weather conditions and people’s movements within a space. These products are often too expensive to prototype at a large scale, but we absolutely need to know what they’re going to look like and how they behave with building inhabitants. By using simulation in the lab, we can explore a range of design, engineering, and human factors issues and make modifications early on.”

LAB REPORT: With funding provided by SyracuseCoE, Krietemeyer is developing a computational tool that combines traditional energy analysis with virtual reality tools. The project includes collaboration with fellow Syracuse University School of Architecture Professor Amber Bartosh, Syracuse University College of Engineering and Computer Science Professor Jianshun Zhang, and visual artist Lorne Covington. “We’re conducting energy analysis and translating that information into dynamic, spatial, 3-D visualizations so we can virtually experience energy flows within a building in an interactive way,” Krietemeyer says.

EXTRA CREDIT: Another aspect of the project examines energy flows at the urban scale. Krietemeyer has created what she calls a “Projective Urban Design Laboratory” using a scale model of the City of Syracuse that she uses to project dynamic energy information onto—data ranging from light pollution to solar radiation—to better visualize ambient energy flows in the city that are typically invisible. The interactive display has been installed at the Museum of Science and Technology (MOST) in Syracuse. “We want to extend this research outside of the lab so we can engage a much wider audience,” Krietemeyer says. “We’re hoping end users and stakeholders will make use of it for potential design decisions for the city.”

"We're conducting energy analysis and translating that information into dynamic, spatial, 3-D visualizations so we can virtually experience energy flows within a building in an interactive way"

BESS KRIETEMEYER

Professor Krietemeyer's Projective Urban Design Laboratory uses a scale model of the City of Syracuse to help visualize energy flows that are typically invisible.

Enabling New Combustion System Development

BEN AKIH-KUMGEH, Ph.D.

ASSISTANT PROFESSOR,
Mechanical and Aerospace Engineering, College of Engineering and Computer Science, Syracuse University

FACULTY FELLOW,
SyracuseCoE

EXPERTISE: Aerodynamics and propulsion, energy conversion and heat transfer, and fluid mechanics.

RESEARCH PROBLEM: Enabling the design of advanced combustion systems through models of renewable and clean fuels to contribute to a more sustainable energy economy. Akih-Kumgeh uses experiments and computations to study the physical and chemical processes that occur during energy conversion with a special focus on the combustion behavior of alternative fuels.

SYRACUSECOE CONNECTION: Akih-Kumgeh directs Syracuse University's Thermodynamics and Combustion Lab, located in the lab wing at SyracuseCoE. He designed the lab, which has been operational since December 2014, specifically to accommodate the 10-meter shock tube used in combustion experiments, as well as equipment to investigate flame propagation. SyracuseCoE provided funding that enabled him to purchase a laser used to quantify pollutant formation during combustion events. "Combustion research is not only concerned with engines but also with its effects on the environment. Our location at SyracuseCoE is of great benefit to my students; they can put their research in the broader context of energy and environmental systems," Akih-Kumgeh says.

RESEARCH METHOD: The shock tube allows Akih-Kumgeh and his students to create very clean conditions of high temperature and pressure to characterize the ignition behavior of promising fuels. Engines operate at various conditions and the research focuses on how these conditions affect ignition. Physical experiments are used to test and improve mathematical models that can predict ignition behavior under a wide number of conditions, eliminating the need to build expensive experiments to test every condition. "Computational analysis of complex processes like combustion allows you to reduce the amount of time needed to develop or modify a cleaner and more efficient engine," Akih-Kumgeh says.

Akih-Kumgeh's team is also studying the chemical compounds formed during the combustion process—such as carbon monoxide—including how much remains once the combustion process has finished. "We can quantify and compare the emissions of different fuels with the idea of reducing the emission of carbon monoxide into the environment," he says.

LAB TO MARKET: Akih-Kumgeh says the same combustion principles that apply to automobiles, jet engines, and rockets can be applied to boilers and residential furnaces that use natural gas. "If you want to increase the use of biofuels inside these systems, then you need to know how the combustion behavior would change and make sure the emissions from that particular modification are within the required limits," he says.

"Combustion research is not only concerned with engines but also with its effects on the environment. Our location at SyracuseCoE is of great benefit to my students; they can put their research in the broader context of energy and environmental systems."

