



Building Energy Smart Technologies Research Center

July 2023 Newsletter

Updates from the BEST Center

Industry Advisory Board (IAB) Recruiting Update

We are happy to announce that three organizations joined the BEST Center as affiliate members this summer. Based in Denver, CO, [Group14 Engineering](#) is a “consulting firm committed to improving the energy and resource efficiency of buildings.” Started in London in 1990, [Atelier Ten](#) is a global leader in environmental design. [Mead & Hunt](#) provide wide ranging planning, architecture design, engineering, and environmental and construction administration services across a breadth of market sectors, including transportation, renewable energy, and municipal infrastructure.

We look forward to connecting with Group14 Engineering, Atelier 10, and Mead & Hunt representatives during upcoming virtual meetings and at the fall IAB meeting in New York City scheduled for November 30-December 1, 2023.

If you have connections with or ideas for prospective IAB members, please contact the BEST Center Manager, Nick Clements (nicholas.clements@colorado.edu).

Website Updates

The BEST Center website (<https://best-iucrc.org/>) is updated! On the newly designed site you will find updated membership information and recruiting materials ([flyer](#) and [overview slides](#)), a summary of the center’s research themes, links to research labs and capabilities, and an updated “people” page including student researcher profiles.

Shared research products, such as manuscripts, reports, posters, and presentations, are available to IAB members via the members only section. As projects funded last year wrap up, shared research products will be uploaded to the “Projects 2022-2023” page in the IAB Members dropdown menu. If you have not yet registered and are a member of an IAB organization, please register as a “subscriber” at this [link](#) to access shared research products and other resources available to IAB members.

Fall Student Recruiting

- **BEST Center Student Resume Books:** We have started gathering resumes/CVs from graduate students working on BEST Center research, and once the fall semester begins, we will begin compiling resumes/CVs from undergraduates and graduates across engineering disciplines interested in working in the building industry. We anticipate resume books will be available to IAB members in September 2023.
- **[CU Boulder Career Fairs:](#)**

- The STEM Buffs Career and Internship Fair is scheduled for October 3-4, 2023 ([Day 1](#), [Day 2](#)). A Handshake account is required to register as an employer for these events. The basic for-profit registration fee is \$495 and includes a booth in a room adjacent to the main area, 4 representatives, 4 parking passes, 4 lunch tickets, and a 6'x30" table with tablecloth. For \$545, the above benefits are included, and your booth would be in the main area ([Glenn Miller Ballroom](#)). Additional sponsorship packages can be found on Handshake. Contact Kate Ufer (kathryn.ufer@colorado.edu) with any questions.
- The in-person [Civil, Environmental, and Architectural Engineering \(CEAE\) Fall career fair](#) is scheduled for September 27, 2023. Registration is currently sold out for Engineering/Consulting companies, but if you are interested in joining the waitlist, please contact Nick Clements (nicholas.clements@colorado.edu). There are still spots available for Construction companies (\$575 registration fee). A virtual CEAE career fair is planned for spring 2024. The Engineering/Consulting session filled up in less than 48 hours this year, so we'll be sure to distribute information regarding next year's fair well in advance so our IAB members can register to attend.
- **CCNY Career Fair:**
 - The CCNY [STEM Career Fair](#) is scheduled for October 5, 2023 from 12-4PM ET. The registration fee is \$300. Contact the CCNY [Career & Professional Development Institute](#) with questions (cpdi@ccny.cuny.edu).
- **University at Albany Career Fair:**
 - The UA [Technology and Science Job & Internship Fair](#) is scheduled for October 4, 2023 from 10AM-3PM ET. A Handshake account is required to register as an employer for this event. Contact the UA Career and Professional Development team with questions (career@albany.edu).

If you are interested in registering for a career fair, please contact the BEST Center manager, Nick Clements (nicholas.clements@colorado.edu) to learn more about registration fee discounts available to BEST Center IAB members.

