Building Energy Smart Technologies (BEST) Center

Fall 2026 Industry Advisory Board Meeting
November 16, 2026

Welcome from the Leadership Team

Thank you for attending the BEST Center's Fall 2026 Industry Advisory Board (IAB) Meeting. We hope you enjoy the discussions with students and colleagues and the updates from ongoing research projects. This is a hybrid meeting, and we welcome everyone joining us in person in Boulder, CO or Albany, NY, as well as those joining remotely.

The morning session will start with a welcome and keynote from Jay Wratten, Executive Director at WSP, titled "*AI is Here. Now What? Moving from Experimentation to Meaningful Impact in the Built Environment*", followed by FY26-27 research project progress presentations. The afternoon session includes an update on the Future of BEST Center and a brainstorming session for FY27-28 research project topics. Students and board members will then participate in a one-on-one interview session, and we will wrap up in closed session with our IAB from 3-4PM MT (5-6PM ET).

The BEST Center is an NSF Industry-University Cooperative Research Center (IUCRC) dedicated to advancing innovative technologies that improve energy efficiency, sustainability, and intelligent operation of buildings, communities, and cities. The Center brings together university researchers and industry partners to conduct collaborative, industry-driven research addressing critical challenges in building energy systems and technologies. BEST operates through two university sites, the University of Colorado Boulder (CU Boulder) and the City College of New York (CCNY), with the University at Albany being an affiliate university. Research activities are guided by the IAB, comprising manufacturers, utilities, engineering firms, and other stakeholders who identify research priorities, select and fund projects, and facilitate the commercialization of research outcomes. Through this structure, BEST fosters innovation, strengthens industry-university partnerships, advances building energy technologies, and trains students to pursue careers in the building sciences.

We thank all the people who made this event possible, and thanks to all our industry partners, faculty, students, and guests for attending.

Best,
Moncef Krarti, BEST Center Executive Director
Nicholas Clements, BEST Center Manager
Ahmed Mohamed, BEST CCNY Site Director
John Zhai, BEST CU Boulder Site Director
Jorge Gonzalez-Cruz, University at Albany

BEST Center Industry Advisory Board Members and Affiliates

Full Members

Associate Members

Affiliates

Meeting Information

Registration
All attendees, including faculty, students, IAB members, and guests must register:

- **Registration Link** (Eventbrite)

Location
Boulder, CO: SEEC Building, Room S372AB, **Google Maps Link**
Albany, NY: ETEC Building, Room 368, **Google Maps Link**
Remote Zoom Link: **https://cuboulder.zoom.us/j/6356894174**

November 16, 2026

Agenda	
8–8:30AM MT (10-10:30AM ET)	**Breakfast and Networking**
8:30-9:15AM MT (10:30-11:15AM ET)	**Welcome and Keynote** Jay Wratten, Executive Director at WSP *AI is Here. Now What? Moving from Experimentation to Meaningful Impact in the Built Environment*
9:15-11AM MT (11:15-1PM ET)	**FY26-27 Project Presentations**
9:15-9:30AM MT (11:15-11:30AM ET)	BEST26-01: An Open-Source Digital Twin Framework for Electrification Retrofit Analysis of Existing Buildings, Faisal Alghmadi, Moncef Krarti, (CU Boulder)
9:30-9:45AM MT (11:30-11:45AM ET)	BEST26-02: Advancing Low-GWP Air-Source Heat Pump Systems for Cold-Climate Multifamily and Light Commercial Buildings: Digital-Twin & Field Deployment, Jorge Gonzalez-Cruz, Geoffrey Turbeville (UAlbany), Moncef Krarti (CU Boulder)
9:45-10AM MT (11:45-12PM ET)	BEST26-03: Development of an Integrated Cost–Benefit and Capital Impact Assessment Tool for AC and DC Power Distribution Systems for Commercial Buildings and Data Centers, Eric Ohene, Moncef Krarti, Nicholas Clements (CU Boulder)
10-10:15AM MT (12-12:15PM ET)	BEST26-04: Decarbonizing Space Heating through Seasonal Thermochemical Energy Storage, John Zhai (CU Boulder), Wentao Wu (Massey University)
10:15-10:30AM MT (12:15-12:30 PMET)	BEST26-05: Heating Electrification Optimization Tool, Phani Vadali, Moncef Krarti (CU Boulder), James Zarske (BAE Systems, Inc.)
10:30-10:45AM MT (12:30-12:45PM ET)	BEST26-06: Evaluation of Overclad Insulated Panels for Building Retrofits, Kylie Rozzell, Moncef Krarti, Eric Ohene (CU Boulder), James Zarske (BAE Systems, Inc.)
11-12PM MT (1-2PM ET)	**Lunch**
12-12:30PM MT (2-2:30PM ET)	**Future of the BEST Center Discussion**
12:30-2:30PM MT (2:30-4:30PM ET)	**FY27-28 Research Topic Brainstorming Session**
2:30-3PM MT (4:30-5PM ET)	**One-on-One Interview Session (IAB and students)**
3-4PM MT (5-6 PM ET)	**IAB Closed Meeting (IAB only)**