BEN AKIH-KUMGEH

Professor Akih-Kumgeh and his students utilize a 10-foot shock tube on research that investigates combustion properties of alternative and conventional fuels. Their aim is improving energy conversion efficiencies and reducing emissions of harmful byproducts.

Operating Off the Grid

JEONGMIN AHN, Ph.D.

ASSOCIATE PROFESSOR,
Mechanical and Aerospace Engineering, College of Engineering and Computer Science, Syracuse University

FACULTY FELLOW,
SyracuseCoE

RESEARCH PROBLEM: Develop alternative energy technologies that improve current thermal systems while reducing harmful emissions by furthering the understanding and application of fuel cells in the energy field.

LAB TO MARKET: Ahn and his research group are experimenting with flame-assisted fuel cells to convert chemical reaction with heat directly to electricity. The idea is to modify existing home furnace/boiler systems with flame-assisted fuel cells that could generate electricity while generating heat, allowing it to run off grid. “If you lose power, your furnace/boiler could still be operated to supply heat and hot water and also generate enough electricity to run your lights and your refrigerator,” Ahn says. When the power is on, the flame-assisted fuel cell technology can offset residential electrical loads up to 20 percent during peak hours of operation, reducing demand on the grid and the electric bill. “Flame-assisted fuel cell technology has the potential to provide a resilient and efficient solution for residents during power interruptions,” says Ahn, who has received interest from potential commercial partners. He has six patents issued or pending related to fuel-cell technology.

SYRACUSECOE CONNECTION: Ahn runs Syracuse University’s Combustion and Energy Research (COMER) Lab, which is located at SyracuseCoE. The new 1,500-square-foot lab was designed by Ahn and is equipped with state-of the-art instrumentation specifically to fabricate fuel cells, batteries, and other electrochemical devices and to characterize and test them with thermo-chemical systems. In 2013, Ahn received funding from SyracuseCoE’s AM-TEC initiative, allowing him to demonstrate proof-of-concept of the flame-assisted fuel cell and to publish several papers. Subsequently, he has received SyracuseCoE assistance with additional funding proposals; most recently, he won a competitive award from NYSERDA to advance the project.

EXTRA CREDIT: Ahn teaches a Syracuse University course on Fuel Cell Science and Technology for both undergraduate and graduate engineering students, one of the few of its kind in the country. The class is held at SyracuseCoE, including time spent in classroom space and in his lab. “Students go to my lab and actually fabricate and test their own fuel cells,” he explains. “It gives them hands-on learning experience working on real-world problems.”

"Students go to my lab and actually fabricate and test their own fuel cells. It gives them hands-on learning experience working on real-world problems."

JEONGMIN AHN

Professsor Ahn's vision is to develop alternative energy technologies that improve current thermal systems while reducing harmful emissions. He currently works with Syracuse University graduate students on research involving solid oxide fuel cell system design, oxy-fuel combustion membranes, and thermal transpiration based propulsion.

Better Boiling for Faster Heat

SHALABH MAROO, Ph.D.

ASSISTANT PROFESSOR,
Mechanical and Aerospace Engineering, College of Engineering and Computer Science, Syracuse University

FACULTY FELLOW,
SyracuseCoE

EXPERTISE: Energy conversion and heat transfer; Maroo heads Syracuse University's Multiscale Research and Engineering Lab.

RESEARCH PROBLEM: Reducing energy consumption and improving performance of manufactured goods through development of nanomaterials that lead to faster heat transfer.

BACKSTORY: Maroo's research hinges on fundamentally changing the boiling process. Experimenting with different nano/micro patterns on silicon and silicon-dioxide surfaces, Maroo and his team found they could increase the bubbles forming on the surface of boiling water, increasing heat transfer compared to smooth heating surfaces. With funding from SyracuseCoE's AM-TEC initiative, the team was able to define the critical height of the surface pattern to optimize heat transfer, increasing heat transfer by 120 percent.

SYRACUSECOE CONNECTION: Maroo received $100,000 from SyracuseCoE in 2013 under an award from the U.S. Department of Energy in support of a regional initiative to strengthen Central New York's cluster of Advanced Manufacturers for Thermal and Environmental Controls (AM-TEC). "That funding allowed us to demonstrate our experimental capabilities, leading to additional support for new research," says Maroo.