Student Highlight: [Geoffrey Turbeville, CCNY](#)

1. Tell us about your background and how you got to where you are today.

Before attending City College, I worked as a plumber in NYC for close to ten years. The Master Plumber I worked under had previously been a PE and received his bachelor's in mechanical engineering from CCNY in the late 80's. He recommended that I pursue engineering and encouraged me to begin taking classes while working. I am a lifelong New Yorker.



2. What got you interested in research, and why are you interested in the BEST Center research you are doing?

I honestly never imagined myself participating in research until a call went out among undergraduate ME students asking if anyone had prior plumbing experience. A friend of mine encouraged me to reach out to one of the PIs at the lab and I began working there right away. I

have always been interested in building a more energy efficient future for buildings and I believe that New York will be the one of the most challenging cities in the world to work on. If we can reduce building carbon emissions here through innovative technology and complex retrofits, then it can be done anywhere.

3. Where do you see your project going in the future, and/or how will working on this project help your career in academia and/or industry?

If we can utilize CO₂ as an effective refrigerant in multifamily heating and cooling, I hope that our research will result in the democratization of refrigerants which are currently expensive and have extremely high global warming potential. I hope to work in sustainably minded mechanical design for the foreseeable future, so being on the cutting edge will be invaluable.

4. What are your career ambitions?

I hope to be involved in the decarbonization of New York City's aging building stock, whether that's by working on creative solutions for retrofitting or by developing entirely new technology to do so.

5. What is an interesting fact about you?

I was in a band in high school that was signed to a major record label and appeared on MTV's "You Hear it First".

In the coming year, Geoffrey will be working on the BEST Center project "Sustainable Air Source Heat Pump Systems for Electrified Transition Markets in the Multi-Family Buildings Sector" with Prof. Jorge Gonzalez-Cruz and Prof. Prathap Ramamurthy. Student profiles are linked to on the [People](#) page of the BEST Center website.

Research Highlights

BEST Center Publications

- Zoltan Nagy, Gregor Henze, Sourav Dey, Javier Arroyo, Lieve Helsen, Xiangyu Zhang, Bingqing Chen et al. (2023). Ten questions concerning reinforcement learning for building energy management. *Building and Environment*, 110435. <https://doi.org/10.1016/j.buildenv.2023.110435>.

In this paper, we explore ten questions related to the application of reinforcement learning (RL) in buildings, specifically targeting flexible energy management. We consider the growing availability of data, advancements in machine learning algorithms, open-source tools, and the practical deployment aspects associated with software and hardware requirements. Our objective is to deliver a comprehensive introduction to RL, present an overview of existing research and accomplishments, underscore the challenges and opportunities, and propose potential future research directions to expedite the adoption of RL for building energy management.

Other Recent Publications

- Moncef Krarti (2023). Optimal optical properties for smart glazed windows applied to residential buildings. *Energy*, 278 Part B: 128017. <https://doi.org/10.1016/j.energy.2023.128017>.
- Moncef Krarti, D Ybyraiymkul, M Kum Ja, M Burhan, Q Chen, MW Shahzad, KC Ng (2023). Energy performance of hybrid evaporative vapor compression air conditioning systems for Saudi residential building stocks. *Journal of Building Engineering*, 69: 106344. <https://doi.org/10.1016/j.jobee.2023.106344>.
- Abdurahman S Alrobaie, Moncef Krarti (2023). Measurement and Verification Building Energy Prediction (MVBEP): An interpretable data-driven model development and analysis framework. *Energy and Buildings*, 295: 113321. <https://doi.org/10.1016/j.enbuild.2023.113321>.