Keynote Speaker Biography and Abstract:

Jay Wratten
Executive Director
U.S. Digital Lead and Global Smart Places Lead
WSP



Jay Wratten is an Executive Director at WSP, where he serves as U.S. Digital Lead and Global Smart Places Lead. His career has evolved from lighting design and engineering into technology-enabled design, innovation advisory, and enterprise digital leadership. Today, he focuses on helping WSP and its clients translate emerging technologies into practical solutions and measurable business outcomes.

Jay's work spans digital strategy, smart infrastructure, digital twins, artificial intelligence, data and analytics, and technology-enabled project delivery. He works across disciplines, markets, and technology partners to connect innovation with real-world challenges and create new approaches to the way infrastructure and the built environment are designed, delivered, and operated.

FY2026-2027 Research Project Executive Summaries

BEST26-01: *An Open-Source Digital Twin Framework for Electrification Retrofit Analysis of Existing Buildings*

Faisal Alghmadi, Moncef Krarti (CU Boulder)

The U.S. building sector accounts for approximately 40% of national energy consumption and 35% of CO2 emissions [1-4]. Achieving decarbonization requires deep energy retrofits and building electrification renovations. Building owners have access to growing operational data (BMS, IoT, utility meters) yet lack tools to translate this data into data-driven retrofit and electrification decisions. Recent advances in Large Language Models and agentic AI enable autonomous model calibration, multi-objective scenario analysis, and natural language decision support technologies that can radically democratize access to digital twin capabilities for the building industry. Digital twin technology offers a solution by creating virtual building replicas that are continuously calibrated against measured performance and used to simulate interventions. However, current implementations are proprietary, expensive, and require specialized expertise, limiting adoption.

This project proposes an open-source, data-driven digital twin framework that integrates measured building data with physics-based and machine learning models to provide systematic retrofit and electrification analysis. The PI has already developed a working prototype (TRL-3) with web-based 3D visualization, BIM/IFC parsing, video-to-3D reconstruction, building envelope characterization, multiple simulation engines (RC, EnergyPlus, Modelica, ML), and real-time sensor integration. This proposed project advances the platform to TRL-5 by implementing automated model calibration, retrofit analysis, standardized M&V procedures, and validation against a CU Boulder campus building.

BEST26-02: *Advancing Low-GWP Air-Source Heat Pump Systems for Cold-Climate Multifamily and Light Commercial Buildings: Digital-Twin & Field Deployment*

Jorge Gonzalez-Cruz (University at Albany), Geoffrey Turbeville (University at Albany)

Buildings in cold and mixed climates face persistent barriers to full electrification of space heating and cooling, particularly in multifamily and light commercial buildings with existing hydronic infrastructure. Conventional air-source heat pumps often struggle to deliver reliable low-temperature heating, acceptable seasonal efficiency, and practical retrofit solutions, while most commercially available systems rely on high-global warming potential (GWP) synthetic refrigerants. These challenges are especially acute in dense urban markets subject to aggressive decarbonization mandates.

This project proposes a full field demonstration of a dual-mode air-source heat pump architecture providing space heating and cooling using carbon dioxide (CO_2, R-744) as a natural refrigerant (GWP = 1). The system operates on a transcritical CO_2 cycle and has already undergone extensive laboratory testing for heating operation, demonstrating stable performance and reasonable coefficients of performance (COP) in heating mode at outdoor temperatures as low as 6° F (refer to Appendix). Cooling operation will be supported by targeted laboratory capability developed in parallel with early project activities and completed prior to field deployment. As a result, the proposed work focuses on deployment-relevant validation under real-world operating conditions rather than fundamental feasibility testing.