LAB REPORT: Maroo is studying how the surface pattern developed under the AM-TEC award can be used within boiler systems to improve heating and save energy costs. Another area of research focuses on cooling of electronics. Maroo received an NSF CAREER Award in 2015 to investigate the fundamental physics associated with nanoscale meniscus evaporation and passive liquid flow to remove large amounts of heat from surfaces in very short amounts of time. Eventually, this knowledge could be applied to achieve next-generation heat exchangers for thermal management of electronics and renewable energy technologies such as concentrated solar photovoltaic cells.

AHA MOMENT: Studying the boiling process, Maroo's research group has created a single vapor bubble in a pool of liquid that can remain stable on a surface for hours, instead of milliseconds. "This will help us understand and predict the boiling process further so we can design structures and surfaces accordingly," he says.

"This will help us understand and predict the boiling process further so we can design structures and surfaces accordingly."

SHALABH MAROO

Maroo and his research group design, fabricate, and test nano-devices with the hope of applying knowledge gained to achieve next-generation heat exchangers for thermal management of electronics and renewable energy technologies, such as concentrated solar photovoltaic cells.

The Labs at SyracuseCoE

COMBUSTION AND ENERGY RESEARCH (COMER)

1

The COMER Lab's vision is to develop alternative energy technologies that improve current thermal systems while reducing harmful emissions. Solid oxide fuel cell system design, oxy-fuel combustion membranes, and thermal transpiration based propulsion devices are some of the major focuses in this laboratory.

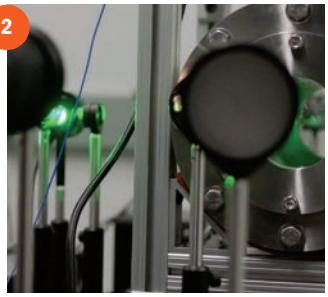
INTERACTIVE DESIGN AND VISUALIZATION LAB

5

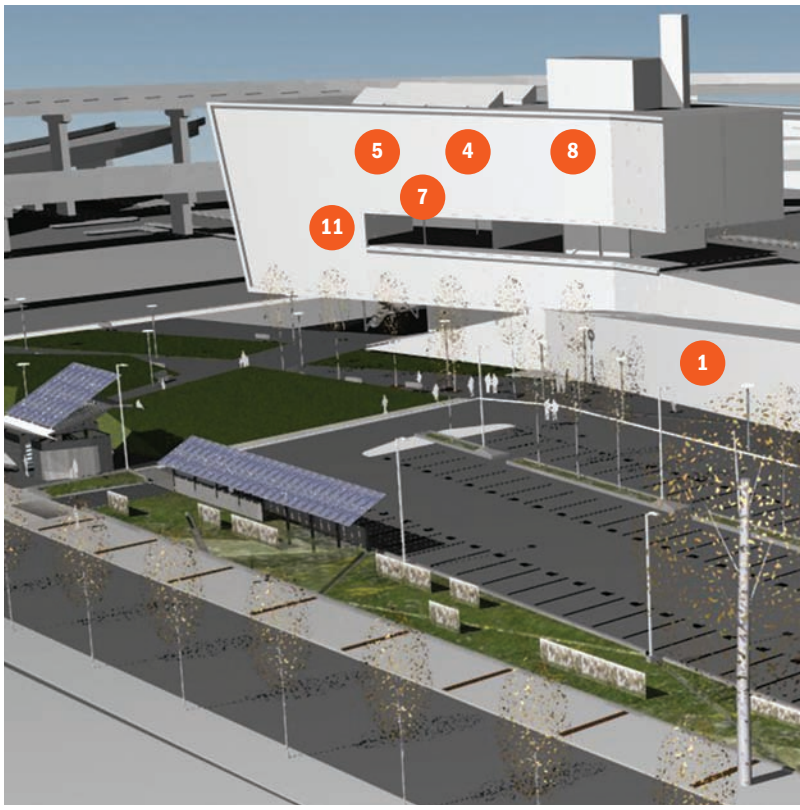
The Interactive Design and Visualization Lab is an immersive design environment for simulating a dynamically responsive building envelope system. The lab supports visualization techniques ranging from digital projections to immersive virtual reality technologies to investigate high-performance building materials, systems, and spaces.