- Mostafa Mohammadian, **Kyri Baker**, Ferdinando Fioretto (2023). Gradient-enhanced physics-informed neural networks for power systems operational support. *Electric Power Systems Research*, 223: 109551. <https://doi.org/10.1016/j.epsr.2023.109551>.
- EA Delesky, RJ Jones, JC Cameron, MH Hubler, **Wil V Srubar III** (2023). Hydrogel-assisted self-healing of biomineralized living building materials. *Journal of Cleaner Production*, 418 (139179). <https://doi.org/10.1016/j.jclepro.2023.138178>.
- Ondrea Kanwhen, **Ahmed Mohamed** (2023). Energy storage systems for commercial buildings in dense urban regions: NYC case study. *Energy Reports*, 10: 300-318. <https://doi.org/10.1016/j.egy.2023.06.023>.
- **Prathap Ramamurthy**, **Jorge Gonzalez**, Luis Ortiz, **Mark Arend**, Fred Moshary (2023). Impact of heatwave on a megacity: an observational analysis of New York City during July 2016. *Environmental Research Letters*, 12: 054011. <https://iopscience.iop.org/article/10.1088/1748-9326/aa6e59/meta>.
- Kaihui Zhao, Yonghua Wu, Jianping Huang, Guillaume Gronoff, Timothy A Berkoff, **Mark Arend**, Fred Moshary (2023). Identification of the roles of urban plume and local chemical production in ozone episodes observed in Long Island Sound during LISTOS 2018: Implications for ozone control strategies. *Environment International*, 174: 107887. <https://doi.org/10.1016/j.envint.2023.107887>.
- Irena A Weclawiak, Yong X Tao, Abdullah-Al-Raihan Nayeem, Isaac Cho, **Jorge E Gonzalez** (2023). Viability and accessibility of the Great Lakes microclimate data over current TMY weather data for accurate energy demand predictions. *Urban Climate*, 50: 101593. <https://doi.org/10.1016/j.uclim.2023.101593>.
- Ahmed Hunbus, Bandar AlMangour (2023). A Critical Review of Construction Using 3D Printing Technology. *Journal of Engineering for Sustainable Buildings and Cities*, 4(2): 020801. <https://doi.org/10.1115/1.4062730>.

Faculty and Building Industry News

Faculty News

- [Professor awarded Fulbright to explore cultural influences on smart technology adoption \(CU Boulder\)](#)

With growing concerns about climate change, a number of “smart” technologies have emerged to reduce energy consumption and decrease reliance on fossil fuels. While most engineers tend to focus on the technology, **Moncef Krarti** researches the acceptance of it.

Krarti recently received a Fulbright Global Scholar award to research these issues in Saudi Arabia and Australia — two distinct cultures with diverse climates and differing sustainability policies for buildings, he said. His research aims to understand the motivations behind whether individuals embrace smart technologies inside their homes, such as heating or air conditioning systems that automatically adjust the temperature inside and smart windows that adjust the tint based on solar heat levels.

- [CU Boulder professor receives Fulbright for holistic approach to indoor air quality \(CU Boulder\)](#)

Professor John Z. Zhai, an expert in building systems engineering and indoor air quality (IAQ) at CU Boulder, has been awarded a Fulbright Fellowship to address this issue in affordable housing in hot and humid climates. Zhai’s work will focus on not only the technical aspects but also the influence of cultural practices on indoor air quality.

From December to May 2024, Zhai will conduct research in three hot and humid countries: Indonesia, Thailand and Malaysia, with a goal to monitor house air quality conditions and analyze potential environmental and societal impact factors. The study will further develop mathematical models that predict indoor contaminant distributions and evaluate various mitigation strategies. His research will

particularly focus on affordable housing, a sector which often encounters more IAQ challenges due to lower budgets, poor design and inexpensive building materials.

IAB Member News

- [RHEEM® ENTERS RESIDENTIAL BOILER MARKET WITH NEW THERMAFORCE™ SUPER HIGH EFFICIENCY CONDENSING PLATFORM \(PR Newswire\)](#)

“Rheem®, a leading global manufacturer of water heating and HVACR products, announces the launch of ThermaForce™, a platform of super high efficiency condensing gas water heaters and boilers for the residential market. Comprised of combi boilers, boilers and tankless water heaters, ThermaForce can provide hot water for hydronic space heating applications including radiant floors, baseboards and hydronic air handlers as well as domestic hot water for sinks, showers, washing machines and more.”