The core of the project is a 1-2 apartment-scale multifamily building field demonstration implemented in partnership with BEST Center member Rheem and the local small business ReWire, with emphasis on system packaging, controls integration, and installation practicality. A building-specific digital twin will be developed for the demonstration site and used to predict heating and cooling performance, energy use, and operating behavior. Measured field data will be used to validate and refine the digital twin, providing high-confidence evidence of system performance and establishing a transferable framework for commercialization. The project will also document retrofit processes and occupant perspectives on the technology, providing a practical basis for commercialization in terms of performance, cost, and usability. This effort directly addresses BEST Center priorities by reducing commercialization risk for low-GWP heat pump technologies and generating actionable data for manufacturers and building owners.

BEST26-03: *Development of an Integrated Cost–Benefit and Capital Impact Assessment Tool for AC and DC Power Distribution Systems for Commercial Buildings and Data Centers*

Eric Ohene, Nicholas Clements, Moncef Krarti (CU Boulder)

Electrical power distribution systems in buildings and data centers are undergoing rapid transformation driven by the proliferation of direct current (DC) energy sources and DC-native technologies. Modern buildings increasingly integrate DC-internal systems such as photovoltaic (PV) arrays, battery storage, solid-state lighting, and electronic devices [1,2]. Similarly, data centers, critical infrastructure supporting digital services, rely heavily on DC-based equipment where efficiency, reliability, and operational cost reductions are essential [3,4].

Despite this shift, conventional electrical infrastructures remain predominantly alternating current (AC)-based. This mismatch requires multiple power conversion devices, leading to efficiency losses, increased system complexity, and higher costs [5,6]. DC distribution systems have therefore emerged as promising alternatives capable of reducing AC-DC power conversion losses and improving system performance. A simulation study by Gerber et al. (2018) considered buildings with solar generation and battery storage, suggesting a medium-sized office could achieve 12-18% energy savings by converting AC to DC power [7]. Residences modeled by Glasgo et al. (2016) could save 9-20% when converted to DC and connected to PV, increasing to 14-25% with battery storage integrated [8].

While technical benefits are well documented, economic evaluation methodologies remain fragmented. Existing studies primarily emphasize efficiency analysis or lifecycle cost comparisons under case-specific assumptions [10,11]. Key gaps persist, including domain-specific assessment approaches, incomplete quantification of soft costs and reliability considerations, and limited assessment of capital investment impacts [9,12].

This study addresses these gaps through the development of an Integrated Cost–Benefit and Capital Impact Assessment Tool for DC power distribution systems in buildings and data centers. The proposed tool will integrate lifecycle cost analysis, performance metrics, and capital investment assessment within a unified decision-support platform, enabling standardized comparison of DC and AC alternatives. The outcomes of this proposed project will support evidence-based infrastructure planning, technology adoption decisions, and long-term capital investment strategies.

BEST26-04: *Decarbonizing Space Heating through Seasonal Thermochemical Energy Storage*

John Zhai (CU Boulder), Wentao Wu (Massey University)

This project will develop a salt hydrate-based and modular heat battery integrated with solar energy production and building HVAC systems. The feasibility and performance of the proposed system will be assessed through an experimental platform including a thermochemical reactor, a concrete slab embedded with water pipes, and a water tank to mimic built environment.

Harnessing renewable energy like solar for space heating constitutes an essential step toward the 2050 carbon neutrality target [1]. A challenge to use solar is the seasonal mismatch between heating demand in winter and prevalent solar production in summer. A promising technology to achieve a seasonal shift of the surplus solar production is thermochemical energy storage (TCES) [2]. In summer, the hydrous salt (e.g., SrBr2.6H2O) is heated and dehydrated by solar energy and thermal energy is stored in the anhydrous salt. In winter, the water vapor hydrates the anhydrous salt to discharge the thermal energy for space heating.

Current TCES are categorized as open and closed systems [3-4]. Open system uses moist air for hydration that suffers poor mass and heat transfer. Closed system uses water vapor for hydration. The honeycomb heat exchanger improves heat transfer, but generation of water vapor consumes significant electricity. Moreover, salt hydration features with fast heat release during the first couple hours of reaction [5]. The intensive peak thermal power makes it challenge to be directly integrated with conventional building HVAC systems. Is there a compatible building HVAC system for salt hydrate-based heat storage? State-of-the-art research on TCES focuses on optimum material selection and reactor design to improve heat and mass transfer [6]. Limited work has been conducted to assess the feasibility, application and performance at the building system level [7-8].