THERMODYNAMICS AND COMBUSTION LAB (TCL)

2

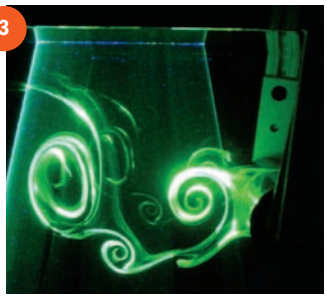


The TCL investigates combustion properties of alternative and conventional fuels with the aim of improving energy conversion efficiencies and reducing emissions of harmful byproducts.



FLOW VISUALIZATION LAB

3



The Flow Lab studies the dynamics in vortex-dominated hydrodynamic flow fields. This work examines the interaction of static structures with a freestream flow for applications in civil engineering and aircraft structures. The lab also investigates complex flow fields such as the oscillation of wings, fins, and flukes for swimming and flying.

WILLIS H. CARRIER TOTAL INDOOR ENVIRONMENTAL QUALITY (TIEQ) LAB

4

SyracuseCoE is known around the world for the unique capabilities of this lab to study the impact of total indoor environmental quality (TIEQ). Factors such as the air temperature, humidity, air quality, lighting, and sound are tested to measure their influence on human performance in offices, schools and other settings.

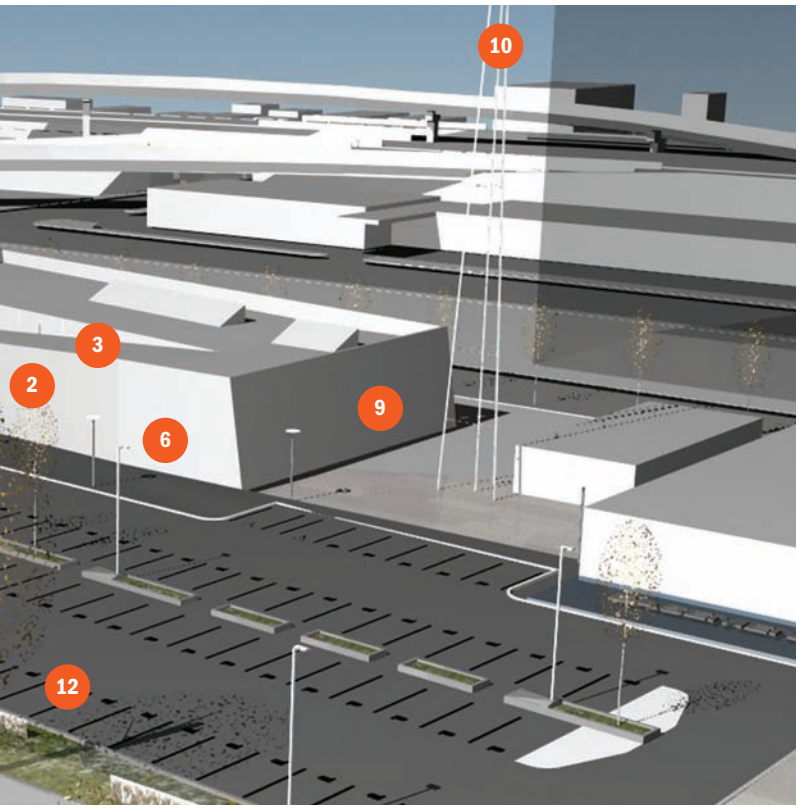
BUILDING ENVELOPE SYSTEM TECHNOLOGY (BEST) TESTBED

6

The BEST Testbed is a 16-foot high and 8-foot wide opening in the south face of SyracuseCoE's headquarters used to evaluate new building envelope systems in a "real building." The current installation demonstrates a mechanism that tracks the sun through the course of a day, producing electricity, hot water, and daylight for occupants.

BUILDING ENERGY AND ENVIRONMENTAL SYSTEMS (BEES) TESTBED

Complementing the first-of-a-kind BEES Lab at Syracuse University's College of Engineering and Computer Science, the BEES Testbed at SyracuseCoE provides "plug-and-play" capabilities for prototypes of new heating, ventilation, and air conditioning (HVAC) systems and domestic hot water heating technologies.