- [Rheem Updates Sustainability Report \(ACHR News\)](#)

“Since Rheem launched its sustainability initiative, A Greater Degree of Good, in 2019, the manufacturer has implemented programs to provide more environmentally sustainable solutions in North America and abroad, the company said in a press release. Two of the case study examples included within the new report showcase Rheem’s Friedrich and IBC businesses.”

- [New Con Edison Battery System is the Largest in New York City \(Con Edison\)](#)

“Con Edison will place the largest battery system in New York City into service, increasing reliability in northeastern Staten Island just in time for the summer heat season, the company’s president said this morning.

The system, which is at a substation in the Fox Hills area, can hold 7.5 megawatts – that’s 7.5 million watts - and discharge that electricity to customers for four hours. That will take stress off Con Edison’s electric delivery system in the area when the demand for power is high, which occurs in the late afternoon and evening hours during the summer.”

- [Nokia deploys private LTE for Xcel Energy’s grid modernization in the United States \(Yahoo! Finance\)](#)

“Nokia today announced it will work with U.S. energy provider Xcel Energy to help modernize grid operations to better serve customers across the company’s eight-state service area. The project will include the deployment of Nokia private LTE network technology, helping support secure, reliable data connectivity and new levels of automation. The network technologies will back a growing mix of renewable power sources for Xcel Energy and optimize the delivery of electricity to its millions of customers.”

- [Xcel Energy offers free home energy audits to save on energy bills \(CBS Colorado\)](#)

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- [Flat Glass Market Report 2023-2028 | Global Size, Share, End Use Industry and Competitive Analysis \(Newswires\)](#)

“IMARC Group has recently released a new research study titled “Flat Glass Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2023-2028”, offers a detailed analysis of the market drivers, segmentation, growth opportunities, trends and competitive landscape to understand the current and future market scenarios.

The global flat glass market size reached US\$ 108.3 Billion in 2022. Looking forward, IMARC Group expects the market to reach US\$ 148.5 Billion by 2028, exhibiting a growth rate (CAGR) of 4.8% during 2023-2028.”

- [The Motorised Control Valves Market Size is Anticipated to Witness Remarkable Growth, With a CAGR of 6.3% Through the Year 2030 \(Yahoo! Finance\)](#)

“According to a market research study published by Zion Market Research, the demand analysis of Global Motorized Control Valves Market size & share revenue was valued at around USD 10.1 billion in 2022 and is estimated to grow about USD 16.2 billion by 2030, at a CAGR of approximately 6.3% between 2023 and 2030.”

- [City of Boulder Extends RTD's “Zero Fare for Better Air” to the Hop Bus Route \(City of Boulder\)](#)

“The City of Boulder is proudly partnering with the Regional Transportation District (RTD) to provide zero-fare services to encourage community members to travel by transit for cleaner air. RTD's “Zero Fare for Better Air,” a statewide initiative to help reduce harmful air pollutants by increasing use of transit, takes place July 1 through Aug. 31.”

- [DPS Collaborates with Group14 Engineering: a B Corp Certified Consultancy Firm Specializing in the Energy and Resource Efficiency of Building Design \(Denver Public Schools\)](#)

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- [Council on Tall Buildings and Urban Habitat Announces 2023 Lifetime Achievement Award Winners \(Architect Magazine\)](#)

“The Council on Tall Buildings and Urban Habitat, a global nonprofit for industry professionals and organizations that supports sustainable tall building design in urban environments, recently announced the winners of its 2023 lifetime achievement awards...The organization will also bestow the Fazlur R. Khan Lifetime Achievement Award upon Patrick Bellew, the founding director of global environmental design and engineering consultancy firm Atelier Ten, for his technical design work on tall building projects.”