The objectives of this project include: 1) developing a modular heat battery using moist air for hydration to save energy and honeycomb to enhance local heat transfer; 2) integrating the heat battery with ventilation and thermally activated building system that embeds water pipes in building envelopes to facilitate the short-term heat storage in building thermal mass; 3) developing models to assess the feasibility and application of the salt hydrate-based heat battery integrated with solar energy production and building HVAC systems.

BEST26-05: *Heating Electrification Optimization Tool*

Phani Vadali, Moncef Krarti (CU Boulder), James Zarske (NORESCO)

As an energy transition strategy to shift to clean energy sources, electrification of buildings is being required by several US cities and states [1-3]. However, building electrification has led to increased demand for the electrical grids and utilities, especially in regions with cold climates and high space heating needs. Indeed, electrification of buildings is expected to double electricity consumption and triple electrical peak demand in the US requiring costly expansion of renewable generation and grid infrastructure [4]. Therefore, cost-effective electrification solutions are needed for wide adoption by owners as well as utilities while maintaining safe, healthy, and comfortable indoor environments [4].

Experience has indicated that electrification is more challenging for existing than new buildings. Replacement existing fuel-based heating systems with electric alternatives may require several technical, economical, and practical difficulties to be addressed [5]. In addition to the high initial

capital costs, electrified heating systems also require additional space and higher electric power capacities. Furthermore, electrification of buildings requires better trained HVAC designers as well as electrical engineers and operation professionals to ensure robustness and reliability. Several electrical heating systems are available with various energy efficiency ratings and implementation cost levels including air source heat pumps, water source heat pumps, ground source heat pumps, and variable refrigerant flow systems. Unfortunately, there are no clear guidelines available to assist professionals on how to choose the best heating systems for electrification retrofit of both residential and commercial buildings. Thus, a systematic evaluation tool is needed to optimize the selection of heating systems suitable for retrofit analysis.

This project aims to extend the capabilities of an existing retrofit analysis tool, SABER, to explore different cost optimal electrification strategies for residential and commercial buildings. The tool will identify the best retrofit measure package along with the appropriate choice of heating system considering the building type and its location as well as the desired optimization objectives and implementation constraints.

BEST26-06: *Evaluation of Overclad Insulated Panels for Building Retrofits*

Moncef Krarti, Eric Ohene (CU Boulder), James Zarske (NORESCO)

It is estimated that more than 50% of US existing buildings were constructed before 1980 [1]. However, it is reported that only 2% of these buildings are retrofitted with only improvements of energy systems other than building envelope elements. The main hindrances of retrofitting building envelopes include high costs, renovation complexity, and occupant disturbance even though opaque facades are responsible for over 25% of building energy use equating to 10% of total US primary energy demand [2,3]. In the last two decades, overclad prefabricated insulated panels have been considered in Europe to facilitate adding thermal insulation to existing opaque facades through the Energiesprong initiative [4]. Some prefabricated insulated panels manufactured in Europe including their installation approaches have been reviewed recently by Biega and Krarti [5].

In the US, however, commercially available products for prefabricated overclad insulated panels are very limited. Indeed, the only available product is a type of structural insulated panel (SIP) that requires removal of the existing building façades prior to installation [5]. The main technical challenges to develop prefabricated overclad insulated for existing US building stocks especially for residential applications include: (i) light wood construction in the US has minimal additional structural load capacity [6], (ii) the US has significantly more climate zones that Europe [6], (iii) nearly every US building is unique and architectural styles vary widely [5], and (iv) decentralized codes throughout the US make it difficult to standardize products.

Some reported studies have emphasized the need for the development and commercialization of low-cost and flexible facade cladding systems to achieve the desired thermal performance of insulated panels, especially for climates with high energy demands for heating and cooling [7,8]. It has been noted that optimizing cladding systems can lead to improved energy efficiency, enhanced indoor environmental quality, and reduced greenhouse gas emissions [9,10]. In this proposed project, an evaluation analysis is considered to review potential cladding systems suitable for integration with insulated panels with the aim of identifying technologies that could be considered for performance testing under laboratory conditions.