SMART TRANSPORTATION TESTBED

The Smart Transportation Testbed offers researchers opportunities to explore projects involving photovoltaic arrays, electric grid systems, vehicle charging stations, alternative transportation, including human-powered mobility and the sharing economy, as well as green infrastructure systems and storm water containment.

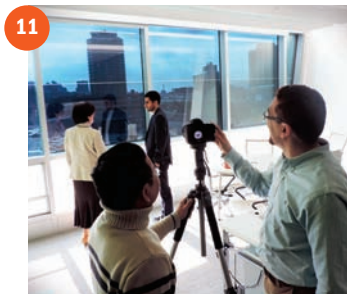
SUNY ESF BIOFUELS PILOT PLANT

The SUNY-ESF Biofuels Pilot Plant is a key facility in the production of next-generation bio-based fuels derived from renewable resources such as locally grown woody feedstocks, including plantation-grown willow, switchgrass, and forest-based biomass.

URBAN ECOSYSTEM OBSERVATORY

A 150-foot tower at SyracuseCoE is extensively instrumented to measure temperature, humidity, air quality, wind speed, wind direction, and traffic on Interstates 81 and 690 (including vehicle speed, type, and number of vehicles). The tower provides detailed information about the impacts of urban activities on air quality and other factors.

TOTAL INDOOR EVIRONMENTAL QUALITY OFFICE TESTBED



Complementing the TIEQ Lab, the existing SyracuseCoE office space also serves as a testbed for new energy-efficient technologies, including HVAC, lighting, and acoustics. An electrochromic window project demonstrates the interactions among daylighting, occupant comfort, and energy used for lighting, heating and cooling.

GREEN INFRASTRUCTURE TESTBED

SyracuseCoE partners conduct research on several green infrastructure typologies, including the Smart Transportation Testbed and the green roof. The aim is to understand the hydrologic performance, ecosystem interactions, and functional limitations, as well as demonstrate storm water quality and quantity management.

New SyracuseCoE Labs

INTERMODAL TRANSPORTATION CENTER (ITC)

LOCATED ON a remediated brownfield site, this facility provides easy access to the Connective Corridor bus and other Centro routes, for anyone traveling between the Syracuse University campus and other Greater Syracuse destinations.

- Parking lot for 99 vehicles
- Pavillion bus shelter
- Drinking fountain with water bottle filling station
- Digital display

Environmental Features

- Storm water management basin
- Bike racks
- Six spots for charging electric vehicles
- Photovoltaic array

UNMANNED AERIAL VEHICLE LAB

THE UNMANNED AERIAL VEHICLE LAB, directed by Amit Sanyal, associate professor of mechanical and aerospace engineering at Syracuse University, provides complete testing facilities for autonomous guidance, navigation, and control of unmanned aerial vehicles (UAV)s in an indoor environment. The lab is equipped with a sophisticated optical tracking system and decentralized wireless ad hoc network (WANET) for real-time telemetry, making it a state-of-the-art test facility to develop autonomous navigation and control of UAVs using onboard sensors and actuators without external navigation aids like GPS or known beacons. The lab will be used to test both single vehicles and multi-vehicle formation and synchronization maneuvers.

SyracuseCoE Partners

ACADEMIC PARTNERS

Syracuse University

SUNY College of Environmental Science and Forestry

SUNY Upstate Medical University

INDUSTRY PARTNERS

Carrier Corporation

Corning

Engie

Hitachi America

King+King

National Grid

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SRC

AFFILIATE PARTNERS

Air Innovations

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LED Spirit, Inc.

Pelitex

Solstice Power

SparkCharge

Standard Hydrogen Corporation

WexEnergy

Windsor Wood

Wireless Grids

CREDITS Kerrie Marshall, Erdy McHenry Architecture, Steve Sartori, Jim Scherzi, Derek Shin, Ben Vollmer, Charles Wainwright

The SyracuseCoE Partner Program

The Partners of SyracuseCoE join a vibrant network of businesses and academic institutions working together to accelerate the commercialization of environmental and energy innovations for a sustainable future.

Learn more at syracusecoe.syr.edu

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