- [WorldGBC Advancing Net Zero Status Report 2023 \(Atelier Ten\)](#)

“The World Green Building Council has released the fifth edition of the Advancing Net Zero Status Report and Atelier Ten is proud to be one of 175 signatories of the Net Zero Carbon Buildings Commitment.”

- [6 Technologies And Trends That Will Impact The Future Of Transportation \(Mead & Hunt\)](#)

“Railways, roadways, airways, waterways, and pipelines have been the primary traditional transportation modes for centuries! These modes have continued to evolve rapidly as technology advances and societal needs change. Advances including electric vehicles (EVs), autonomous vehicles, sustainability solutions, hyperloop technology, drones, and advances in urban planning are expected to make transportation safer, more efficient, and environmentally sound. Here are my predictions for how these trends and technologies will impact our transportation infrastructure moving forward.”

- [5 Ways Digital Twins Can Help The AEC Industry \(Mead & Hunt\)](#)

“Digital twins are a quickly-developing technology. Essentially, a digital twin is a digital representation of something in the real-world. The digital twin receives data from its real-world twin at regular intervals, making it an extremely useful tool to aid infrastructure management and development.”

Building Industry News

- [Case Study: The University of Iowa's FDD Program Spanning 7 Million Square Feet \(Nexus Labs\)](#)

“Iowa's FDD program began in 2014 and has gone through iterations as they've learned. They summarized the phases of the program as follows:

- Phase 1: We thought we could self-manage everything. Deployed 1-building pilot of on-prem solution where the team wrote their own faults. Learned a ton, decided they bit off more than they could chew, and changed course.
 - Phase 2: Released an RFP that outsourced more of the process, selected Clockworks Analytics, and deployed to the first 43 buildings in under a year.
 - Phase 3: Set up Analytics Resource Group (ARG) to integrate Insights into Operations and drive action. That's the focus of this case study.
 - Phase 4 (next phase): Getting front lines more involved and getting them to log in to the software more frequently in their day-to-day workflows."
- [The secret behind New York's most energy efficient new office building \(Fast Company\)](#)

"A typical office building in New York City uses huge amounts of energy for heating and cooling. A new 16-story office tower in Manhattan takes a Nordic-inspired approach that's fundamentally more efficient: One system, based on heat pumps and water-filled pipes, is designed to move heat where it's needed on each floor, between floors, and even to and from the building next door."

- [Heat Vision: "Thermometer in the sky" satellite can revolutionize building efficiency from space \(ZME Science\)](#)

"If you're trying to look at something at 500km (311 miles) away, the odds are you won't see much. But the HotSat-1 satellite has enough resolution to see individual rooftops and walls. Furthermore, it has sensors to see if the buildings are leaking heat and should be better insulated. It's the eye in the sky we need to make our buildings more efficient and eco-friendly."

- [German research institute unveils 99.74% efficient power electronics for solid-fuel heat pumps \(pv magazine\)](#)

"Germany's Fraunhofer Institute for Applied Solid State Physics (IAF) has developed an ultra-efficient circuit topology for voltage converters with an electrical efficiency of 99.74%. The tech could considerably raise the coefficient of performance for electrocaloric heat pumps and the scientists are now considering components based on semiconductor gallium nitride (GaN) for higher power density and efficiency."

Upcoming Conferences & Meetings

- [2023 ASHRAE Building Performance Analysis Conference, Austin, Texas, Sept 11-13, 2023](#)

"ASHRAE will host the annual Building Performance Analysis Conference September 11-13, 2023 at the Hyatt Regency Austin, in Austin, Texas. This will be the tenth consecutive ASHRAE modeling conference and 12th overall. Designers, Architects, Consulting Engineers, Building Owners, Principals of Firms, Researchers, Utility Providers, Policy Experts, Contractors and Facility Managers will address the practices of energy modeling and building performance simulation using existing simulation tools, software development and future simulation research and applications."

Amanda O'Donnell (CUNY Building Performance Lab) will be presenting the results of the BEST sponsored project titled *Energy-Reduction M&V using Calibrated Simulation (IPMVP Option D)* during the conference (*Generating Energy Models of Existing Buildings using Open Data*, Seminar 9: Modeling Existing Buildings I). A copy of the presentation is currently available to IAB Members in the members-only section of the BEST Center website.

- [Intelligent Building Operations Workshop \(IBO-Boulder 2023\), Boulder, Colorado, Sept 28-29, 2023](#)

“IBO-Boulder will gather practitioners and researchers to discuss how the building control community can bridge the abyss from algorithms to applications and will be hosted by RASEI (the Renewable and Sustainable Energy Institute between the University of Colorado and the National Renewable Energy Laboratory) in Boulder, Colorado.

IBO-Boulder will be a two-day event covering successful business offerings available today, field demonstrations of intelligent building systems, barriers to adoption, and where researchers, educators, and funders can direct their efforts in the future. The purpose of this workshop is to enable a platform for lively exchange among building science and energy system practitioners and researchers and to allow for feedback early on in multi-year research endeavors.”

Please contact **Prof. Gregor Henze** (gregor.henze@colorado.edu) to inquire about registration and being added to the invite list.

- [2023 Decarbonization Conference for the Built Environment](#), Washington DC, Oct 25-27, 2023

“The conference will focus on educating attendees on methods to decrease carbon emissions, both embodied and operational, in order to reduce the impact of buildings on the climate crises. The conference program will address current and future governmental policies and regulations for which engineers, architects, owners and operators need to be aware of to address environmentally-responsible building requirements.”

- [10th ACM International Conference on Systems for Energy Efficient Buildings, Cities, and Transportation \(BuildSys '23\)](#), Istanbul, Turkey, Nov 15-16, 2023

“Advances in the effective integration of networked sensors, building controls, and physical infrastructure are transforming our society, allowing the formation of unprecedented built environments and interlocking physical, social, cyber challenges. Moreover, built environments, including buildings and critical urban infrastructure, account for over half of society's energy consumption and are the mainstay of our nation's economy, security and health. As a result, there is a broad recognition that systems optimizing explicitly for the built environment are particularly important in improving our society, and represent the foundation for emerging "smart cities"”

Important Dates: 7/10/2023: Abstract registration, 7/17/2023: Paper submission due

- [ASHRAE 2024 Winter Conference](#), Chicago, IL, Jan 20-24, 2024

Nick Clements will be attending both technical committee meetings and the AHR Expo for networking with prospective IAB members.

Important Dates: 8/2/2023: Debate, Panel, Seminar, Forum, Workshop, and Debate Proposals Due

- [2024 ASHRAE International Conference on Building Decarbonization](#), Madrid, Spain, Apr 17-19, 2024

“This 3rd ASHRAE topical conference provides a unique opportunity for professionals to share information, exchange ideas and collaborate on the design, construction, ownership and operation of facilities that have a minimal or neutral impact on the environment in terms of carbon footprint. Our primary objective is to enrich the knowledge base while fostering global collaborations in decarbonization efforts, ultimately leading to a sustainable future for our planet. Join us at this groundbreaking event and be a part of the solution towards a greener, more sustainable built environment.”

Important Dates: 9/11/2023: Abstracts due; 12/11/2023: Paper manuscripts due

- [IBPSA-USA SimBuild 2024](#), Denver, CO, May 21-23, 2024

“SimBuild 2024 marks the 20th anniversary of the first SimBuild conference, held in 2004. The theme of the conference is “Celebrating Two Decades of SimBuild.” Join us as we commemorate IBPSA-USA's

contributions to sustainability and building performance simulation and look toward the future. The program will highlight the work of IBPSA-USA and its members and provide a platform to envision the future of simulation, as we explore emerging technologies, trends, and strategies that will continue to drive building performance excellence in the years ahead.”

Important Dates: 8/7/2023: Extended abstracts due

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